Federal Democratic Republic of Ethiopia
Ministry of Education
Special Capacity Building Training Program for Secondary School Teachers

Mathematics Trainees' Module

June, 2024
Ministry of Education
Addis Ababa

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Part I- Teaching Chemistry Trainees' Module

Developer:

1. Abera Abate (PhD)
2. Berie Getie (MSc)

Part II- Educational Technology-EdTech

1. **Developer:** Inku Fasil
2. **Reviewer:** Alemu Tesfaye

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Part I- Teaching Mathematics

Module Introduction

The basis for the change of the secondary school (Grade 9-12) Math curricula was based on MoE national assessment of the study done by the Cambridge international (2019). The study figured out major drawbacks in Math Education: lack of relevance of contents; Prevalence of difficult and overloaded contents in the text book; Absence of interactive learner-centered methodologies; Absence of proper implementation of continuous assessment and lack of elements of 21st century skills like collaboration have been affecting students' performance, interest towards the subject, and the quality of education in general.

After discussing the strengths & weaknesses of the existing Math curriculum. the new Ethiopian general education Math curriculum is developed. Secondary education learning themes were designed for all grades (grades 9-12); 9 units for G-9, 7 Units for G-10, 8 Units for G-11 and 5 Units for G-12 was outlined; Math for social science as well as natural science was merged together for G-11 & 12; Periods for each unit is given; The content flow chart (CFC) formulated; minimum learning competence (MLC) for each title is developed; Learning strategies and evaluation techniques suggested. Finally, after these preliminary activities, both the ST and TG are developed.

Thus, the following is the main difference between new and old mathematics content flow chart:

New Math CFC	Old Math CFC
Grade 9	
Unit 1': Further on Sets	Unit 1: The number System
Unit 2: The number System	Unit 2: Solving of Equations
Unit 3: Solving of Equations	Unit 3: Further on Sets
Unit 4: Solving inequalities	Unit 4: Relations and Functions
Unit 5: Introduction to Trigonometry	Unit 5: Geometry and Measurement
Unit 6: Regular Polygons	Unit 6 Statistics and Probability
Unit 7: Congruency and Similarity	Unit 7: Vectors in Two Dimensions
Unit 8: Vectors in two dimensions	
Unit 9: Statistics and Probability	
Grade 10	
Unit 1: Relations and Functions	Unit 1: Polynomial Functions
Unit 2: Polynomial Function	Unit 2: Exponential and Logarithmic Functions
Unit 3: Exponential and Logarithmic Functions	Unit 3: Solving Inequalities
Unit 4: Trigonometric functions	Unit 4: Coordinate Geometry
Unit 5: Circles	Unit 5: Trigonometric Functions
Unit 6: Solid figures	Unit 6: Plane Geometry

New Math CFC	Old Math CFC
Unit 7: Coordinate Geometry	Unit 7: Measurement
Grade 11	
Unit 1: Relations and Functions	Unit 1: Further on Relation and Functions
Unit 2: Rational Expressions & Rational Functions	Unit 2: Rational Expressions and Rational Functions
Unit 3: Matrices	Unit 3: Coordinate Geometry
Unit 4: Determinants and their properties	Unit 4: Mathematical Reasoning
Unit 5: Vectors	Unit 5: Statistics and Probability
Unit 6: Transformation on the Plane	Unit 6: Matrices and Determinants
Unit 7: Statistics	Unit 7: The Set of Complex Numbers
Unit 8: Probability	Unit 8: Vectors and Transformation of the Plane (For NS Students)
	Unit 9 Further on Trigonometric Functions (For NS Students)
	Unit 10 Introduction to Linear Programming (For SS Students)
	Unit11 Mathematical Applications in Business (For SS Students)
Grade 12	
Unit 1: Sequences and Series	Unit 1: Sequences and Series
Unit 2: Introduction to Calculus	Unit 2: Introduction to Limits and Continuity
Unit 3: Statistics	Unit 3: Introduction to Differential Calculus
Unit 4: Introduction to Linear Programming	Unit 4: Applications of Differential Calculus
Unit 5: Mathematical Applications in Business	Unit 5: Introduction to Integral Calculus
	Unit 6 Three-Dimensional Geometry &Vectors in Space (For NS Students)
	Unit 7 Mathematical Proofs (For NS Students)
	Unit 8 Further on Statistics (For SS Students)
	Unit 9 Mathematical Applications for Business & consumers (For SS Students)

The students' textbook is also **"unitized,"** that is, divided into respective lessons with the principle of "one lesson, one topic" while each one lesson is basically composed of four components: **Activity, Definition/Theorem/Note, Examples and Exercises (ADEE, or DEE or EE)**

The trainees are advised to follow the four components of each lesson and provide the required assistance to the students regularly. For detailed discerption of the four components of each lesson refer mathematics students' text book "**Introduction about the Students' Textbook**".

Thus, this training module can be considered as part of the TPD and developed based on national survey conducted by MoE collected from trainees that they have difficulty to teach mathematics content at each grade level from grade 9-12.

Purpose of the module

This training Module on Mathematics Education for trainees is aimed to:

- ❖ Provide content and pedagogical knowledge to trainees based on new mathematics curriculum.
- ❖ Provide trainees with opportunities to explore their own values, attitudes and knowledge regarding the new mathematics curricula;
- ❖ Provide trainees with opportunities to use the knowledge and skills acquired during training to promote appropriate conceptual understanding of mathematics

Pedagogical Approaches

Active and participatory teaching/learning approaches are employed throughout the module. Activities are mainly experiential in nature, and trainees are required to actively engage as participants in all of the lessons. In particular, the following pedagogical approaches are employed.

Problem-based Learning (PBL): Problem-based learning develops trainees' critical thinking and problem-solving skills. It is a highly structured, cooperative learning mode to enhance both individual and collective knowledge by engaging teacher trainees' in critical and deep enquiry of real-life problems.

Real-life applications: Real-life applications are essential visualization techniques in mathematics teaching and learning. A typical goal of school mathematics courses is the ability to relate mathematics to real life (Gravemeijer & Terwel, 2000; NCTM, 2000).

Trainees have to strive to make mathematics more alive, realistic, and accessible. They have to encourage more individuals to learn mathematics by making it more alive, even though it is a difficult subject. They to demonstrate why mathematics is needed in everyday life by making it more realistic. They have to make mathematical problem-solving skills accessible to as many students as possible by making it more accessible, even if everyone has varied potential and prospects in this area of mathematics. They frequently employ real world problems in our schooling to put our beliefs into reality. It's crucial to remember that these problems are typically complex, requiring a wide variety of knowledge and experience to handle (Agata, 2000; Blum, 2002).

Real-life mathematical applications are frequently recommended as a strategy to motivate trainees. It can also help students understand mathematical concepts better, motivate them, and improve their attitudes toward mathematics (Gainsburg, 2008).

Examples and non-examples: Trainees' visual abilities in mathematics are developed through examples and non-examples. Examples are an important aspect of mathematical thinking, learning, and teaching, especially when it comes to conceptualization, generalization, abstraction, argumentation, and analogical reasoning. Non-examples that are related with conceptualization and definition and help to emphasize essential elements of a concept are also included in our study of examples. Non-examples can help to clarify distinctions and provide a deeper knowledge of mathematical concepts. Non-examples and examples can appear anywhere in a unit or lesson, but they're most commonly utilized to introduce new concepts. Using examples allows students to generalize concepts and identify connections between related concepts. Non-examples, on the other hand, educate students how to distinguish between ideas and concepts so that they do not repeat them.

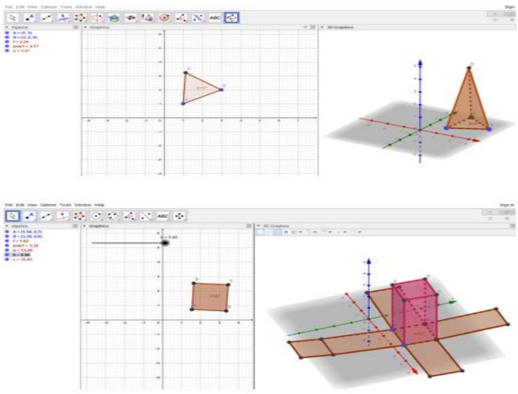
Guided Discovery Method: Under this approach, the trainee assists the students either through the art of questioning or by explaining to them what they are to do or in the recall and/or the application of relevant principles; the trainee then allows them to work on their own, carrying out the activities designed for the period. With the appropriate guidance provided by the trainee, the students usually discover the concept to be learnt; or the generalization to arrive at. We should be clear here that the trainee guides the students and does not simply provide the solution to them.

Questions and Answering Method of Teaching: The question-answer teaching method focuses on asking students to answer sets of questions in replacement of lecturing. The designed questions should encourage and challenge students to correct their misconceptions and understand the concept by themselves. Students are required to express and discuss their own ideas with other students and instructor. The instructor needs to provide opportunities and prompt students to answer the questions by conducting discussions while controlling the scope of discussion to not go off the topic

Manipulative: Visualization techniques in mathematics include manipulatives like real objects or models, as well as paper folding. Manipulatives are actual things that trainees can see and manipulate to teach or represent abstract mathematical concepts. Tangrams, cubes, and base-ten blocks are among the colorful shapes and objects featured.

According to learning theory, mathematical understanding in young children is tightly linked to sensory perception and real experience. After experiencing the ideas on a physical level, students learn to understand symbols and abstract concepts. Manipulatives are useful tools in mathematics because they assist trainees' progress from a concrete to an abstract understanding. Trainees who see, touch, sort, disassemble, and manipulate physical objects create clearer mental images and can better express abstract ideas than those who have fewer concrete experiences. Trainees who learn mathematics through manipulative experiences are more likely to bridge the gap between their everyday lives and the abstract world of mathematics.

GeoGebra Software: GeoGebra is a frequently used software program in mathematics classrooms (Tatar & Zengin, 2016). GeoGebra is notable for combining the properties of both Computer Algebra Systems (CAS) and Dynamic Geometry Environments (DGE) into a single software package. This software allows users to visualize any mathematical object in its algebraic, graphical, and spreadsheet forms at the same time. As a result, using GeoGebra helps students have a deeper understanding of intended mathematics topics. Furthermore, math education studies found that successful use of GeoGebra helped and improved students' conceptual understanding and performance in a range of mathematics courses, including geometry and algebra. The below figure show snapshots taken by using GeoGebra software.



Multiple representations: Duval (2006) claims that representations are necessary to express meaning extracted from or evident from mathematical objects and concepts, regardless of their form. Trainees can visualize (for instance, through diagrams and graphs) mathematical concepts, create connections, and develop new ideas, for instance, by using different representations. Through exercises with multiple representations, including different forms of expression, trainees develop their mathematical illustration skills and get a deeper understanding of mathematics (e.g., speaking, writing). Trainees and students may have a clear understanding of how to solve a mathematical problem with multiple representations. Graphs, tables, pictures, and written explanations are examples of multiple representations that can help students visualize the bigger picture of a mathematical task. However, if trainees and students are unfamiliar with solving problems using multiple representations, understanding mathematical concepts may be difficult.

Case Study: Case studies are often real-life stories that describe in detail what happened to an individual, family, school or community. Case studies are powerful catalysts for thought and discussion. The case study method involves an in-depth examination of a single instance or event. This method helps student teachers make use of real-life incidents to see how theoretical knowledge might be applied to real cases. Case study offers a systematic way of looking at the events, collecting data, analyzing information, and reporting the results, which in return supports enquiry learning among student teachers. Student teachers are able to gain a deeper and more thorough understanding of why the events or instances happened as they did

Brainstorming: In brainstorming, student teachers actively generate a broad variety of ideas about a particular topic or question in a given, often brief period of time. Quantity of ideas is the main objective of brain-storming. Evaluating or debating the ideas occurs later. Brainstorming allows student teachers to generate ideas quickly and spontaneously. It helps them use their imagination and break loose from fixed patterns of response

Class discussion (in small or large groups): In class discussion, the class examines a problem or topic of interest with the goal of better understanding an issue or skill, reaching the best solution, or developing new ideas and directions for the group. Class discussion provides opportunities for trainees to learn from one another and practice turning to one another in solving problems. It also enables trainees to deepen their understanding of the topic and personalize their connection to it. Class discussion helps trainees develop skill in listening, assertiveness, and empathy.

Assessment Recommendations

To ensure that the trainees have acquired the relevant knowledge, skills and attitudes, both formative and summative assessment techniques will be employed. Process evaluation will be carried out to appraise the implementation of the curriculum. This will help to identify challenges and successes on the delivery of the module, trainees' receptivity and administrative support. Findings will identify areas for improving the curriculum and its delivery. End of course assessment will also be administered to gain a summative appraisal of the module.

To have information about the impact, a follow-up evaluation will be conducted on trainees after they have completed the training and after a reasonable time has elapsed. The follow-up may be conducted using a questionnaire.

This module is prepared based on the national Technical Teams framework for Summer-Based Special Teacher professional development for school Teachers. The module consist eleven units. The objectives, activities, key ideas and some implications for teaching are identified as follows.

- Each topic is linked to specific learning objectives which state the intended outcomes of working on particular topics. Learning objectives are defined and stated in the way the section can be implemented.

- Activities are provided to allow participants to be engaged in learning about the topics raised

- The topics are followed by key notes, which provide description or explanation for each major issue to be addressed. It provides answer to questions that may be raised by trainees teaching mathematics.

- Implications of each topic are incorporated to indicate the conclusions that can be drawn from the sessions. This could be put either in the form of questions and/or in the form of specific recommendations.

Structure of the Module

Unit 1: Problem-solving-based Mathematics Instruction (4 hrs.)

Session1. 1: Why and how of teaching through problem-solving (1 hr.)

Session 1.2: Nature of problem-solving tasks (1 hr.)

Session 1.3: Lesson Structure of problem-solving based approach (2 hrs.)

Unit 2: Teaching Relations and Functions (G10, G11) (12 hrs.)

Session 2.1: Teaching the concept of relation (4 hrs.)

Session 2.2: Teaching the concept of Function (2 hrs.)

Session 2.3: Teaching Power Functions (4 hrs.)

Session 2.4: Teaching Composition of Functions (2 hrs.)

Unit Summary

Unit 3: Teaching Polynomial Functions and Rational functions (G11) (5 hrs.)

Section 3.1: Teaching polynomial functions (2 hrs.)

Section 3.2: Teaching rational functions (3 hrs.)

Unit Summary

Unit 4: Teaching Exponential and Logarithmic Functions (G10) (9 hrs.)

Session 4.1: Teaching Exponents Functions (2 hrs.)

Session 4.2: Teaching Graphs of Exponential Functions (2 hrs.)

Session 4.3: Teaching Logarithmic Functions (2 hrs.)

Session 4.4: Teaching Graphs of Logarithmic Functions (3 hrs.)
Unit Summary

Unit 5: Trigonometric Functions (G9, G10) (9 hrs.)

Session 5.1: Teaching trigonometric Ratios based on right angled triangle (3 hrs.)

Session 5.2: Teaching trigonometric Values of different angles (3 hrs.)

Session 5.3: Teaching graphs of sine, cosine and tangent functions (3 hrs.)

Unit Summary

Unit 6: Teaching Coordinate Geometry and Solid Figures (G10) (9 hrs.)

Session 6.1: Teaching Distance between Two Points (2 hrs.)

Session 6.2: Teaching Division of a Line Segment (2 hrs.)

Session 6.3: Teaching Solid Figures: Prisms and Cubes (2 hrs.)

Session 6.4: Teaching Solid Figures: Cylinders and Cones (3 hrs.)

Unit Summary

Unit 7: Teaching Vectors (G11) (4 hrs.)

Session 7.1: Teaching Vectors and their representations (2 hrs.)

Session 7.2: Teaching Vector cross product and its applications (2 hrs.)

Unit Summary

Unit 8: Teaching Transformations on the Plane (G11) (7 hrs.)

Session 8.1: Teaching line Translation (2 hrs.)

Session 8.2: Teaching Reflection of a circle in the line (2 hrs.)

Session 8.3: Teaching Rotation when the center of rotation is about the point (3 hrs.)

Unit Summary

Unit 9: Teaching Statistics and Probability (G9, 11 and 12) (11 hrs.)

Session 9.1: Teaching Measures of Central Tendency of Raw Data (2 hrs.)

Session 9.2: Teaching Measures of Central Tendency of Grouped Data (2 hrs.)

Session 9.3: Teaching Measures of Dispersion: Mean Deviation from the Mean (2 hrs.)

Session 9.4: Teaching Measures of Dispersion: Variance and Standard Deviation (2 hrs.)

Session 9.5: Teaching Probability of Simple Events (3 hrs.)

Unit Summary

Unit 10: Teaching Introduction to Linear Programming (G12) (8 hrs.)

Session 10.1: Teaching graphical Solutions to the System of Linear Inequalities (2 hrs.)

Session 10.2: Teaching Graphical method of solving linear programming problems (3 hrs.)

Session 10.3: Teaching solving Linear Programming Problems Using Microsoft Excel (3 hrs.)

Unit Summary

Unit 11: Teaching Introduction to Calculus (G12) (6 hrs.)

Session 11.1: Rates of Change (2 hrs.)

Session 11.2: Teaching the Derivatives –The Slope Function (2 hrs.)

Session 11.3: Teaching the Integral-Riemann Sum Investigation (2 hrs.)

Unit summery

Unit 1: Problem-solving-based Mathematics Instruction (4 hrs.)

Introduction

In this unit, the shift from the rule-based, teaching-by-telling approach to a problem-solving-based approach to mathematics teaching is explained and illustrated with mathematics examples. Problem-solving approach is a method of teaching that can allow learners to 'do mathematics' and through this build up their understanding of mathematics. This unit contains three main sessions which are: why and how of problem-solving approach, nature of problem solving tasks, and a three-phase lesson structure.

Unit Outcomes

After completing this unit, you will be able to:

- Appreciate the need for a shift in thinking about mathematics instruction.
- Understand the key principles of problem-solving-based approach to teaching mathematics.
- Apply the principles to design and teach effective problem-solving-based mathematics lessons from the textbook.

Key contents

Session 1.1: Why and how of teaching through problem-solving (1 hr.)

Session 1.2: Nature of problem-solving tasks (1 hr.)

Session 1.3: Lesson Structure of problem-solving based approach (2 hrs.)

Unit Summary

Session 1.1: Why and how of problem-solving approach (1 hr.)

In this session, we discuss about the need to shift from the rule-based approach to a problem-solving-based approach to mathematics teaching. We begin the discussion with an activity so that we can build upon your own current experience and understanding. This should help you better to engage with the discussion that follows.

Session Objectives:

Upon completion of this session, you will be able to:

- Critically reflect on the value of teaching with problems.

Activity-1: Teacher Reflection (30 minutes)

Reflect on the following questions from your prior knowledge and experiences.

a) What mathematics teaching methods/approaches do you know?
b) What are the main characteristics of each method/approach? Are they different from the methods used in other subjects?
c) What mathematics teaching methods/approaches are often used in Ethiopia? How effective are they? Why or why not?

Activity-2: Solving Linear Inequalities as a Case Study (30 minutes)

Consider the following two instructions as case studies that Teacher A and Teacher B taught the same concept to grade 9 students. Read through the two case studies and then answer the questions that follow. Share your answer to your nearby colleague, and then to the whole class.

a) Which of these two approaches is most like the way that you teach?
b) Which of these two approaches do you prefer and why?
c) Which of these two approaches allows for meaningful construction of ideas? Explain your answer.

Case study-1: Teacher A

Instructional activities
After checking students' homework, the teacher asks: *Who can remember what you have learned last period?* One student gives response: *We learn about linear equation.* Teacher A then asks: *What is linear equation?* Another student says: *Which involve equal sign.* The teacher then says: *A linear equation is an equation which can be written as $ax + b = 0$.* Teacher A gives two sample linear equations emphasizing: a, and b are constants, x is a variable, and the value of x is a solution. The teacher announces the title of the current lesson: *Solving linear inequalities*.
The teacher writes the following definition: <u>*Definition*</u>*: An inequality is said to be linear inequality if it is written in one of the following forms: $ax + b < 0$, $ax + b \leq 0$, $ax + b > 0$, or $ax + b \geq 0$, for $a \neq 0$.* Teacher A then provides examples to support the definition. *$x + 3 > 0$, $x + 4 \leq 0$, $2x + 1 < 0$, and $3x + 7 \geq 0$ are linear inequalities.* Teacher A writes the addition, subtraction, multiplication and division properties of inequalities on the blackboard. She then demonstrates the properties as follows. $\frac{2}{3} < \frac{5}{3}$ *and* $\frac{2}{3} - \frac{1}{3} < \frac{5}{3} - \frac{1}{3}$ $4 > 2$ *and* $4 \times 3 > 2 \times 3$ $10 < 15$ *and* $10 \div 5 < 15 \div 5$ The teacher then provides the following example: *Find the solution set for the inequality $x + 4 < 7$* Teacher A then demonstrates the solution interacting with students. $x + 4 < 7$ $x + 4 - 4 < 7 - 4$ $x < 3$
The teacher then provides the following examples as a classwork: *Find the solution set of each of the following inequalities in the set of real numbers.* *a)* $x - 2 > 5$, *b)* $2x < 10$ *c)* $\frac{1}{4}x > 3$, *d)* $x + \frac{7}{8} < 1$ After 10 minutes of students work in small groups, the teacher demonstrates the solutions of all the examples to the whole class.

Finally the teacher provides a short summary. **Teacher A** gives emphasis for properties of inequalities. At the end, she provides homework exercises from the textbook.

Case study-2: Teacher B

Instructional activities

The teacher starts the lesson by providing the following exercises to students to work in pairs.

1. *Simplify each of the following algebraic expressions into their lowest terms.*
   a) 12y + 12 – 6y *b) 2x + 7 + 5x – 15 + 6 – x*
2. *Solve each of the following equations.*
   a) z + 5 = 9 *b)7n = 14* *c) 2m – 4 = 6*

After checking students work, she summarizes students' answers to the whole class.

The teacher announces the title of the lesson: *solving linear inequalities* and the objectives of the lesson as well. Teacher B then asks: *What is inequality? What is the difference b/n equation and inequality?* Two students give responses. In her feedback, she emphasizes the difference in the meaning of the signs.

Teacher B asks: *what do you know about bank account?* One student gives response. She emphasizes the key terms *saving* and *withdrawing*.

Teacher B then provides the following tasks written on a piece of paper:

Helen had 400 Birr in her bank account. She saves additional 5 birr each week in her account. Her brother Tolcha had 582 birr in his account. He withdraws 8 birr each week from his saving.

a) In which week does Helen have 565 birr in her account? In which week does it be greater than 565 birr?
b) In which week does Tolcha have 422 birr in his account? In which week does it be less than 422 birr?
c) At what week do Helen and Tolcha have the same amount of money in their accounts? In which week does Helen's money is greater than Tolcha's money?

The teacher asks questions during checking students work when they are working individually and in small groups, encouraging them to try more than one method. The teacher takes notes of some student work.

After some time had passed, the teacher invites students to present their solutions to the whole class.

After four students have presented their work, the teacher connects their solution strategies and produces the following answer to each case:

a)

$$400 + 5w = 565$$
$$400 + 5w - 400 = 565 - 400$$
$$5w + 400 - 400 = 565 - 400$$
$$5w = 165$$
$$5w/5 = 165/5$$
$$w = 33 \text{ weeks.}$$

Week	*Amount in Helen's account*	
1^{st}	$400 + 5$	$400 + 1 \times 5$
2^{nd}	$400 + 10$	$400 + 2 \times 5$
3^{rd}	$400 + 15$	$400 + 3 \times 5$
4^{th}	$400 + 20$	$400 + 4 \times 5$
5^{th}	$400 + 25$	$400 + 5 \times 5$
6^{th}		
	$400 + w\times5$ $400 + 5w$	

So, the money in her account is equal to 565 at the 33^{rd} *week and is greater than it at weeks 34, 35, 36, and so on. That is,* $400 + 5w > 565$ *at* $w > 33$ *week.*

b)

Hence, $582 - 8w < 422$

$$582 - 8w + 8w < 422 + 8w$$
$$582 < 422 + 8w$$
$$582 - 422 < 422 - 422 + 8w$$
$$160 < 8w$$
$$160/8 < 8w/8$$
$$20 < w$$

That is, $w > 20$ *week.*

Hence, his money in his account is less than 422 after the 20th week.

Week	*Amount in Tolcha's account*	
1^{st}	$582 - 8$	$582 - 1 \times 8$
2^{nd}	$582 - 16$	$582 - 2 \times 8$
3^{rd}	$582 - 24$	$582 - 3 \times 8$
4^{th}	$582 - 32$	$582 - 4 \times 8$
5^{th}	$582 - 40$	$582 - 5 \times 8$
6^{th}		
		$582 - 8w$

c) Based on the answers in a) and b), we have:

$$400 + 5w > 582 - 8w$$
$$5w + 8w > 582 - 400$$
$$13w > 182$$

$w > 182/13$ *$w > 14$ week* *Helen’s money is equal to Tolcha’s money at week 14 and greater at week 15 and more.*
The teacher provides the following exercises, and ordered them to work individually. *Solve each of the following inequalities.* *a)* $x + 5 < 8$ *b)* $y - 3 > 2$ *c)* $2z < 10$ *d)* $2x - 3 > 7$ *e)* $4y - 1 < 3y + 8$ The teacher walks around the classroom to check every student’s work.
The teacher provides summary orally through questioning. The teacher gives emphasis for comparing solving equations and inequalities, based on the number of solutions and solution strategies. Finally, she provides home work exercises from the textbook.

Key Ideas

The first approach in Case Study 1 involves going straight into formal mathematics and using 'rules'. One advantage of this approach is that it is quick and easy for the teacher, and some students may be able to answer similar questions correctly. A disadvantage of the first approach is that it offers little opportunity for learners to do mathematics. Since learners are to follow the rules demonstrated by the teacher, they may not construct a deep understanding of the content. It does not encourage learners to create and invent their own constructions of the concept.

On the other hand, the second approach described in Case Study 2 requires more time initially, both in terms of planning outside of class and during in-class activities. Since the teacher does not provide specific rules to follow, she/he must be prepared to handle various types of thinking, including divergent and sometimes incorrect ideas. Despite this challenge, one benefit of this approach is that students are able to discuss and explore concepts in a meaningful way. Through collaboration with peers and guidance from the teacher, students can work through fundamental principles and tackle more complex examples. This approach allows students to construct their own understanding of new content before formal definitions and formulas are introduced by the teacher. Overall, the second approach emphasizes problem-solving as a means of enhancing students' comprehension of the subject matter. It also aids in the development of students' problem-solving skills.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

1) https://lessonresearch.net/teaching-problem-solving/overview/

2) https://fhsu.pressbooks.pub/ecumath/chapter/chapter-4-teaching-mathematics-through-problem-solving/

Session 1.2: Nature of Problem-solving Tasks (1 hr.)

In this session, we look at a variety of different problem-solving tasks in order to identify the characteristic features that will help you to design your own tasks. We will start with an activity that explores integer subtraction to illustrate some general issues.

Session Objectives:

Upon completion of this session, you will be able to:

- Identify key characteristics of problem-solving tasks in mathematics.
- Select and analyze appropriate tasks and problems for learning mathematics.

Activity-1: Problem-solving Tasks? (30 minutes)

Discuss on the following questions in small groups of three to five members.

1) What is problem-solving? What is the difference between problem solving and the doing of routine exercises?

2) Based on the temperature change task given below; reflect on the following questions.

a) Would you use tasks like this in your teaching? Why/Why not?

b) What are the key characteristic of the problem-solving task given below?

c) Does it provide for learners to explore the concept in different ways?

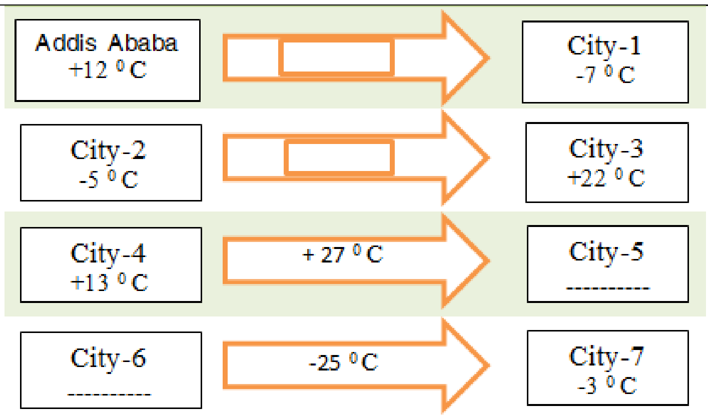
d) Does it provide opportunity for learners to solve non-routine problems?

3) Can you give or design similar types of tasks to teach integer subtraction?

Temperature Change Task

Based on the information given below, answer the following problems.

Temperature Change



1. When we travel from Addis Ababa (+12 ^{0}C) to City-1 (-7 ^{0}C), does the temperature rise or fall? How much is the change in temperature? Describe how you reached to this answer.
2. What is the temperature change when we travel from City-2 (-5 ^{0}C) to City-3 (+22 ^{0}C)? Describe how you reached to this answer.
3. If the temperature of a city in Ethiopia is greater than that of City-1 by 15 ^{0}C, then what is the temperature of this city?
4. Determine the temperature of City-5? Describe how you reached to this answer.
5. Determine the temperature of City-6? Describe how you reached to this answer.

Key Ideas

A mathematics problem-solving task is a task/problem that poses a question to be answered but students do not have a readily available memorized rules, or solution methods for answering it (Lester & Cai, 2016; NCTM, 2000). A problem-solving task is one that engages the learners in thinking about and developing the important mathematics they need to learn. This can be contrasted with the traditional approach to teaching in which teachers explain a rule, provide an example and then drill the learners on similar examples. It must be stressed that whether something is a problem or not is dependent on the level of sophistication of the problem solver. A learner in grade 8 may be required to solve a problem in which the method and solution are not obvious, and yet the same problem given to older students, for example, in 10th grade, may be quite routine.

The temperature change task given above illustrates a key characteristic of a problem-solving approach: it provides for learners to explore the concept in practical and different ways. It also provides a chance to apply and connect previously constructed mathematical understanding. Another key characteristic of the problem is the focus on equipping learners to tackle non-routine problems.

Problem solving should be a primary goal of all mathematics instruction and an integral part of all mathematical activity. Learners should use problem-solving approaches to investigate and understand mathematical content. What is critical, though, is that if the mathematics is to be taught through problem solving, then the tasks or activities are the vehicle by which the desired curriculum is developed. Teachers don't teach the concepts first, and then require learners to do exercises – the problem-solving activity is the vehicle through which the concepts are taught.

Activity-2: Routine or Non-routine? (30 minutes)

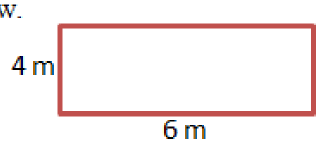
Given below is a list of six problems suitable for primary school learners to learn area and perimeter of rectangles.

a) Select the problems that you would consider as routine for the learners.

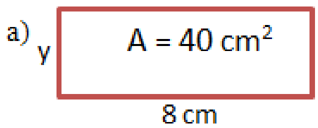
b) Select the problems that you would consider as non-routine.

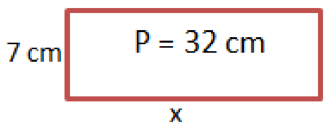
c) What are your criteria to classify the problems as routine or non-routine?

1. Find the area and perimeter of the rectangle shown below.

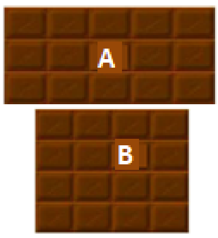


2. A group of school students want to prepare a rectangular seedling garden of length 6 m and width 4 m. What is the area and perimeter of the garden?
3. Find the unknowns x and y in each of the following two cases.





4. The figures below are two bars of biscuits. If the price of these biscuit bars is the same, which biscuit do you want to buy? Why do you choose that biscuit? What is your strategy for choosing the biscuit you want to buy? Explain your answer. Use the given grid/square paper to help you compare the shapes.



5. A farmer has a 16 meters long fence and he plans to enclose a rectangular grazing field with it.

   a) What is the area of the grazing field he can enclose? Use square paper to draw the field.

   b) How can he enclose the largest grazing field? At what condition is the field smallest?

   c) Do the above two cases by considering that the farmer has 24 meters long fencing material.

6. Student A and student B have a rectangular flower garden each with perimeter 16 meters and 20 meters respectively. Do you think that student B's garden is wider than student A's garden? How?

Key Ideas

The nature of instructional tasks or problems presented to students is a key aspect of teaching and learning mathematics. It highly influences students' level of engagement, and, thus, the learning outcomes achieved. However, not all mathematical tasks afford the same opportunities for the same type of student learning.

Tasks which are connected to real-life contexts; tasks which require students to apply multiple solution approaches and multiple representations provide maximal learning opportunities. These tasks are called non-routine. Non-routine tasks require students to explore and understand mathematical concepts, processes, or relationships by using complex, non-algorithmic thinking. While, tasks which require students only to recall and apply previously learned facts, rules, procedures, formulae, or definitions are routine and cannot help them to do mathematics. The focus of these types of tasks is on correct answers rather than understanding. They do not need real comprehension of concepts involved, and often focus on recall of basic facts and proficiency in computational techniques, and hence they do not require much cognitive demand on the students.

When you are planning a lesson, part of your work is to select (or design) tasks that will facilitate the learning of the mathematical content to be covered in that lesson. Most teachers use their textbooks as the everyday guide to the curriculum. Many of the new textbooks are written with the learner in mind and they contain challenging and stimulating activities in which learners can be engaged. However, there is always an opportunity for teachers to adapt textbook activities so that they are more suitable for the particular situation of their learners. Teachers can also design their own activities with the specific needs of their learners in mind.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

1) https://lessonresearch.net/teaching-problem-solving/overview/

2) https://fhsu.pressbooks.pub/ecumath/chapter/chapter-4-teaching-mathematics-through-problem-solving/

Session 1.3: Lesson Structure of Problem-solving Based Approach (2 hrs.)

Each of the main three phases of a lesson – before, during and after – are considered critical for successful problem-solving lessons. To learn more about lesson phases in problem-solving based approach, let you participate actively in the following activities.

Session Objectives:

Upon completion of this session, you will be able to:

- Describe, with insight, the three-phase lesson format for problem solving referred to as before, during and after.
- Critically describe the teacher's actions in the before, during and after phases of a problem-solving lesson.
- Design effective problem-based lesson from the textbook and other resources.

Activity-1: Lesson Phases– before, during and after (30 minutes)

Discuss the following questions in small groups of three to five members. Write a report of your discussion.

a) What must be the teacher's action **BEFORE** students start solving the problems?
b) What is the teacher's and students' role **DURING** problem-solving (that is, during students solve the problems in small groups)?
c) What is the teacher's and students' role **AFTER** problem-solving (that is, after they solve the problems in small groups)?
d) Compare the structure of lessons in the two case studies in session 1.1 in terms of the before, during and after lesson phases. What are the implications of this comparison to your teaching?

Key Ideas

Teaching through problem-solving does not mean simply providing a problem or task, sitting back and waiting for something to happen. The teacher is responsible for making the atmosphere and the lesson work. To this end, Van de Walle (2004) sees a lesson as consisting

GETTING READY

- Activate student's prior knowledge which is of three main phases: before, during and after. He proposes the following simple three-phase structure for lessons when teaching through problem solving:

Before

During

LEARNERS' WORK

- Let students start doing the new problem in small groups.
- Listen carefully and provide hints.
- Observe and assess.

After

WHOLE-CLASS DISCUSSION

- Accept learner solutions without evaluation.
- Conduct discussions as learners justify and evaluate results and methods.

Activity-2: More s)

For this activity, you are required to use the temperature change task given in session 1.2. Or you can use your own ones from the textbook. Discuss the following questions in pairs and share the agreed upon answer to the whole-class.

a) If you were using the temperature change task in your classroom, what specifically would you do during each of the 'before, during, and after' phases of the lesson? Describe each phase clearly.
b) What do you expect the learners to do during each of the phases of the lesson?

Activity-3: Lesson Design (as a homework activity) (1 hr.)

Now let us put into practice what we have explored in this unit. This may take more time to finalize. If it is not finalized within the allotted time, it can be a homework activity.

a) Look through your current teaching plans. Choose a concept/topic which you had planned to teach in a more traditional way based on past experience but which you realize you could now use problem-solving for.
b) Redesign and teach the lesson using problem-solving as your main teaching strategy.
c) Write a comparison between the new lesson and your previous one and answer the following questions.
   (i) What can you and the learners do differently?
   (ii) Do learners learn any better or worse when you use this new approach?

Key Ideas

The above activity focuses on planning in the problem-based classroom – in an attempt to give you the confidence and competence to pursue this approach with your learners. You know that people involved in a teaching-learning situation would find it difficult to teach effectively without using a good lesson plan. The three-phase lesson format described above provides a basic structure for problem-based lessons. That basic structure resulted from the need for learners to be engaged in problems followed by discussion and reflection.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

1) Website: https://fhsu.pressbooks.pub/ecumath/chapter/chapter-4-teaching-mathematics-through-problem-solving/

2) Book: Van de Walle, JA (2004). Elementary and middle school mathematics – teaching developmentally. New York: Pearson.

Unit Summary

Problem-solving is an essential strategy in mathematics education that empowers students to develop critical thinking, logical reasoning, and mathematical proficiency. It is an integral part of all mathematics learning. Learning takes place as a result of problem solving and the mathematical ideas are the outcomes of the problem-solving experience. When using problem-solving approach in mathematics, learners become actively involved in doing mathematics. They are engaged in selecting strategies, justifying solutions, extending and generalizing problems. There is cooperation and questioning as learners acquire, relate and apply new mathematical ideas through sharing, inquiring and discussing. Learners are also investigating relationships, and the problems act as a catalyst for connecting mathematical concepts and skills.

Teaching mathematics through problem solving is a transformative approach that fosters mathematical thinking and prepares students for both academic and practical success. By implementing effective strategies, providing a supportive environment, and engaging students in meaningful problem-solving tasks, educators can empower students to become confident and capable problem solvers.

For effective implementation of problem-solving approach to teach mathematics, teachers need to consider the following key strategies.

a. Select appropriate problems: Problems should be challenging, yet accessible, and encourage multiple solution paths.
b. Provide a problem-solving environment: Create a classroom culture where students feel comfortable taking risks and collaborating.
c. Guide students through problem-solving process: Use scaffolding techniques, such as probing questions and providing hints, to support students without giving away the answer.
d. Encourage multiple solution strategies: Emphasize that there may be different ways to solve a problem and celebrate diverse approaches.
e. Reflect on solutions: Encourage students to analyze and discuss their solutions, and identify areas for improvement.

Unit 2: Teaching Relations and Functions (12 hrs.)

Introduction:

This unit aims at helping trainees establish an understanding about the concepts of relations functions. In this unit, you will discuss on methods of teaching relations and functions. That means, you will discuss how to teach relations in a variety of ways, including patterns, words, tables, graphs, equations, diagrams, visual representation and technology. Relations describe connections between elements in sets, while functions represent specific types of relations that assign each element of one set to exactly one element of another set. Introducing students to relations and functions involves exploring concepts such as domain, range, mapping diagrams, and function notation. By understanding relations and functions, students develop critical thinking skills, logical reasoning, and problem-solving abilities that are crucial in various mathematical contexts. Through interactive examples, visual representations, and practical applications, educators can inspire students to appreciate the significance of relations and functions in modeling real-world scenarios, analyzing data, and solving mathematical problems. This foundation in relations and functions sets the stage for students to delve deeper into advanced mathematical topics and applications. By investigating into these concepts, Trainees will develop critical thinking skills, problem-solving abilities, and a deeper comprehension of how mathematical structures can describe various phenomena in the world around them.

Through engaging lessons, interactive activities, and real-world examples, you can inspire your students to explore the intricacies of Relations and Functions, fostering a strong foundation in algebra that will benefit them in their academic pursuits and beyond.

In general, this unit is subdivided in to four sections. In all the sections, you will see main points that will help you teach relations and functions.

Unit Outcomes:

After completing this unit, you will be able to:

- Outline how to teach relations and functions.
- Apply the methods of teaching real-life application of relations and functions.
- Use different techniques of teaching relations and functions.
- Select appropriate teaching aids to teach relations and functions.
- Plan to connect relations and functions to real life situations in teaching

Key contents

Session 2.1: Teaching the Concept of relation (4 hrs)

Session 2.2: Teaching the Concept of Function (2 hrs)

Session 2.3: Teaching the Concept of Power Functions (4 hrs)

Session 2.4: Teaching the Concept of Composition of Functions (2 hrs)

Unit Summery

Session 2.1: Teaching of the concept of Relation (4 hrs.)

Session Objectives:

After completing this session, the trainees will be able to:

- ✓ Discuss various ways of teaching the concept of relation.
- ✓ Understand the concept of Relations.
- ✓ Identify effective teaching strategies for teaching relation.
- ✓ Demonstrate how Relations are used in practical situations

- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of relation.
- ✓ Adapt the discussion to their own situations and then plan to use it to their own classrooms.

☞**Activities**

Activity 1: Teacher Reflection on their Teaching (25 minutes)

How did you teach the concept of relation to you students? (you can frame your reflection in terms of the following key components of an instruction)

- ✓ Activating students' prior knowledge
- ✓ Nature of tasks/activities provided (context, multiple representation, routine/non-routine, etc.)
- ✓ Students classroom discussion and teacher's role in the discussion
- ✓ Summary/consolidation
- ✓ Challenges you face in teaching.

Activity-2: Real-life Application of Relation(25 minuties)

In small group discuss real-life application of relations and reflect to the whole class?

Key Ideas

- In academic institutions, relations are applied to track the enrollment status of students in different courses. By defining relations between students and courses they are enrolled in, schools can manage class schedules, academic progress, and course prerequisites efficiently.
- Businesses use relations to manage and analyze their interactions with customers. By categorizing customers based on their purchase history, preferences, and behavior, businesses can tailor their marketing efforts and maintain strong relationships with their customers.
- Relations are utilized in airline flight scheduling to determine connections between different flights, airports, and routes. By establishing relations between departure and arrival times, flight connections, and aircraft availability, airlines can optimize their flight schedules and enhance operational efficiency.

- By defining relations between patients, healthcare providers, medications, and diagnoses, healthcare facilities can improve patient care and ensure accurate record-keeping.

- In the study of social networks, relations are used to analyze connections between individuals, groups, and communities. By defining relations based on interactions, friendships, and collaborations, influence patterns, and information flow in social networks.

❖ By incorporating real-life applications of relations in teaching, trainees can make mathematical concepts more relevant and engaging for students.

❖ Real-world examples help students see the practical significance of relations, fostering a deeper understanding of abstract mathematical concepts.

Activity-3: Lesson analysis (1hrs)

Consider the following two instructions as case studies that mathematics teacher A used **pattern recognition** as a teaching strategy to help students understand relation concepts. The teacher started the lesson by introducing the idea of patterns and how they can be used to identify relationships between elements. The teacher presented students with **a series of patterns**, such as **number sequences, geometric shapes, or color patterns, and asked them to identify the underlying relations**. Students were encouraged to look for commonalities and differences in the patterns to determine the rules governing the relationships. By analyzing patterns, students were able to see how elements are related to each other and apply this understanding to relation concepts in mathematics. The teacher then transitioned to discussing relations as sets of ordered pairs and how patterns can be used to represent these relations graphically. Through pattern recognition activities, students were able to develop a deeper understanding of relation concepts and apply them to solve mathematical problems effectively.

Another mathematics teacher B utilized pattern **creation and analysis** as a teaching method to help students grasp relation concepts. The teacher encouraged students to create their own patterns **using numbers, shapes, or symbols and then analyze the relationships between the elements in the patterns.** Students were tasked with identifying the rules or formulas that govern the patterns they created and representing them as relations. Through this hands-on approach, students were able to see how elements in a pattern are related to each other and how these relationships can be expressed mathematically as relations. The teacher guided students in translating their patterns into sets of ordered pairs and graphing them to visualize the relations. By engaging in pattern **creation and analysis activities**, students developed a deeper understanding of relation concepts and gained proficiency in applying them to solve mathematical problems and taught the concept of relation to Grade 9 or 11 students. Let the trainees to read the two case studies and then answer the following questions.

1. Which of these two approaches is most like the way that you teach?
2. Which of these two approaches do you prefer and why?
3. Which of these two approaches allows for meaningful construction of ideas? Explain your answer.

Key Ideas

- Both mathematics teachers followed ADEE approaches which are stated in their text book.
- Effective teaching practices for the concept of relations in mathematics can help students develop a deep understanding of the topic.
- Teaching relations using patterns helps develop students' ability to recognize and analyze mathematical patterns that correspond to specific relationships. Trainees can engage students in identifying patterns, making connections between elements, and extrapolating relationships based on observed patterns.
- Trainees can scaffold learning by starting with simple patterns and gradually introducing more complex patterns to illustrate diverse types of relations.
- Relating patterns to real-world contexts allows teachers to demonstrate how relations and patterns are used to model relationships in various fields.
- Trainees can facilitate discussions on how patterns represent relationships in data analysis, sequences, functions, and other applied mathematics contexts.

Activity 4. Teaching using Guided Discovery Method (1hrs)

Discuss how you teach the concepts of a relation by using guided discovery method in small group? Based on the following leading questions:

1. Give specific examples of relation in your surroundings. Some of them might be: in our daily life, we come across many patterns that characterize relations such as brother and sister, teacher and student, etc. Similarly, in mathematics, you come across different relations such as a number x is less than a number y, y is a multiple of x, and so on. In all these cases, we find that a relation involves pairs of objects in some specific order. Everyday phenomena involve two quantities that are related to each other by some rule of correspondence. The mathematical term for such a rule of correspondence is a relation**.**

2. Identify the two sets involved in the relation. For example, if they are working with a relation between students and their favorite subjects, one set would represent the students and the other set would represent the subjects.

3. List the elements in each set. For instance, if the students are Alex, Guutaa, and Chaltu, and the subjects are Math, Science, and English, then the sets would be {Alex, Guutaa, Chaltu} and {Math, Science, English}.

4. Specify how elements from the two sets are related to each other. they can represent this as pairs of elements. For example, if Alex's favorite subject is Math, they would represent this relationship as (Alex, Math).

5. Create a visual representation, such as a graph or a table, to show the relation between elements.

Key Ideas

- Relation deals about relationship between two quantities or things.
- A relation establishes a correspondence between elements from different sets, pairing them based on a specified rule or condition.
- Relations reflect relationships between elements, indicating how one element is related to another based on a specific criterion or property.
- R is the set of ordered pairs (x, y) such that y is the square of x
- The domain of a relation is the set of all input values (x-values) for which the relation is defined, while the range is the set of all output values (y-values) that result from applying the relation to the elements in the domain. For instance, the domain of the relation in the above relation is the set containing all real numbers such as {1, 2, 3, 4, 5, ...} and its range is the set consisting of all square of real such as {1 4, 9, 16, 25, ...}.
- There are different types of relations such as one-to-one, many-to-one, one-to-many, and many-to-many. Each type of relation shows the number of elements paired between the sets.

Activity 5: Teaching sketching the graphs of relations involving inequalities using tables or GeoGebra software (1hrs)

Be in groups of four and discuss how you can teach sketching the graphs of relations involving inequalities using tables or GeoGebra software with the following steps.

1.Discuss on the basic inequality notation (">", "<", ">=","<="), along with the meaning of each symbol in relation to the graph.

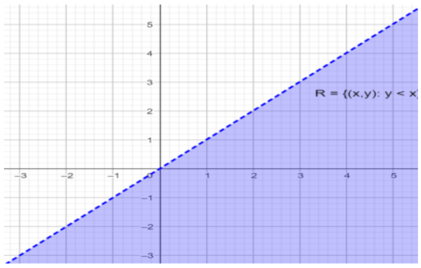
2. Draw the graph of curve (s) involved in the relation on the *xy*-coordinate system.

3. use a solid line, If the relating inequality is ≤ or ≥; use a broken line, if it is < or >.

4.choose a few test points to determine which side of the inequality the solution lies on. Then take arbitrary ordered pairs represented by points, from opposite sides of the line(s), and determine which of the pairs satisfy the relation.

5.Say, the region that contains this point representing the ordered pair satisfying the relation will be the graph of the relation and reflect to the whole class

As an example, draw the graph of the relation R = {(x, y): $y < x$, where x and y are real numbers}. It is as shown below:



Key Ideas

❖ Relations can be represented using various methods like tables, directed graphs, and arrow diagrams.

❖ When sketching graphs of relations involving inequalities, it is essential to identify the boundary lines that represent the equality in the inequality statement. Boundary lines help in determining the boundary points of the region that satisfies the inequality.

❖ After identifying the boundary lines, shading the feasible region based on the inequality constraints is crucial. The shading indicates the area or region where the inequality is satisfied, providing a visual representation of the solution set.

❖ Understanding the signs (<, ≤, >, ≥) in the inequality statement determines whether the boundary lines should be solid (included in the solution) or dashed (excluded from the solution). Analyzing the signs guides the shading process to depict the correct set of points that satisfy the inequality.

❖ Sketching graphs of relations with multiple inequalities involves identifying the intersection of the shaded regions for each inequality. The feasible region is the area where all inequalities are satisfied, represented by the overlapping shaded regions of the individual inequalities.

❖ Utilizing tables or GeoGebra software for sketching graphs of relations involving inequalities offers trainees a powerful visualization tool. Visual representations aid in making abstract concepts more tangible, allowing students to see the relationship between inequalities and their graphical representations clearly.

Activity 6: Conceptual Challenges (10 minutes)

What are the challenges students or even teachers face in understanding the concept of relation? (*To answer this question, refer to the content in the new textbook*)

Homework Activity

Design a lesson how you teach inverse of a relation using tabular format and graphical method of teaching or GeoGebra.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/cc-eighth-grade-math/cc-8th-linear-equations-functions/cc-8th-function-intro/v/relations-and-functions

Phet Simulation: https://phet.colorado.edu/en/simulations/function-builder-basics

GeoGebra software.

Session 2.2: Teaching of the Concept of Functions (2 hrs.)

Session Objectives:

After completing this session, you will be able to:

- ✓ Identify effective teaching strategies for teaching functions.
- ✓ Understand the fundamental concept of functions.
- ✓ evaluate functions for specific input values, fostering competence in substituting variables and calculating corresponding outputs.
- ✓ apply function concepts in various mathematical situations, such as representing patterns, or solving equations.

- ✓ visualize functions graphically
- ✓ Adapt the discussion to their own situations and then plan to use it to their own classrooms.

☞**Activities:**

Activity 1: Teachers Reflection on their Teaching (30 minutes)

How did you teach the concept of function to your students? (you can frame your reflection in terms of the following key components of an instruction)

- ✓ Activating students' prior knowledge
- ✓ Nature of tasks/activities provided (context, multiple representation, routine/non-routine, etc.)
- ✓ Students classroom discussion and teacher's role in the discussion
- ✓ Summary/consolidation
- ✓ Challenges you face in teaching

Activity 2: Real-life Application of Functions (30 minutes).

Discuss real-life application of function individually?

Key Ideas

❖ Demand and supply functions in economics help to analyze the relationships between price, quantity, and market equilibrium.

❖ Engineers use functions to model and analyze systems such as electrical circuits, mechanical structures, fluid dynamics, and control systems.

❖ Functions are used in physics to describe physical phenomena such as motion, wave behavior, and quantum mechanics. Equations of motion, wave functions, and energy potentials are examples of functions used to model and predict physical interactions.

❖ Functions are fundamental in programming and software development. In computer science, functions are used to define algorithms, perform calculations, manipulate data, and create modular and reusable code.

❖ Biological processes such as growth, metabolism, genetics, and ecology can be modeled using functions. Functions help analyze gene expression, population dynamics, enzyme kinetics, and evolutionary relationships in biological systems.

Activity-3: Teaching using questioning and Answering Method (40 minutes).

Define functions and give different examples of a function and not a function and explain how you can teach those definitions and examples. Do this individually and then share their definitions in pairs. List all the definitions forwarded by each pair and list down on the blackboard and reflect it the whole class

Key Ideas

❖ Correspondence between age and human height within a certain age group (e.g., the growth chart for children) is a function. Each age corresponds to a unique height.

❖ The relation defined by $f(x) = 2x + 5$ is a function

❖ A vertical line, such as $x = 4$, is not a function.

❖ The relationship between a student's grades and the courses they take is not a function.

❖ Functions describe relationships between sets of values, where each input value corresponds to exactly one output value.

❖ The domain of a function is the set of all possible input values, while the range is the set of all possible output values.

❖ Functions are commonly denoted by symbols like $f(x)$ or $g(y)$, where the function is represented in terms of its input variable.

❖ Functions follow the rule that each input has a unique output, and no input is associated with multiple outputs.

❖ Teaching functions using questioning and Answering Method helps you to build a fundamental understanding of mathematical concepts such as relationships, variables, and dependencies.

Activity 4: Conceptual Challenges (20 minutes)

What are the challenges students or even teachers face in understanding the concept of function? (*To answer this question, refer to the content in the new textbook*)

Homework Activity

Design a lesson how you teach functions using real-life application method of teaching.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/cc-eighth-grade-math/cc-8th-linear-equations-functions/cc-8th-function-intro/v/relations-and-functions

Phet Simulation: https://phet.colorado.edu/en/simulations/function-builder-basics

https://www.youtube.com/watch?v=BWfRZgE3Djw

Session 2.3: Teaching Power Functions (4 hrs.)

Session Objectives: specific

After completing this session, you will be able to:

- ✓ identify various ways of teaching the concept of power function.
- ✓ understand the concept of power functions and their general form of f(x) = a x^r, where a is a constant and r is a real number.
- ✓ recognize the graphical representation of power functions
- ✓ understanding how the exponent r affects the shape of the graph.
- ✓ explore the properties of power functions, such as domain, range, zeros, symmetry, and behavior as x approaches positive or negative infinity.
- ✓ differentiate the difference between even and odd power functions based on their symmetry properties.
- ✓ identify real-world applications of power functions in various fields.

☞ **Activities:**

Activity 1: Teachers Reflection on their teaching (30 minutes)

How did you teach the concept of power function to your students? (you can frame your reflection in terms of the following key components of instruction)

- ✓ Activating students' prior knowledge
- ✓ Nature of tasks/activities provided (context, multiple representation, routine/non-routine, etc.)
- ✓ Students classroom discussion and teacher's role in the discussion
- ✓ Summary/consolidation
- ✓ Challenges you face in teaching

Activity 2: Real life Application (30 minutes).

Discuss why you teach power function and reflect to the whole class?

Key Ideas

❖ Power functions are fundamental in mathematics and serve as building blocks for understanding more complex functions and mathematical concepts. Teaching power functions provides trainees with a strong foundation in algebra and functions.

❖ Power functions are used extensively in various real-world applications such as physics, biology, economics, engineering, and computer science.

❖ Understanding power functions requires trainees to analyze patterns, make connections between graphical representations and algebraic expressions, and solve problems using mathematical reasoning.

❖ Power functions provide an opportunity for trainees to develop their graphical understanding of functions. By exploring how changing the exponent affects the shape of the graph, students can enhance their visualization skills and gain insights into function behavior.

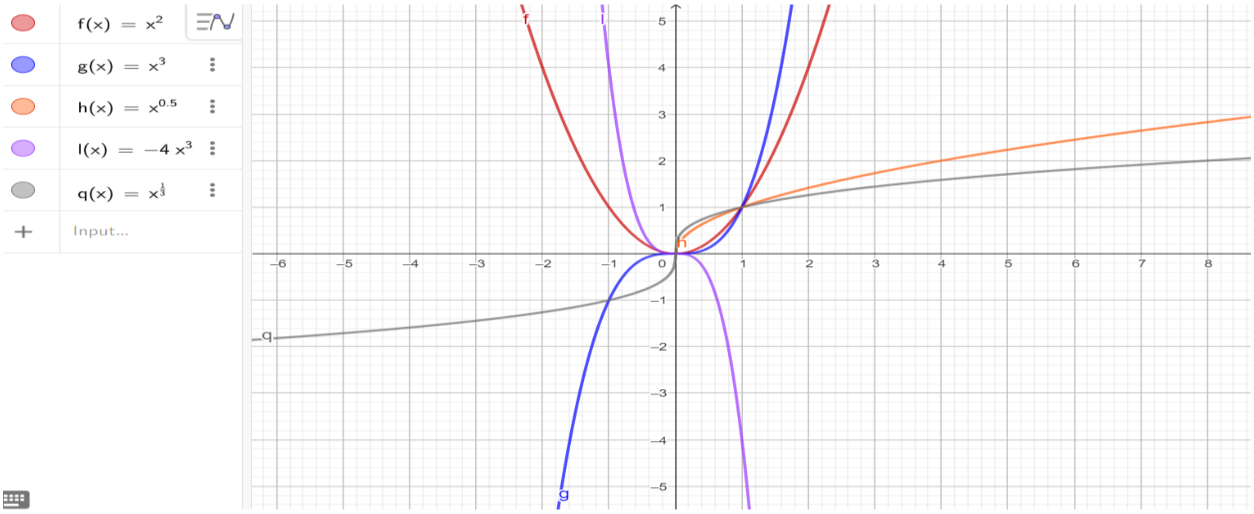
Activity-3: Teaching power function using hands on-activities (1.20hrs).

How you would like to teach power function using hands on-activities based on the following steps and reflect to the whole class

1. Take sets of function cards from grade 11 text book with different power functions, such as f(x) = x^2, g(x) = x^3, h(x) = $x^{0.5}$, l(x) $= -4x^{-3}$, q(x) = $x^{\frac{1}{3}}$ etc.

2. analyze the properties of those power functions on their cards. you can discuss characteristics like domain, range, behavior as x approaches positive or negative infinity, and whether the functions are even, odd, increasing, decreasing, or constant.

3. sketch the graphs of the functions you have been given on graph paper or using technology.



4. compare and contrast the different power functions you have explored. Discuss how the exponent impacts the shape and behavior of the functions.

Key Ideas

- Power functions are mathematical functions of the form f(x) = a x^r, where a is a constant and r is a real number.
- The exponent r in a power function determines the shape of the graph and behavior of the function. Different values of r lead to different types of power functions.
- The domain is typically all real numbers, but the range varies based on the exponent r and the sign of the coefficient a.
- Power functions can be classified as even or odd functions based on the behavior of their graphs with respect to symmetry. Even power functions have symmetry about the y-axis, while odd power functions have rotational symmetry about the origin.
- Graphical representation of power functions helps in visualizing how changing the exponent affects the curve. Trainees can observe patterns in the graphs and understand the impact of varying r and a.
- Analyzing the behavior of power functions as x approaches positive or negative infinity is crucial. Depending on the value of the exponent and the sign of the coefficient, the function may increase or decrease without bound or approach a horizontal asymptote.

• The rate of change of a power function is determined by its exponent. Higher exponents lead to functions with steeper slopes, indicating a faster rate of change.

Activity-4: Teaching power function using GeoGebra (1.30hrs).

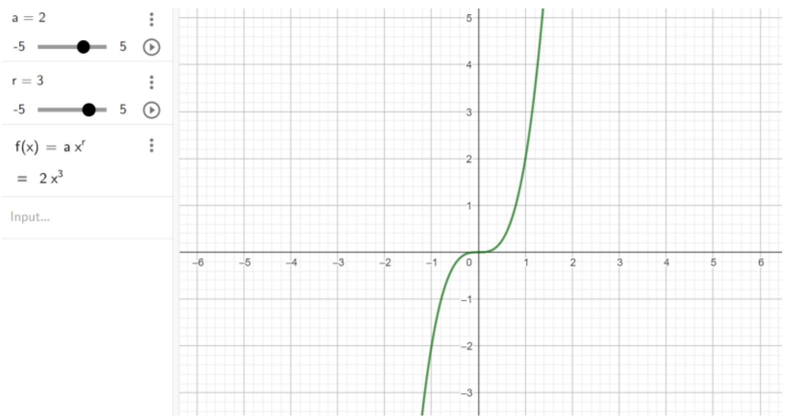
Discuss how you teach power function using GeoGebra in small groups as follows and reflect it to the whole class

1. Open GeoGebra software on the computer or device, and create a new GeoGebra file to start working on the power function visualization.

2. Set up the coordinate axes on GeoGebra to create a Cartesian plane where the power function graph will be displayed. Label the x-axis and y $-$axis appropriately.

3. Use the input bar in GeoGebra to define the power function f(x) = a x^r. Assign initial values to 'a' and ' r ' to create a specific example of a power function to work with during the activity.

4. Plot the power function on the coordinate plane by entering the function equation into the input bar. Observe how changes in the values of 'a' and ' r ' affect the shape and behavior of the function graph.



5. experiment with adjusting the values of 'a' and ' r ' using sliders or input boxes in GeoGebra and observe how these parameter changes impact the graph of the power function.

6. observe how varying the parameter 'a' influences the vertical stretch or compression of the function graph, while changing ' r ' affects the horizontal shift and curvature.

7. discuss the characteristics of power functions based on the observed graph, focusing on features such as intercepts, asymptotes, end behavior, and the overall shape of the curve.

Key Ideas

❖ The defining characteristic of power functions is the variable exponent ' r ', which differentiates them from other types of functions.

❖ Power functions may have asymptotic behavior, approaching certain values as x tends to infinity or negative infinity.

❖ The magnitude of the constant 'a' influences the scaling and vertical shift of the power function graph.

❖ Power functions exhibit various shapes on the graph depending on the values of 'a' and ' r ', representing concave-up, concave-down, linear, or exponential curves.

❖ The domain and range of a power function depend on the specified values for 'a' and ' r ', determining the set of input and output values the function can accept.

❖ Power functions may intersect the x-axis, y-axis, or both, depending on the values of 'a' & ' r '.

❖ Utilizing GeoGebra for teaching power functions enables you to provide visual representations of function graphs, making abstract mathematical concepts more tangible and accessible to students.

❖ GeoGebra enables you to compare multiple power functions side by side, helping students analyze and contrast how variations in parameters impact the function's behavior, facilitating a deeper understanding of function transformations.

Activity-5: Conceptual Challenges (30 minutes).

What are the challenges students or even teachers face in understanding the concept of power function? (*To answer this question, refer to the content in the new textbook*)

Homework Activity

Take five different power functions from Grade 11 students’ textbook, design a lesson using GeoGebra software and reflect to the whole class.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

-------------**Takeaway Resources**

Khan Academy: https://www.khanacademy.org/math/cc-eighth-grade-math/cc-8th-linear-equations-functions/cc-8th-function-intro/v/relations-and-functions

Phet Simulation: https://phet.colorado.edu/en/simulations/function-builder-basics.

GeoGebra software.

Session 2.4: Teaching Composition of Functions (2hrs)

Session Objectives:

After completing this session, you will be able to:

- ✓ Identify effective teaching strategies for teaching composition of Functions
- ✓ Understand the concept of composition of Functions
- ✓ Analyze composition of Functions.
- ✓ Adapt the discussion to their own situations and then plan to use it to their own classrooms.

☞Activities

Activity-1: Teachers Reflection on their Teaching (30 minutes)

How did you teach the composition of function to your students? (you can frame your reflection in terms of the following key components of instruction)

- ✓ Activating students' prior knowledge
- ✓ Nature of tasks/activities provided (context, multiple representation, routine/non-routine, etc.)

- ✓ Students classroom discussion and teacher's role in the discussion
- ✓ Summary/consolidation
- ✓ Challenges you face in teaching

Activity-2: Real-life Application of Composition of function (30 minutes).

Be in to small group, discuss why you teach composition of function and reflect to the whole class?

Key Ideas

❖ In navigational systems like GPS, the composition of functions is used to calculate routes and determine the most efficient paths for navigation. By combining functions that represent distance, speed, and time, navigational systems can provide real-time directions to help users reach their destinations efficiently.

❖ In economics, the composition of functions is utilized in economic models and forecasting. By combining functions that represent factors like consumer behavior, market demand, and resource allocation, economists can analyze economic trends, forecast market conditions, and make informed decisions in financial planning and policy-making.

❖ In biomedical research, the composition of functions plays a role in analyzing complex biological data and modeling physiological processes. By combining functions that represent gene expression, metabolic pathways, and cellular interactions, researchers can gain insights into disease mechanisms, drug interactions, and treatment responses for advancing healthcare and medical science.

❖ Teaching real-life applications of composition of functions helps you to demonstrate the practical utility of mathematical concepts, making abstract topics more relevant and engaging for students.

❖ Teaching real-life applications of composition of functions enables you to connect abstract mathematical concepts to students' everyday experiences, facilitating a deeper appreciation for the practicality and versatility of mathematics in various aspects of their lives.

Activity 3: Teaching composition of Functions Application Method (1hrs).

Please be in small groups (4-5) and discuss how you teach composition of functions application method and reflect to the whole class.

Key Ideas

- Suppose you wanted to calculate how much it costs to heat a house on a particular day of the year. The cost to heat a house will depend on the average daily temperature, and the average daily temperature depends on the particular day of the year.
- Now you can just define two relationships: The temperature depends on the day, and the cost depends on the temperature. Using descriptive variables, you can note these two functions as follows.
- The first function, $C(T)$, gives the cost C of heating a house when the average daily temperature is T degrees Celsius, and the second, $T(d)$, gives the average daily temperature of a particular city on day d of the year. If you wanted to determine the cost of heating the house on the 5th day of the year, you could do this by linking the two functions together, an idea called ***composition of functions***.
- Using the function $T(d)$, you could evaluate $T(5)$ to determine the average daily temperature on the 5th day of the year. You could then use that temperature as the input to the $C(T)$ function to find the cost to heat the house on the 5th day of the year, $C(T(5))$.
- When the output of one function is used as the input of another function, we call the entire operation **composition of functions**. We write $f(g(x))$, and read this as "f of g of x" or $(f \circ g)(x)$ or "f composed with g at x".

https://www.youtube.com/watch?v=sS5Poi0RbeM

https://www.youtube.com/watch?v=pQLbtnsNVUg

Activity-4: Conceptual Challenges (25 minutes).

What are the challenges students or even teachers face in understanding the concept of composition of function? (*To answer this question, refer to the content in the new textbook*)

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

Takeaway Resources

- ✓ **Khan Academy:** https://www.khanacademy.org/math/cc-eighth-grade-math/cc-8th-linear-equations-functions/cc-8th-function-intro/v/relations-and-functions
- ✓ **Phet Simulation:** https://phet.colorado.edu/en/simulations/function-builder-basics
- ✓ **GeoGebra software**

Unit Summary

Teaching the concepts of relations involves exploring how elements from one set are related to elements in another set. By illustrating these relationships through examples and diagrams, students can understand how to represent relations using tables, graphs, mappings, and ordered pairs. Introducing concepts like reflexivity, symmetry, and transitivity helps students analyze the properties and characteristics of relations. Emphasizing real-life applications of relations, such as social networks, family trees, and mathematical functions, can make the topic more engaging and relevant to students. Through activities that involve identifying, representing, and analyzing relations, students develop critical thinking skills and a deeper understanding of the fundamental principles underlying relationships between elements in sets.

Teaching the concepts of functions involves introducing the idea of a relationship where each input value (domain) corresponds to exactly one output value (range). By emphasizing the concept of mapping inputs to outputs and using various representations such as tables, graphs, equations, and diagrams, students can grasp how functions work. Exploring key components such as domain, range, slope, intercepts, and transformations helps students understand the behavior and characteristics of functions. Real-life examples, such as distance-time graphs, population growth models, and financial calculations, can demonstrate the practical applications of functions. Engaging students in activities that involve identifying, evaluating, and manipulating functions fosters problem-solving skills and a deeper comprehension of how mathematical concepts apply to real-world scenarios.

Power functions are a type of algebraic function represented by $f(x)$ = a x^r, where a is a constant and r is a real number. These functions show a relationship where the output (dependent variable) is proportional to the input (independent variable) raised to a constant power. The exponent r determines the shape of the function: for positive r the function may exhibit growth or decay behavior, while negative r can lead to functions with horizontal asymptotes. Power functions are prevalent in modeling various natural phenomena and are essential in calculus, physics, engineering, and other fields for analyzing relationships between variables.

The composition of functions is a fundamental concept in mathematics where two functions are combined to create a new function. Given two functions $f(x)$ and $g(x)$, their composition is denoted as $(f \circ g)$, and is defined as $f(g(x))$. This means that the output of the inner function, $g(x)$, serves as the input for the outer function, $f(x)$. The composition allows for the transformation of inputs through multiple functions sequentially, enabling the analysis of complex relationships and transformations. Understanding function composition is crucial in areas like calculus, algebra, and computer science for modeling and solving problems where functions interact and influence each other.

Unit 3: Teaching Polynomial Functions and Rational Functions (4 hrs.)

Introduction

In the realm of algebra, polynomial functions and rational functions play integral roles in modeling mathematical relationships and solving practical problems. Polynomial functions, characterized by expressions involving variables raised to non-negative integer powers and coefficients, form the basis of many mathematical operations and serve as fundamental building blocks for more complex functions. Understanding the degree, leading coefficient and graphical behavior of polynomial functions allows students to analyze patterns, predict trends, and interpret data in various contexts. On the other hand, rational functions, structured as fractions with polynomial numerators and denominators, offer insights into rates, proportions, and asymptotic behaviors in functions. Exploring the domain restrictions, simplification techniques, and applications of rational functions equips students with tools to address real-world scenarios involving complex mathematical relationships.

Teaching polynomial functions and rational functions provides you with a comprehensive understanding of algebraic concepts and analytical methodologies that are essential in problem-solving and critical thinking. By delving into polynomial functions, you learn to identify polynomial types, perform operations, employ factoring techniques, and interpret graphical representations to analyze mathematical patterns and relationships. Similarly, exploring rational functions introduces you to the complexities of function composition, domain restrictions, asymptotic behaviors, and solution strategies, enabling them to solve intricate mathematical equations and make informed decisions based on rational function models. Through the study of polynomial and rational functions, you develop foundational skills in algebra that empower them to engage with mathematical concepts in a diverse range of applications and enhance their problem-solving abilities in various academic and practical contexts.

Unit outcomes

After completing this unit, you will be able to:

- ❖ Identify effective teaching strategies for teaching polynomial functions and rational functions
- ❖ understand the structure of polynomial functions and rational functions.
- ❖ analyze graphs of polynomial functions and rational functions.
- ❖ understand domain restrictions in rational functions.
- ❖ Explore real-life applications of polynomial functions and rational functions.
- ❖ Adapt the discussion to their own situations and then plan to use it to their own classrooms

Key Contents

Section 3.1: Teaching polynomial functions(2hrs)

Section 3.2: Teaching rational functions (3 hrs)

Unit Summary

Section 3.1: Teaching Polynomial Functions (2hrs)

Session Objectives:

After completing this session, you will be able to:

❖ Identify effective teaching strategies for teaching composition of Functions

❖ understand the basic structure of polynomial functions.

❖ identify the degree of a polynomial (highest power of the variable) and the leading coefficient in polynomial expressions.

❖ understand the concepts of roots and factors of polynomials, emphasizing the relationship between roots (zeros) of a polynomial and its factorization.

❖ Adapt the discussion to their own situations and then plan to use it to their own classrooms.

☞ **Activities**

Activity-1: Teachers Reflection on their Teaching (30 minutes)

How did you teach polynomial functions to your students? (you can frame your reflection in terms of the following components of an instruction)

- ✓ Activating students' prior knowledge
- ✓ Nature of tasks/activities provided (context, multiple representation, examples/non-examples, etc.)
- ✓ Students classroom discussion and teacher's role in the discussion
- ✓ Summary/consolidation
- ✓ Challenges you face in teaching.

Activity-2: Real-life Application of Polynomial Function (30 minutes)

Discuss real-life application of polynomial function with your colleagues and reflect to the whole group?

Key Ideas

❖ Polynomial functions are utilized to model population growth over time, predict demographic changes, and analyze trends in urban development, assisting urban planners, demographers, and policymakers in making informed decisions about resource allocation and infrastructure planning.

❖ In finance, polynomial functions are used to forecast stock market trends, analyze investment returns, and optimize portfolio allocation, enabling investors, financial analysts, and fund managers to evaluate risk, predict market behavior, and make strategic investment decisions.

❖ Polynomial functions are employed in physics and aerospace engineering to calculate trajectories of moving objects, predict projectile motion, simulate orbit paths, and analyze motion dynamics, providing scientists, engineers, and navigators with tools to plan missions, guide spacecraft, and optimize flight paths.

❖ In healthcare and biomedical research, polynomial functions are used to analyze biological data, model disease progression, predict treatment outcomes, and interpret medical imaging results, supporting healthcare professionals, researchers, and clinicians in understanding health trends, diagnosing illnesses, and developing treatment strategies.

❖ Teaching real-life applications of polynomial functions enables you to showcase interdisciplinary connections between mathematics and other fields such as finance, engineering, science, or data analysis, demonstrating the versatility of polynomial functions in diverse contexts.

Activity-3: Teaching polynomial Functions using Application Method (40 minutes)

Discuss how you teach polynomial Functions using Application Method in small group and reflect

1. Read the following scenario: An oil pipeline bursts in the Gulf of Mexico, causing an oil slick in a roughly circular shape. The slick is currently 24 miles in radius, but that radius is increasing by 8 miles each week.
2. formulate the formulas for radius and Area functions based on the scenario you provided. For example. If you wanted to write a formula for the area covered by the oil slick, you could do so by composing two functions together. The first is a formula for the radius, *r*, of the spill, which depends on the number of weeks, *w*, that has passed. Hopefully you recognized that this relationship is linear: $r(w) = 24 + 8w$. You can compose this with the formula for the area(*A)* of a circle: $A(r) = \pi r^2$.
3. how for radius and Area functions can be represented as polynomial functions. Discuss the degree of the polynomial, the leading coefficient, and the different terms in the function.
4. From the above functions gives a formula for the area in terms of weeks: $A(w) = A(r(w)) = \pi(24 + 8w)^2 = 576\pi + 384\pi w + 64\pi w^2$. you can use algebraic methods to simplify the functions and analyze the results. Discuss how this formula is an example of a **polynomial**.

5. Once the you have calculated the radius and area functions, analyze the functions to make decisions about area of an oil pipeline. Discuss how changes in variables can impact the revenue and profit of the business.

Key Ideas

- **A polynomial** is simply the sum of terms each consisting of a transformed power function with positive whole number power.
- A **polynomial** is a function that can be written as $f(x)=a_0+a_1x+...+ a_nx^n$. Each of the constants a_n are called **coefficients** and are real numbers.
- A **term** of the polynomial is any piece of the sum, i.e., any a_nx^n .
- The **degree** of the polynomial is the exponent of the term with highest power of the variable that occurs in the polynomial.
- The **leading term** is the term with the highest degree.
- The **leading coefficient** is the coefficient of the leading term. Because of the definition of the "leading" term, polynomials are rearranged so that the powers are descending as

  $f(x)= a_nx^n + a_{n-1}x^{n-1}+...+ a_1x +a_0.$
- The roots or zeros of a polynomial function are the values of the variable that make the function equal to zero. These are the x-values where the graph of the function intersects the x-axis.
- The end behavior of a polynomial function describes the behavior of the function as x approaches positive or negative infinity. It is determined by the degree and leading coefficient of the polynomial function.
- Teaching polynomial functions through application methods helps trainees develop a deeper understanding of how mathematical models can represent and analyze various phenomena, fostering connections between abstract concepts and practical situations.
- Teaching polynomial functions through application methods offers opportunities for you to practice problem-solving techniques, model real-world phenomena, and make predictions based on mathematical analysis, fostering analytical thinking and decision-making abilities.

Activity-4: Conceptual Challenges (20 minutes).

What are the challenges students or even teachers face in understanding the concept of polynomial function? (*To answer this question, refer to the content in the new textbook*)

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

Takeaway Resources

https://www.youtube.com/watch?v=jLCftTjDLO4

https://www.youtube.com/watch?v=BmBXqM2EZk0

Section 3.2: Teaching Rational Functions (3 hrs.)

Session Objectives:

After completing this session, you will be able to:

- ❖ Identify effective teaching strategies for teaching rational functions
- ❖ realize the structure of rational functions as ratios of polynomial functions, recognizing the numerator, denominator, and the restrictions on the domain.
- ❖ identify and analyze asymptotes in rational functions.
- ❖ interpret and sketch graphs of rational functions.
- ❖ understand simplification techniques
- ❖ illustrate the practical applications of rational functions in real-world phenomena.
- ❖ Adapt the discussion to their own situations and then plan to use it to their own classrooms.

☞**Activities**

Activity-1: Teachers Reflection on their Teaching (30 minutes)

How did you teach rational functions to your students? (you can frame your reflection in terms of the following key components of instruction)

- ✓ Activating students' prior knowledge
- ✓ Nature of tasks/activities provided (context, multiple representation, examples/non-examples, etc.)
- ✓ Students classroom discussion and teacher's role in the discussion
- ✓ Summary/consolidation

✓ Challenges you face in teaching

Activity-2: Real-life Application of Rational Function (30 minutes).

Watch the following video about application of real-life examples of rational functions and reflect to the whole group?

https://www.youtube.com/watch?v=d-W5SnyRtE8 (In physics)

https://www.youtube.com/watch?v=0Z9Bc7Lgpcg (In economics)

Key Ideas

❖ In economics, rational functions are used to model supply and demand curves, cost functions, and profit maximization in business decision-making.

❖ Rational functions play a vital role in engineering and physics to describe harmonic motion, electrical circuits, fluid dynamics, and resonance phenomena, analyzing vibrations, and predicting system behavior.

❖ In chemistry, rational functions are employed to model reaction rates, concentration changes over time, and pH levels in chemical solutions, assisting chemists in understanding reaction kinetics, formulating chemical equations, and predicting equilibrium states.

❖ Rational functions are utilized in medical science to analyze blood flow rates, drug interactions, dose-response relationships, and growth models in biological systems, providing healthcare professionals with tools to predict outcomes, optimize treatment plans, and interpret medical data.

❖ Teaching real-life applications of rational functions helps you to develop a deeper contextual understanding of how mathematical models are used in diverse fields, while also honing their skills in applying mathematical concepts to real-world problems.

❖ Teaching real-life applications of rational functions equips you with skills and knowledge applicable in future careers, such as data analysis, modeling, problem-solving, and decision-making, preparing them for practical use of mathematics in professional settings.

Activity-3. Teaching graphs of Rational Functions using GeoGebra (1.30 hrs).

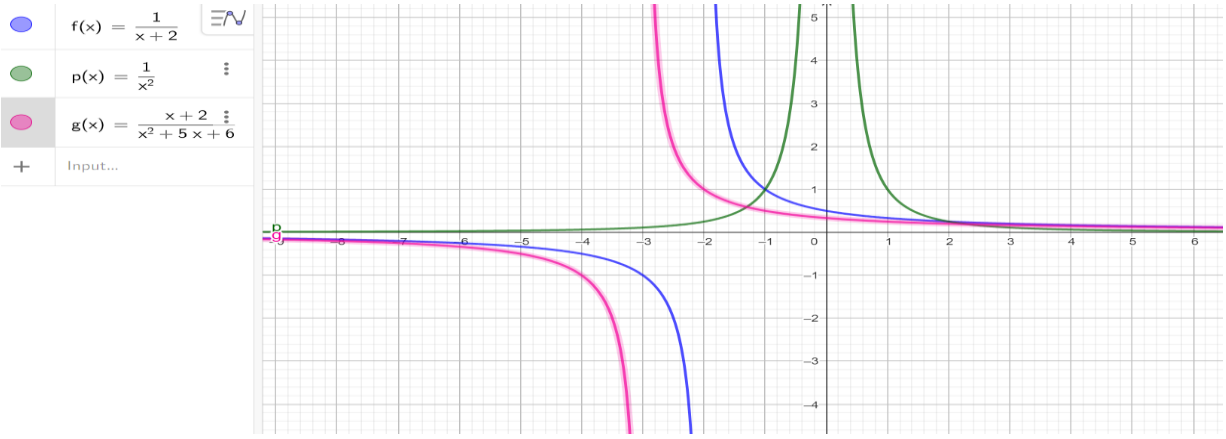
Discuss how you teach sketching graphs of rational functions using GeoGebra with your peers by using the following steps.

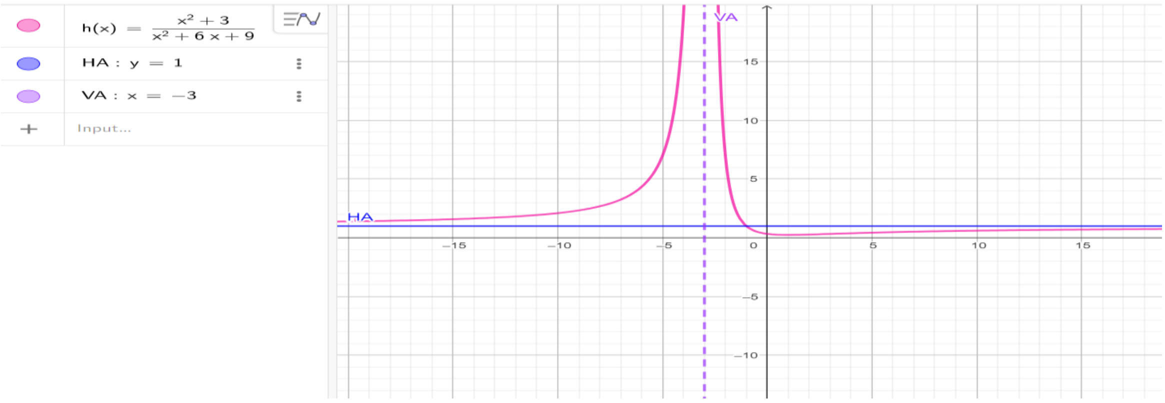
1. Open GeoGebra and set up the coordinate axes to create a suitable graphing environment for plotting the rational functions, ensuring students can visualize the representation effectively.

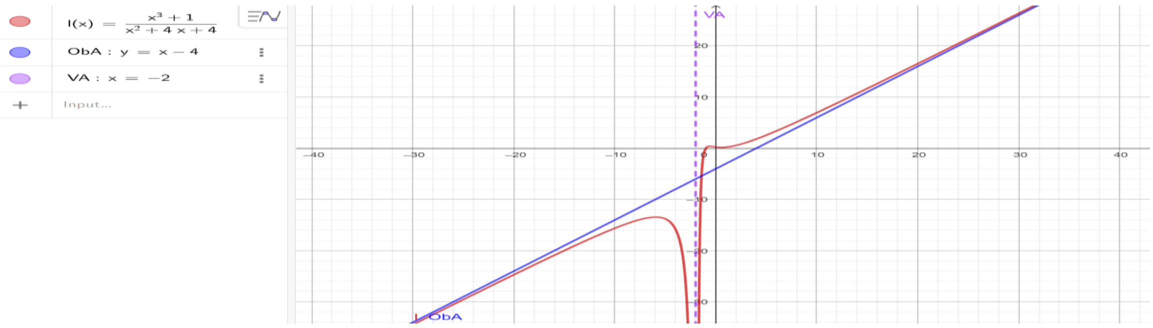
2. Choose different examples of rational functions from grade 11 student text book with varying degrees in the numerator and denominator to demonstrate different graph behaviors and characteristics during the activity.

3. Input the selected rational function equations into GeoGebra

4. Plot the rational functions on the graph by depicting the function curve based on the input equations, observe the shape, intercepts, asymptotes, and behavior of the function visually.







5.analyz the graphed rational functions, prompting them to identify key features such as x-intercepts, y-intercepts, asymptotes (vertical, horizontal, or oblique), and any discontinuities in the function.

Key Ideas

❖ Vertical asymptotes occur at values of $'x'$ where the denominator of the rational function equals zero, leading to vertical lines on the graph where the function approaches infinity or negative infinity.

❖ Horizontal asymptotes indicate the behavior of the function as $'x'$ approaches positive or negative infinity based on the degrees of the numerator and denominator polynomials, describing the function's end behavior at extremes.

❖ Holes occur where factors in the numerator and denominator cancel out, leading to discontinuities in the graph. Represent holes as open circles on the graph, indicating points where the function is undefined.

❖ If $p(x)$ and $q(x)$ be polynomials with no common factors other than one. The graph of the rational function $f(x) = \frac{p(x)}{q(x)}$ with $p(x) = a_m x^m + a_{m-1} x^{m-1} + \ldots + a_1 x + a_0$ and $q(x) = b_n x^n + b_{n-1} x^{n-1} + \ldots + b_1 x + b_0$ has the following characteristics.

1. The x-intercepts of the graph of f are the real zeros of $p(x)$.
2. The graph of f has vertical asymptotes at each real zero of $q(x)$.
3. The graph of f has at most one horizontal asymptote.
   a) If $m < n$, then the line $y = 0$ is a horizontal asymptote.
   b) If $m = n$, then the line $y = \frac{a_m}{b_n}$ is a horizontal asymptote.
4. If m > n, then the graph f has oblique asymptote of the form $y = ax + b$.

❖ Vertical asymptotes indicate values of $'x'$ where the function approaches infinity or negative infinity, leading to breaks in the graph where the function is undefined due to division by zero in the denominator. The presence of vertical asymptotes signifies points where the function exhibits infinite behavior, such as rapid growth or decay, but the graph itself does not cross these asymptotes.

❖ When graphing rational functions with vertical asymptotes, the function approaches the asymptote but does not intersect or cross it. Instead, the graph may show a clear gap or break in continuity at the vertical asymptote, indicating points where the function is not defined. Graphically, vertical asymptotes are represented as dashed lines on the coordinate plane, helping visualize where the function approaches but does not cross these asymptotic line

❖ A rational function can cross a horizontal asymptote. This crossing occurs when the function behaves in such a way that it intersects the horizontal line defined by the asymptote on the graph. This indicates that the function and the horizontal asymptote meet at specific points along the graph, showing deviations from the asymptotic behavior at those particular values of $'x'$. Crossings of horizontal asymptotes provide valuable insights into how the function behaves in relation to the asymptote at specific points on the graph.

❖ The graphs can cross oblique asymptotes. Oblique asymptotes, also known as slant asymptotes, are non-horizontal lines that the function approaches as x approaches positive or negative infinity. The crossing of an oblique asymptote by the graph of a rational function occurs when the curve of the function intersects or coincides with the slant line of the oblique asymptote on the graph. This crossing signifies how the function aligns with or deviates from the oblique asymptote at particular points, illustrating the relationship between the function's curve and the slant line as the function approaches extreme values. The crossing of oblique asymptotes provides insights into the behavior of the rational function and its convergence towards the slant asymptote in specific regions of the graph.

❖ Using GeoGebra to teach graphs of rational functions allows teachers to provide visual representations of complex mathematical concepts, making abstract ideas more tangible and enhancing students' understanding through interactive visualizations.

❖ Teachers can facilitate dynamic exploration of rational function graphs using GeoGebra's interactive features, enabling students to experiment with adjusting parameters, analyzing curve behaviors, and investigating key graph features such as asymptotes, intercepts, and end behavior in a hands-on manner.

❖ Teaching graphs of rational functions with GeoGebra helps develop students' technological literacy as they navigate the software to explore mathematical concepts, visualize function graphs, and analyze graphical representations, enhancing their proficiency in using digital tools for mathematical purposes.

Activity-4: Conceptual Challenges (20 minutes).

What are the challenges students or even teachers face in understanding the concept of rational of function? (*To answer this question, refer to the content in the new textbook*)

Homework Activity (10 minutes).

1. Take rational functions independently from grade 11 students text book, draw its graph using GeoGebra, first input your chosen rational function equations, graph them, and analyze the resulting graphs to deepen your understanding of the functions' behavior visually and reflect to your colleagues.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

Takeaway Resources

https://www.youtube.com/watch?v=fy45qX8cUwQ

https://www.youtube.com/watch?v=hZDUfsWk4n0

https://www.youtube.com/watch?v=CQhPrdLdxbE

https://www.youtube.com/watch?v=fy45qX8cUwQ

GeoGebra software

Unit Summery

Teaching polynomial functions involves introducing students to the concept of algebraic functions that can be written in the form $f(x)=a_0+a_1x+...+ a_n x^n$. Trainees learn about the different types of polynomials, such as linear, quadratic, cubic, and higher-degree polynomials, and how to identify their key characteristics, including degree, leading coefficient, and end behavior. They also explore how to graph polynomial functions, analyze their behavior, and solve polynomial equations using various techniques such as factoring and the rational root theorem.

Rational functions, on the other hand, are functions that can be expressed as the ratio of two polynomials, $f(x) = \frac{p(x)}{q(x)}$, where $p(x)$ and $q(x)$ are polynomials and $q(x) \neq 0$. Rational functions may have vertical asymptotes where the denominator is zero, horizontal asymptotes determined by the degrees of the numerator and denominator polynomials, and holes in the graph where factors cancel out. These functions can exhibit a wide range of behaviors, including discontinuities, and asymptotic behavior as x approaches infinity or negative infinity. Rational functions are important in calculus and mathematical analysis due to their relationship with limits and derivatives. In general, teaching polynomial and rational functions equips students with essential algebraic tools for understanding and analyzing a wide range of mathematical functions.

Unit 4: Teaching Exponential and Logarithmic Functions (9 hrs.)

Introduction

Exponential and logarithmic functions arise in many natural phenomena. Some of the many applications of exponential and logarithmic functions include the following: (1) In Population Growth and Decay, exponential functions model exponential growth (e.g., population growth, bacterial growth), and logarithmic functions model exponential decay (e.g., radioactive decay, drug elimination). (2) In Finance, exponential functions model compound interest and continuous growth, and logarithmic functions solve equations involving compound interest and present value calculations. (3) In Chemistry, exponential functions model the rate of chemical reactions and the decay of radioactive isotopes, and logarithmic functions are used to calculate pH levels and equilibrium constants. (4) In Computer Science, exponential functions model the growth of data in algorithms and the complexity of computations, and logarithmic functions are used in sorting algorithms and data compression techniques. (5) In Physics, exponential functions model the intensity of light and sound waves, and logarithmic functions are used to measure the intensity of earthquakes (Richter scale) and the loudness of sound (decibel scale). (6) In Engineering, exponential functions model the growth of populations of microorganisms in bioreactors, and logarithmic functions are used in signal processing and control systems. (7) In Economics, exponential functions model exponential growth in economic indicators (e.g., GDP, inflation), and logarithmic functions are used to model demand curves and elasticity. (8) In Medicine, exponential functions model the growth of bacteria in infections, and logarithmic functions are used to calculate drug dosages and the effectiveness of treatments.

These are just a few examples of the numerous applications of exponential and logarithmic functions. Their ability to model exponential growth and decay, as well as their inverse relationship, makes them indispensable tools in various scientific, engineering, and real-world domains. To understand these natural processes of growth and decay, it is important, then, to understand the properties of exponential and logarithmic functions. In this unit, we will explore the concepts of exponential and logarithmic functions in different ways. We will also explore the different approaches you can use to teach the concepts of exponential and logarithmic functions. There are four main sessions include in this unit: exponential functions, graphs of exponential functions, logarithmic functions, and graphs of logarithmic functions.

Unit Outcomes

After completing this unit, you will be able to:

- ✓ Understand the concepts of exponential and logarithmic functions meaningfully.
- ✓ Know various approaches of teaching the exponential and logarithmic functions.

Key contents

Session 4.1: Teaching Exponential Functions (2 hrs.)

Session 4.2: Teaching Graphs of Exponential Functions (2 hrs.)

Session 4.3: Teaching Logarithmic Functions (2 hrs.)

Session 4.4: Teaching Graphs of Logarithmic Functions (3 hrs.)
Unit Summary

Session 4.1: Teaching Exponential Functions (2 hrs.)

Ethiopia is the second most populous country in Africa with a population of about 120 million people in 2021 (Source: https://www.globaldata.com). The population is growing at a rate of about 2.6% each year. When populations grow rapidly, we often say that the growth is "exponential," meaning that something is growing very rapidly. To a mathematician, however, the term *exponential growth* has a very specific meaning. In this session, we will take a look at *exponential functions*, which model this kind of rapid growth and rapid decay as well. We will also explore the teaching approaches teachers can use to teach exponential functions in their classrooms.

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Discuss various ways of teaching exponential function.
- ✓ Identify effective teaching strategies for teaching exponential function.
- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of exponential function.
- ✓ Improve your conceptual understanding of exponential function.
- ✓ Adapt the discussion to your own situations and then plan to use it to your own classrooms.

Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about exponential function? You can frame your answer based on the following questions.

a) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

b) What teaching strategies would you use to improve the instruction?

c) How would you tackle the challenges you face in teaching the concept?

Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson (Lesson 4.1) as a case study that a teacher taught the concept of exponential function to grade 10 students. Read through the lesson and then answer the following questions. Work in pairs and then share it to the whole class.

a) Is it similar to the way that you teach the concept?
b) Do you prefer to use it in your classroom? Why?
c) Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 4.1: Exponential Function

Learning Objectives:

At the end of this lesson, students will be able to:

2. Define an exponential function representing a scenario involving growth or decay.
3. Identify if a function is modeling growth or decay.
4. Sketch graphs of exponential functions of the form $f(x) = b^x$, for $0 < b < 1$ and $b > 1$.

Introduction:

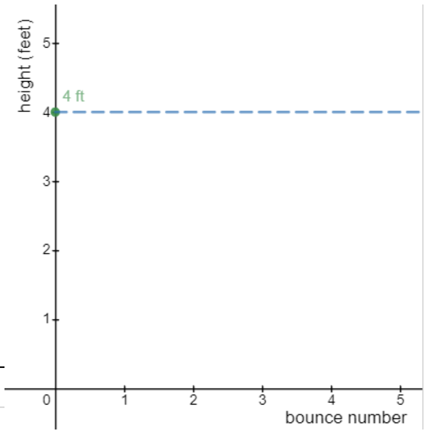
The following activities introduce the idea of exponential growth and decay. From the activities you will observe how the pattern in an exponential function is different from the pattern in a linear function.

Activity-1: Figure out which balls are bad

You own a tennis ball manufacturing company. An angry employee just added a bunch of BAD tennis balls to a shipment. Your job is to figure out which tennis balls are bad.

1. How did you determine if the tennis balls were good or bad?
2. Once you have made a ball that would meet the regulations set by the International Tennis Federation, fill in the table below with the bounce heights for each corresponding bounce number. Then sketch a graph of the heights. *(The International Tennis Federation has ruled that tennis balls must have a rebound height of 50% of its previous bounce height.)*
3. Find the height of the ball in the 10^{th} and 20^{th} bounces?
4. Which type of function best models your tennis ball?
5. Write your equation. What do you think the values in the equation mean?

Bounce #	Height (ft.)
0	4
1	
2	
3	
4	
5	

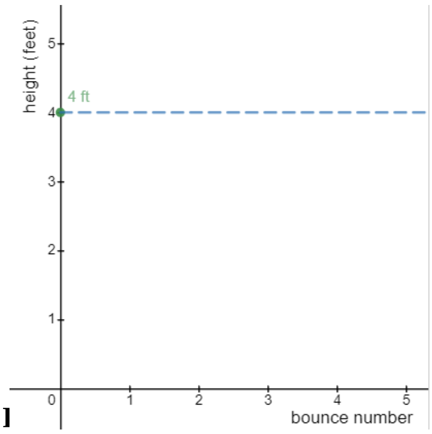


Activity-2: Double your pay

A company owner hires you as a computer programmer. You will be paid 1 birr for the first job and then your pay will be doubled each time you complete a job.

a. How much money should you expect to make on the third job?
b. Fill in the table below with the payment in birr for each corresponding job. Then sketch a graph of the payment.
c. Write a rule that gives how much money you will make on the nth job.
d. On which job will you first make over a million birr per job?

Job #	Pay (birr)
1	1
2	
3	
4	
5	



Important Ideas: Exponential I

Exponential functions are of the form y = b^x or y = a.b^x , where a is the initial amount and b is the growth/decay rate.

If 0 < b < 1, we have exponential decay

If b > 1, we have exponential growth.

Check Your Understanding

1. If the initial population of rats was 20 and grew to 25 after the first year, which of the following functions best models the population of rats, P, with respect to the number of years, t, if the population growth of rats is considered to be exponential?
   a. $P = 5t + 20$ b. $P = 20(1.25)^t$
   c. $P = 20(1.2)^t$ d. $P = 5t^2 + 20$

a. Suppose that you deposit money into a savings account that receives 5% interest per year on the amount of money that is in the account for that year. Assume that you deposit $400 into the account initially.
   a. How much money is in the account at the end of the year?
   b. Determine the amount of money in the account after 2 years and 10 years.
   c. Give an equation for the amount in the savings account S(t) as a function of the number of years since the $400 was invested.
   d. How long it will take for the initial investment of $400 to double?

Key Ideas

As you can see from the case study lesson, the activities provided students the opportunity to explore the concept of exponential function by them-selves through solving context embedded non-routine problems. The problems were used to explore both exponential growth and decay. The lesson followed the "Experience First and Formalize Later" approach, so that after doing the activities, students are to formalize the definition of exponential function.

Activity-3: Conceptual Challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of exponential function? *To answer this question, you need to refer to the content in the new textbook.*

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/algebra/x2f8bb11595b61c86:exponential-growth-decay

Session 4.2: Teaching Graphs of Exponential Functions (2 hrs.)

As is indicated in the introduction section of the unit, exponential functions are used for many real-world applications. Working with an equation that describes a real-world situation gives us a method for making predictions. Most of the time, however, the equation itself is not enough. We learn a lot about things by seeing their pictorial representations, and that is exactly why graphing exponential equations is a powerful tool. It gives us another layer of insight for predicting future events.

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Discuss various ways of teaching graphs of exponential functions.

- ✓ Identify effective teaching strategies for teaching graphs of exponential functions.
- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of graphs of exponential functions.
- ✓ Improve your conceptual understanding of graphs of exponential functions.

Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about graphs of exponential function? You can frame your answer based on the following questions.

a) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

b) What teaching strategies would you use to improve the instruction?

c) How would you tackle the challenges you face in teaching the concept?

Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson as a case study that a teacher taught the concept of graphs of exponential functions to grade 10 students. Read through the lesson and then answer the following questions. Work in pairs and then share your answer to the whole class.

a) Is it similar to the way that you teach the concept?
b) Do you prefer to use it in your classroom? Why?
c) Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 4.2: Graphs of Exponential Functions

Learning Objectives:

At the end of this lesson, students will be able to:

5. Identify the domain and range of an exponential function.
6. Sketch graphs of exponential functions and identify the y-intercept and asymptote.
7. Describe transformations of an exponential function from graphs and equations.

Introduction:

In lesson 4.1, we explored how the height of a bouncing ball could be modeled by an exponential relationship. In this lesson, we'll look at more graphs of exponential equations and use what we know about transformations to match the graphs to their equations.

Activity: Matching graphs

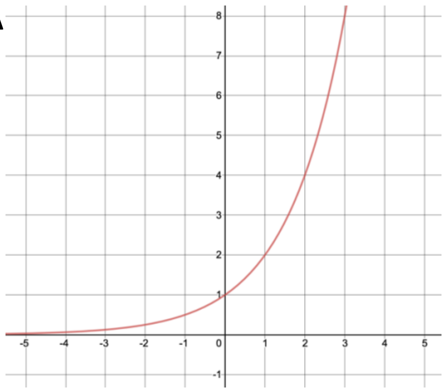
1. Match graphs A-F with their equation. Record your results in the table.

Graph	Function

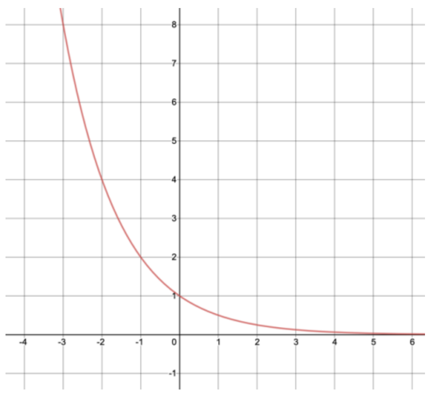
2. How can you tell from an equation whether the function models exponential growth or decay?
3. Student A believes that graph **D** represents the parent function $y = 3^x$ after it has been shifted to the left one unit. Student B believes that graph **D** represents the parent function $y = 3^x$ after it has been vertically stretched by a factor of 3. Who is correct? Give a convincing reason.

$y = \left(\frac{1}{2}\right)^x$	$y = 3^x + 2$	$y = -2^x$
$y = 2^x - 1$	$y = 2^x$	$y = 3^{x+1}$

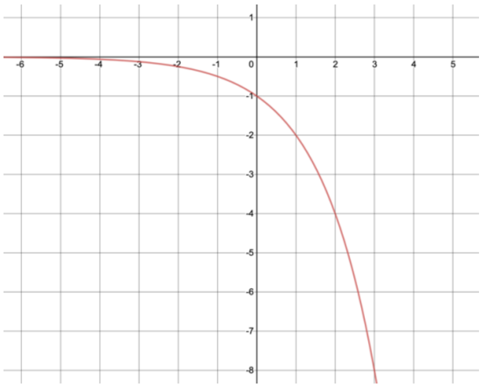
A



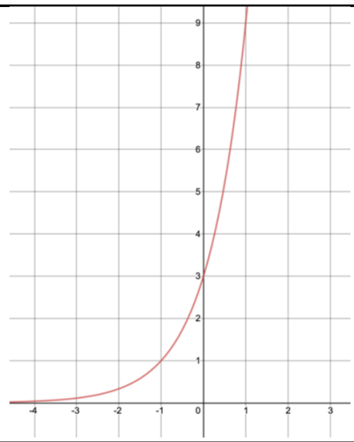
B



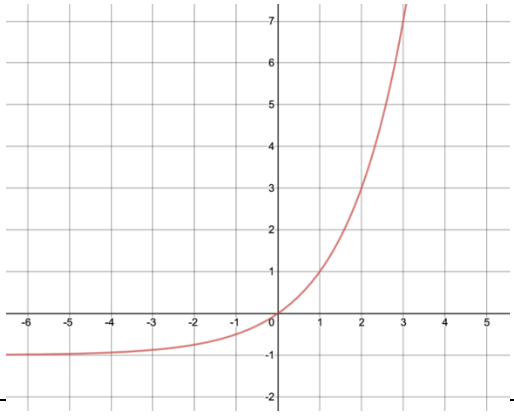
C



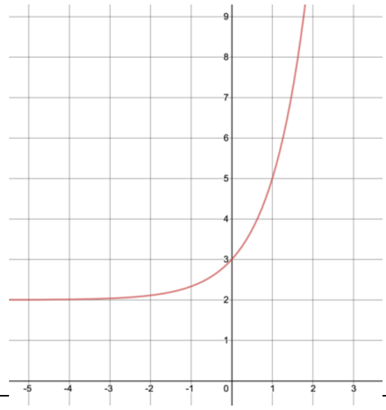
D



E



F



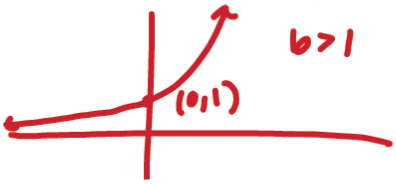
4. Let $f(x) = 2^x + 1$.
   a. List the parent function and describe what transformations occurred to produce $g(x)$.
   b. What is the domain of $g(x)$?
   c. What is the range of $g(x)$?
   d. Find the y-intercept of $g(x)$.
   e. Write the equations of any asymptotes of $g(x)$.
   f. Sketch the graph of $g(x)$.

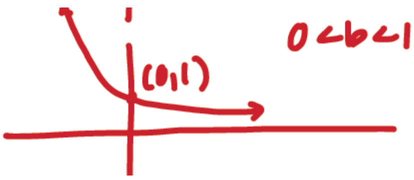
Important Ideas: Graphs of Exponential Functions

Let $f(x) = b^x$.

- Since, $f(0) = b^0 = 1$, the y-intercept is at (0,1).
- Domain of f is IR
- Range of f is {y: y > 0}
- Horizontal asymptote is y = 0 (or the x-axis).

Transformations affect range and horizontal asymptote.





Check Your Understanding

1. Let $g(x) = 2^{x+1} + 6$.
   a. List the parent function and describe what transformations occurred to produce $g(x)$.

b. What is the domain of $g(x)$? What is the range of $g(x)$?

c. Find the y-intercept of $g(x)$.

d. Write the equations of any asymptotes of $g(x)$.

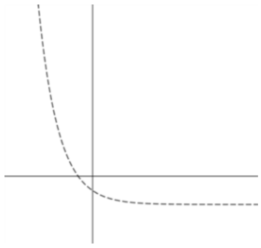
2. An exponential function of the form $f(x) = a^x + c$ is shown. Which of the following statements MUST be true?

a. $c < -1$

b. $a = \frac{1}{2}$

c. $a + c > 0$

d. $0 < a < 1$



Key Ideas

When you teach graphing exponential functions, you need to guide students through the process by identifying key points such as the y-intercept (when x = 0), the behavior as x approaches positive or negative infinity, and any horizontal asymptotes. Emphasize the exponential growth or decay nature of the graph based on the value of the base "a" and how it impacts the shape of the graph.

After graphing parent functions such as $f(x) = 2^x$, students need to learn about transformations of exponential functions, such as vertical shifts, horizontal shifts, reflections, and stretches/compressions. Help students understand how each transformation affects the graph of the exponential function and how to identify these transformations in different scenarios. You can also connect the graph of exponential functions to real-world applications and scenarios to help students understand the practical significance of exponential growth and decay. Explore examples such as population growth, compound interest, and radioactive decay to demonstrate how exponential functions are used to model various phenomena in different fields. Encourage students to analyze and interpret graphs of exponential functions in context to deepen their understanding of the concepts.

Activity-3: Conceptual challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of graphs of exponential functions? *To answer this question, you need to refer to the content in the new textbook.*

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy: https://www.khanacademy.org/test-prep/v2-sat-math/x0fcc98a58ba3bea7:advanced-math-easier/x0fcc98a58ba3bea7:exponential-graphs-easier/a/v2-sat-lesson-exponential-graphs

Session 4.3: Teaching Logarithmic Functions (2 hrs.)

Logarithmic functions are the inverse of exponential functions and provide valuable insights into relationships involving exponential growth or decay. In this session, we will take a look at *logarithmic functions*, which model this kind of growth or decay. We will also explore the teaching approaches teachers can use to teach logarithmic functions in their classrooms.

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Discuss various ways of teaching logarithmic functions.
- ✓ Identify effective teaching strategies for logarithmic functions.
- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of logarithmic functions.
- ✓ Improve your conceptual understanding of logarithmic functions.
- ✓ Adapt the discussion to your own situations and then plan to use it to your own classrooms.

Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about logarithmic function? You can frame your answer based on the following questions.

a) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

b) What teaching strategies would you use to improve the instruction?

c) How would you tackle the challenges you face in teaching the concept?

Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson as a case study that a teacher taught the concept of logarithmic functions to grade 10 students. Read through the lesson and then answer the following questions. Work in pairs and share your answer to the whole class.

a) Is it similar to the way that you teach the concept?
b) Do you prefer to use it in your classroom? Why?
c) Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 4.3: Logarithmic Functions

Learning Objectives:

At the end of this lesson, students will be able to:

8. Define a logarithmic function representing a scenario involving growth or decay.
9. Describe a logarithmic function as an inverse function of an exponential function.
10. Convert equations from exponential form to logarithmic form and vice versa to solve simple exponential and logarithmic equations.

Introduction:

We've been working with a lot of exponential functions, but today we're going to explore a different kind of function. Can you figure out how it works?

Activity: A mystery function

1. Selected values of a mystery function are given in the table below. Fill in the table as much as you can.

x	4	2	½	1	16	8	1/8	64	32	0	1/4	-1	$\sqrt{2}$	3
y	2		-1		4	3			5				1/2	

2. Write a rule that relates x and y.
3. Which of the outputs were you not able to find? Why do you think that is?
4. Student A believes that $(24, 4.585)$ is a point on the graph of this function. Is he correct? How do you know?
5. How are the outputs for $x = 8$ and $x = 1/8$ related? Why do you think this happens?
6. Student B thinks that the output for $x = 3$, would be $y = 1.5$. Give a convincing argument to prove whether she is correct or not.
7. Student C wants to know what power she can raise 4 to, to get 64. She writes $4^{?} = 64$.
   - How is this similar or different than the mystery function?
   - Provide Student C with a strategy for figuring out what "?" is.

Important Ideas: Logarithmic Functions

The output of a logarithmic function tells you what exponent you must raise the base to, to arrive at the input.

$\log b^{X} = y \quad \longleftrightarrow \quad b^{y} = x$

Logarithmic form		Exponential form

If no subscript is given, assume b = 10. If the base is e, use the natural log : $\log_e{}^{x} \rightarrow \ln x$

Domain : x > 0 (since powers of b are always positive)

Range : IR (since exponents can be negative or positive.)

Check Your Understanding

1. Evaluate each logarithm. Then write the logarithmic equation in exponential form.

   a. $\log_2 32$ b. $\log_5 5$ c. $\log_{36} 6$ d. $\log \frac{1}{100}$ e. $\ln e^3$

2. Fill in the table of values for each function.

x	-1	0	1	2	3
$f(x) = 3^x$					

x	1/3	1	3	9	81
$g(x) = \log_3 x$					

   What is the relationship between $f(x)$ and $g(x)$? How could someone tell this just by looking at the entries in the table?

3. You have a juicy secret. On the first day of school you tell your closest friend. On the second day you both tell one other person. Every day, each person that knows the secret passes it on to one more person that hasn't heard it before.
   a. On what day will 64 people have heard the rumor?
   b. On what day will the whole city of Kentwood (population 51, 868) have heard the rumor?

Key Ideas

To help students understanding logarithmic function, you need to start by emphasizing that logarithmic functions are the inverse of exponential functions, meaning that they "undo" the effects of exponential functions. Help students see how logarithmic functions can be used to solve exponential equations and vice-versa. You can also explore real-world applications of logarithmic functions to help students understand their practical significance. Examples include measuring acidity with pH levels, modeling earthquake intensity with the Richter scale, and analyzing exponential growth rates using the concept of doubling time. Encourage students to apply logarithmic functions to solve problems in various fields and interpret the results in context to deepen their understanding of logarithmic functions.

Activity-3: Conceptual Challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of logarithmic functions? *To answer this question, you need to refer to the content in the new textbook.*

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/algebra-home/alg-exp-and-log

Session 4.4: Teaching Graphs of Logarithmic Functions (3 hrs.)

In the session on Graphs of Exponential Functions, we saw how creating a graphical representation of an exponential model gives us another layer of insight for predicting future events. How do logarithmic graphs give us insight into situations? Because every logarithmic function is the inverse function of an exponential function, we can think of every output on a logarithmic graph as the input for the corresponding inverse exponential equation.

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Identify effective teaching strategies for teaching graphs of logarithmic functions.
- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of graphs of logarithmic functions.
- ✓ Improve your conceptual understanding of graphs of logarithmic functions.

Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about graphs of logarithmic function? You can frame your answer based on the following questions.

a) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

b) What teaching strategies would you use to improve the instruction?

c) How would you tackle the challenges you face in teaching the concept?

Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson as a case study that a teacher taught the concept of graphs of logarithmic functions to grade 10 students. Read through the lesson and then answer the following questions. Work in pairs and share your answer to the whole class.

a) Is it similar to the way that you teach the concept?
b) Do you prefer to use it in your classroom? Why?
c) Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 4.4: Graphs of Logarithmic Functions

Learning Objectives:

At the end of this lesson, students will be able to:

- Identify the domain and range of a logarithmic function.
- Sketch graphs of logarithmic functions and identify the y-intercept and asymptote.
- Describe a logarithmic function as an inverse function of an exponential function.
- Describe transformations of a logarithmic function

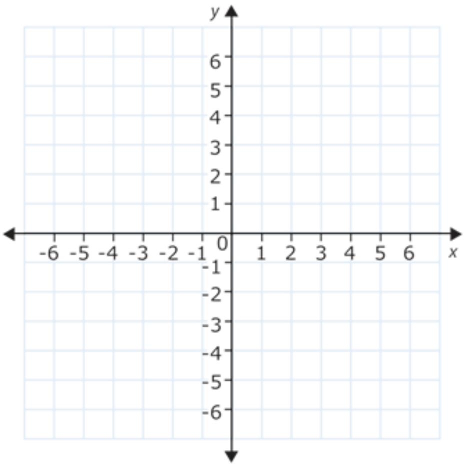
Introduction:
You learned yesterday that logarithms undo exponentials by finding the missing exponent. Today we're going to explore the graphs of these inverse functions.

Activity-1: Linking to exponential function

1. Consider the function $f(x) = 2^x$. Complete the table.

x	-2	0	1	2	3	4
$f(x)$						

2. Graph $f(x) = 2^x$ on the plane and use it to **complete the column for $f(x)$ only**.



Equation	$f(x) = 2^x$	$g(x) = \log_2 x$
Intercept		
Domain		
Range		
symptote		

3. Now consider another function, $g(x) = \log_2 x$. Complete the table.

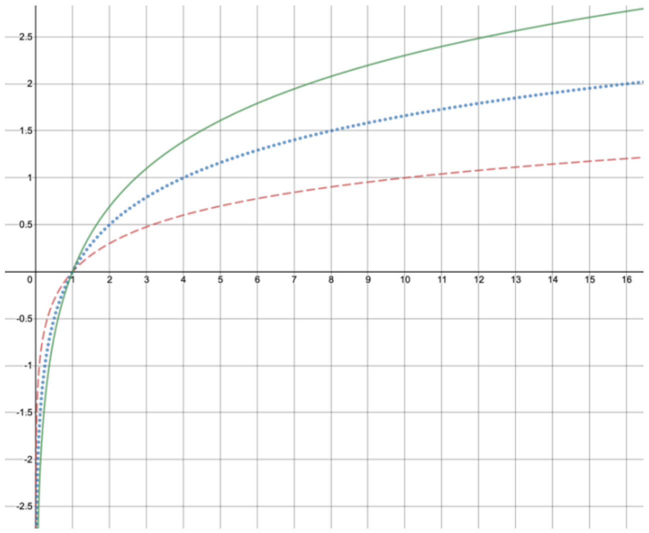
x	-5	1/8	1/4	1/2	1	2	4	8
$g(x)$								

4. Use the values from the table to graph $g(x)$ on the plane above with $f(x)$. Complete the column for $g(x)$ in question #1

5. Add the line $y = x$ to your graph. What do you notice?
6. How do the intercept, domain, range and asymptote of the exponential function relate the intercept, domain, range and asymptote of the logarithmic function?

Activity-2: Comparing Graphs

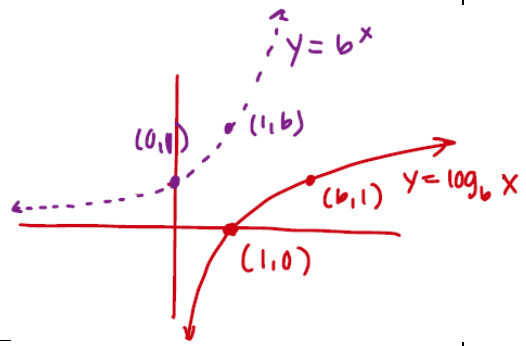
1. The graphs of three parent logarithmic functions are shown below.
   a) What do all of these graphs have in common?
   b) The equations for the three graphs are $y = \log x$, $y = \log_4 x$ and $y = \ln x$. Which is which? How do you know?
   c) Use the graph to estimate $\log_4 6$. What does your answer mean?



2. Suppose we shift the function $y = \log_4 x$ to the right three units.
   a) Write a new equation, $g(x)$, for the transformed function.
   b) How will this transformation affect the x-intercept, asymptote, domain, and range?

Important Ideas: Graphs of Logarithmic Functions

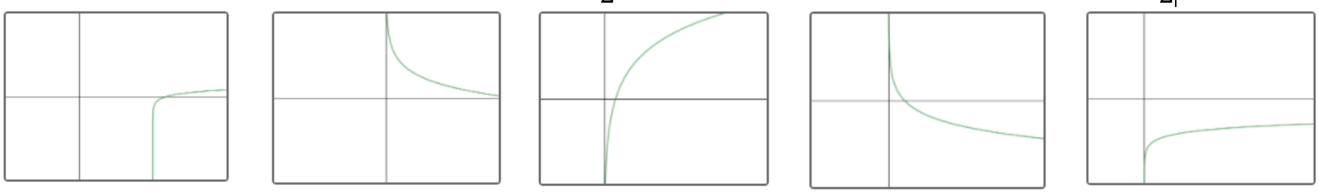
Parent logarithmic functions look like $y = \log_b{}^x$
for any base $b > 0$, $b \neq 1$.
Domain: $x > 0$
Range: IR
(1, 0) → x-intercept
Vertical asymptote: x = 0 (or the y-axis).
$y = b^x$ and $y = \log_b{}^x$ are inverses!



Check Your Understanding

1. Graph $f(x) = \log_3(-x)$ without a calculator and identify the following: Vertical Asymptote, x-intercept, domain, range.
2. Match the following equations with their graphs. Do not use a calculator.

$y = -2\log_2 x$ $\quad$ $y = 3\log_2 x$ $\quad$ $y = \frac{1}{2}\log_2(x-5)$ $\quad$ $y = -2\log_2 x + 5$ $\quad$ $y = \frac{1}{2}$



A	B	C	D	E

3. Sketch the graph of the function $y = 2 + \log_3(x - 4)$and find the intercept, domain, range and asymptote.

Key Ideas

To teach graphing of logarithmic functions, you better start by helping students understand the basic shape of a logarithmic function graph. Emphasize that the graph of a logarithmic function typically has a vertical asymptote at x = 0 (if the base is greater than 1) or x = 0 (if the base is between 0 and 1). The graph will also approach but never touch the y-axis. Then, help students to focus on how different transformations affect the graph of a logarithmic function. For example, changing the base of the logarithm will alter the steepness of the curve, while horizontal shifts will move the graph left or right. Encourage students to experiment with different transformations and observe how they impact the graph. Help students understand the domain and range of logarithmic functions. The domain of a logarithmic function is all positive real numbers, while the range is all real numbers. Explain how these restrictions are reflected in the graph and why certain values are not included in the domain or range.
In addition, you need to highlight the relationship between exponential and logarithmic functions when teaching graphs of logarithmic functions. Emphasize that the graph of a logarithmic function is the inverse of an exponential function, and show how this connection is reflected in their respective graphs. Encourage students to compare and contrast the graphs of exponential and logarithmic functions to deepen their understanding of these concepts.

Activity-3: Conceptual Challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of graphs of exponential functions? *To answer this question, you need to refer to the content in the new textbook.*

Activity-4: Lesson Design: Properties of exponents and logarithms (1 hr.)

Now let us put into practice what we have explored in this unit. This may take more time to finalize. If it is not finalized within the given time, it can be a homework activity. Let you work in pairs.

a) Look through your previous teaching plans and redesign the lesson according to your current understanding.
b) Write a comparison between the new lesson and your previous one.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/algebra-home/alg-exp-and-log/alg-graphs-of-logarithmic-functions/v/logarithmic-function-graphs

Unit Summary

Exponential and logarithmic functions are a fundamental topic in mathematics with wide-ranging applications across various fields. This unit delved into definitions, graphs, and applications of both types of functions. In the sample lessons, for example, students are provided the opportunity to explore the exponential growth and decay patterns exhibited by exponential functions and to learn how to transform their graphs. The lessons also provide the opportunity to study logarithmic functions as the inverses of exponential functions, understanding how to graph and solve equations involving logarithms.

The unit emphasized the close relationship between exponential and logarithmic functions, proving the inverse relationship between them. Real-world applications were incorporated throughout the unit, showcasing the relevance of these functions in modeling population growth, decay rates, financial calculations, and more.

Overall, this unit provided trainees with a solid foundation in exponential and logarithmic functions, equipping them with the knowledge and skills necessary to teach the concepts to their students in real classrooms.

Unit 5: Teaching Trigonometric Functions (8 hrs.)

Introduction:

Welcome to the lesson on Trigonometric Functions! In this session, we will explore the fundamental concepts of trigonometry and how it plays a crucial role in secondary school mathematics. Trigonometry deals with the study of triangles and the relationships between their sides and angles. Understanding trigonometric functions is essential for solving various mathematical problems involving angles, distances, and periodic patterns.

As a trainee, it is important to have a solid grasp of trigonometric functions so that you can effectively teach your students how to apply these concepts in real-world scenarios and in more advanced mathematical topics. By the end of this lesson, you will have a clear understanding of trigonometric functions like sine, cosine, and tangent, as well as how to use them to solve problems and analyze geometric relationships.

Unit Outcomes

After completing this unit, you will be able to:

- Identify effective teaching strategies for teaching Trigonometric Functions
- understand the basic trigonometric functions
- explain how trigonometric functions are used to solve problems involving right triangles.
- understand how trigonometric functions are related to the unit circle
- practical applications of trigonometric functions in real-world.
- identify how to graph trigonometric functions and understand their characteristics.
- Adapt the discussion to their own situations and then plan to use it to their own classrooms

Key Contents

Session 5.1: Teaching trigonometric Ratios based on right angled triangle(3hrs)

Session 5.2: Teaching trigonometric Values of different angles (3hrs)

Session 5.3: Teaching graphs of sine, cosine and tangent functions(2hrs)

Unit Summary

Session 5.1: Teaching Trigonometric Ratios based on Right Angled Triangle (3hrs)

Session Objectives:

After completing this unit, you will be able to:

- ensure that students grasp how the trigonometric ratios.
- apply trigonometric ratios to solve problems involving right-angled triangles.
- calculate the missing side lengths or angle measures using trigonometric functions
- identify special right-angled triangles

- apply the properties of these special triangles to simplify trigonometric calculations and problem-solving.

- demonstrate the practical relevance of trigonometric ratios in real-world scenarios.

☞**Activities:**

Activity-1: Teacher reflection on their Teaching (30 minutes)

How did you teach the trigonometric ratios based on a right-angled triangle to you students? (you can frame your reflection in terms of the following key components of instruction).

- ✓ Activating students' prior knowledge
- ✓ Nature of tasks/activities provided (context, multiple representation, routine/non-routine, etc.)
- ✓ Students classroom discussion and teacher's role in the discussion
- ✓ Summary/consolidation
- ✓ Challenges you face in teaching.

Activity 2: Real life application of Trigonometric Ratios (30 minutes).

Discuss real life application of trigonometric ratios in pairs and reflect to the whole class?

Key Ideas

- Architects use trigonometric ratios to calculate the height or width of a building, determine the slope of a roof, or calculate the measurements needed for constructing structures.
- Civil engineers use trigonometric ratios to design bridges, roads, and tunnels by calculating angles and distances. It helps them analyze forces acting on structures.
- Trigonometric ratios are used to analyze vectors, forces, and motion.
- Pilots, sailors, and navigators use trigonometry to calculate their position, course, and distances between points. Trigonometric ratios help in determining angles and distances on maps and charts.
- Relating trigonometric ratios to real-life situations helps trainees see the practical implications and utility of what they are learning. This can lead to a deeper understanding of the concepts.

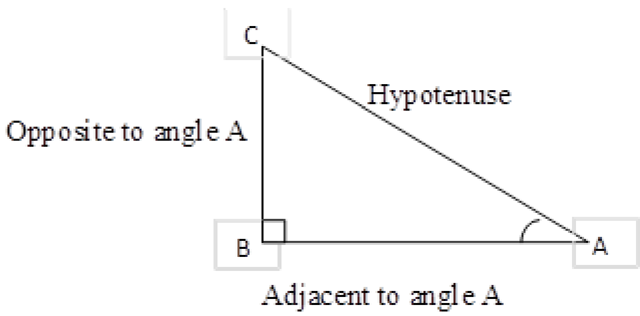
- Real-life applications of trigonometry allow trainees to make connections with other subjects such as physics, geography, and even art. This can foster a more holistic approach to learning and show students the interconnectedness of different disciplines.
- Real-life applications provide context for trigonometric concepts, making them more meaningful and easier to remember for trainees. This can lead to better retention and a deeper understanding of the material.

Activity-3: Teaching Trigonometric Ratios using Tangram puzzle or GeoGebra(1hrs).

Be in small group, discuss on how you teach Trigonometric Ratios using:

a. **Tangram puzzle**

1. Take a set of tangram puzzle pieces or printable tangram templates.
2. Start by drawing a right-angled triangle ABC with right angle at B. discuss the trigonometric ratios of the acute angles to conclude that the ratios are the same as the following ratios.



$$\sin A = \frac{Side opposite angle A}{hypotenuse} = \frac{BC}{AC}$$

$$\cos A = \frac{Side adjacent angle A}{hypotenuse} = \frac{AB}{AC}$$

$$\tan A = \frac{Side\ opposite\ angle\ A}{Side\ adjacent\ angle\ A} = \frac{BC}{AB}$$

Figure 3: Right angled triangle

3. explain how these ratios are calculated based on the sides of the triangle and the angles involved.
4. use the tangram pieces to create a right-angled triangle and label the sides of the triangle with specific lengths (e.g., 3 cm, 4 cm, 5 cm).
5. measure the angles and sides of their tangram triangle using a ruler or protractor.
6. calculate the sine, cosine, and tangent ratios for the angles in the triangle.
7. compare and discuss their findings with each other to deepen their understanding of trigonometric ratios.

b. GeoGebra.

1. Open GeoGebra and create a right triangle using the "Polygon" tool. Label the vertices as A, B, and C, with angle A as the right angle.

2. Use the "Segment" tool to draw the three sides of the triangle and label them as a, b, and c, where side c is the hypotenuse.

3. Use the "Angle" tool to measure and display the values of angle B and angle C in the triangle.

4. show how sine, cosine, and tangent are defined as the ratios of the lengths of the sides of the triangle.

5. Use the "Input" box in GeoGebra to create dynamic labels for the trigonometric ratios (sin, cos, tan) based on the measurements of the sides of the triangle.

6. interact with the triangle by dragging the vertices to change the angles and side lengths. Have them observe how the trigonometric ratios change as the angles and side lengths are varied.

7. make observations about the relationships between the angles, side lengths, and trigonometric ratios. Identify patterns and make conjectures based on their observations.

Key Ideas

- Relationships between Ratios: The trigonometric ratios are interconnected and can be used to find missing angles or side lengths in right-angled triangles. These ratios help us calculate various trigonometric functions based on the angles involved in a triangle.
- Tangram puzzles provide a hands-on learning experience that allows trainees to physically manipulate geometric shapes, leading to a deeper understanding of trigonometric concepts. This hands-on approach can help teachers engage with the material in a more meaningful way.
- By actively working with tangram puzzles to explore trigonometric ratios, trainees can engage in active learning experiences that promote critical thinking and problem-solving skills. This engagement can lead to a more interactive and dynamic teaching style in the classroom.
- GeoGebra provides a dynamic and visual way to represent geometric concepts, making it easier for trainees to understand abstract ideas such as trigonometric ratios. Trainees can use GeoGebra to create interactive diagrams that help students visualize the relationships between angles and side lengths in right triangles.
- Teaching trigonometric ratios using GeoGebra can also benefit trainees by enhancing their own technology skills and pedagogical practices. Trainees can explore new ways of integrating technology into their teaching, collaborate with colleagues, and stay up-to-date with innovative instructional strategies.

Activity-4: Conceptual Challenges (30 minutes).

What are the challenges students or even teachers face in understanding about trigonometric ratios? (*To answer this question, refer to the content in the new textbook*)

Homework Activity (30 minutes).

Take two practice problems from grade 10 students' text book to apply your understanding of trigonometric ratios using GeoGebra. Use the software to verify your calculations and explore different scenarios.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

Takeaway Resources

GeoGebra software

Session 5.2: Teaching Trigonometric Values of different Angles(3hrs)

Session Objectives:

After completing this session, you will be able to:

- ✓ identify effective teaching strategies for teaching trigonometric values of different angles
- ✓ understands the concept of trigonometric ratios (sine, cosine, tangent, cosecant, secant, and cotangent) and their relationship with right-angled triangles.
- ✓ calculate trigonometric values for standard angles (0°, 30°, 45°, 60°, 90°) and to apply these values in solving geometry and physics problems.
- ✓ find trigonometric values for any angle (acute, obtuse, or reflex angles) using reference angles and the unit circle.
- ✓ explore the applications of trigonometric values in real-world scenarios
- ✓ adapt the discussion to their own situations and then plan to use it to their own classrooms.

☞**Activities:**

Activity-1: Teachers Reflection on their Teaching (30 minutes)

How did you teach finding trigonometric values of different angles to your students? (you can frame in terms of the following components of instruction)

- ✓ Activating students' prior knowledge
- ✓ Nature of tasks/activities provided (context, multiple representation, routine/non-routine, etc.)
- ✓ Students classroom discussion and teacher's role in the discussion
- ✓ Summary/consolidation
- ✓ Challenges you face in teaching

Activities-2: Teaching the Concepts of Angle using Think-pair-share (30 minutes).

1.Define the word 'Angle'. Do this individually and then share your definitions in pairs. List all the definitions forwarded by each pair and list down on the blackboard and reflect on it to the whole class.

2. discuss on how you teach angles in standard position. After the discussion, reflect your discussion to the whole class.

watch this link https://www.youtube.com/watch?v=LFY5JuQ49Kg (5 minutes)

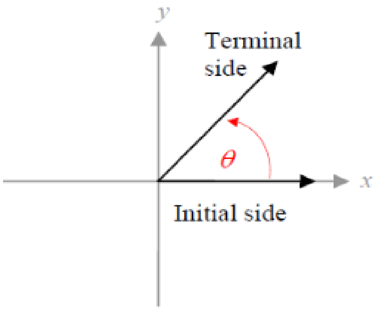
Key Ideas

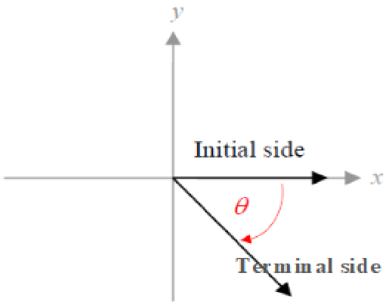
- Angle is a measure of rotation of a given ray about its initial point. The original ray is called the **initial side** and the final position of the ray after rotation is called the **terminal side** of the angle. The point of rotation is called the vertex.

(I) Positive Angle (II) Negative Angle

- An angle is said to be in standard position if the vertex of the angle is at the origin and the initial side of the angle lies along the positive x-axis.

- In standard position, angles that rotate counterclockwise from the positive x-axis are considered positive, while angles that rotate clockwise are negative.





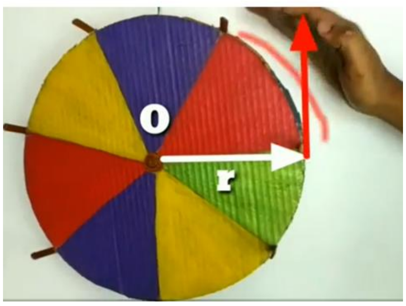
- The reference angle of an angle in standard position is the acute angle formed between the terminal side of the angle and the x-axis. you should be able to find the reference angle for any given angle.

- Quadrantal angles are angles in standard position whose terminal side lies on one of the axes ($x - axis\ or\ y - axis$). you should understand how to determine the exact value of trigonometric functions for quadrantal angles.

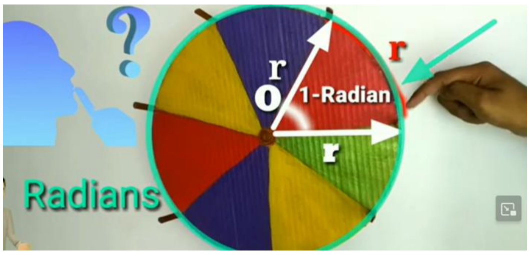
Activity-3: Teaching the relationship between degree and radian measure using manipulatives (1.20hrs)

Be in small groups, discuss how you teach the relationship between degree and radian measure using manipulatives through the following activity steps:

1. Take a set of tangram puzzle pieces or printable tangram templates, ruler, protractor, string and scissor.
2. use the tangram pieces to create a circle with center O and radius r
3. measure the angles and radius of their tangram circle using a ruler or protractor.
4. Next, place this radius of the circle at the end point of radius and bend it toward the circle then it forms an arc, which is equal to the radius as shown

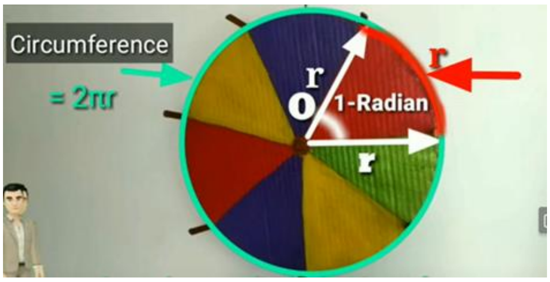


5 . draw another radius from the end of this radius, then and call the angles formed between these two radii is 1-radian as shown below.

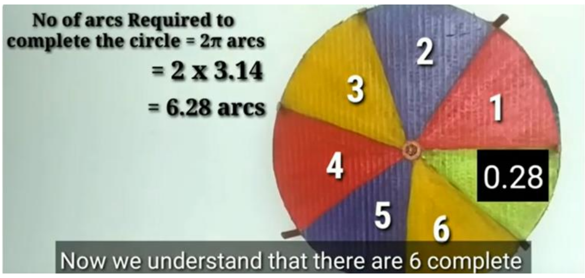


6. how many these arcs form the complete circle? Why we called it radian?

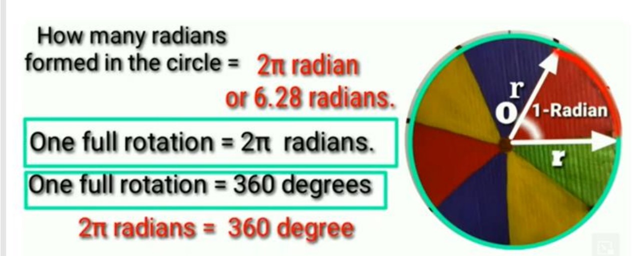
7. recall the boundary of the circle is called circumference of the circle which is



8. imagine or observe that no of arcs required to complete the circle = 2Π r arcs = 2× 3.14 = 6.28 arcs and they understand that there are 6 complete arcs and the remain in as shown below



9. compare and discuss the connection between radian and degree measure findings with each other to deepen their understanding about radian and degree measure as shown below



Moreover, open this link https://www.youtube.com/watch?v=LFY5JuQ49Kg / videos and watch it and reflect your understanding to the whole class (25 minutes)

Key Ideas

- Degree is a unit of measurement for angles, where a full circle is divided into 360 equal parts.

- Each degree is further divided into 60 minutes (') and each minute is divided into 60 seconds (").
- Angles can be measured in degrees using a protractor or other measuring tools.
- Radian is another unit of measurement for angles, where a full circle is equal to 2π radians.
- One radian is defined as the angle subtended at the center of a circle by an arc that is equal in length to the radius of the circle.
- Radian measure is often used in advanced mathematics and physics due to its close connection with trigonometric functions.
- The conversion factor between degrees and radians is π radians = 180 degrees.
- To convert from degrees to radians, multiply the degree measure by $\pi/180$.To convert from radians to degrees, multiply the radian measure by $\frac{180}{\pi}$.
- Understanding the relationship between degree and radian measures allows trainees to work interchangeably between the two units when solving problems involving angles.
- Tangram puzzles provide a hands-on and interactive way for students to explore geometric concepts and relationships. By using Tangram pieces to create various shapes and angles, students can visually see the connections between different trigonometric ratios.
- Tangram puzzles offer a visual representation of angles and geometric shapes, making it easier for students to understand the concept of trigonometric ratios. Trainees can use Tangram puzzles to demonstrate how trigonometric functions such as sine, cosine, and tangent are related to the sides of a right triangle.

Activity-4: Conceptual challenges (30 minutes).

What are the challenges students or even teachers' face in understanding how to find trigonometric values of different angles? (*To answer this question, refer to the content in the new textbook*)

Homework Activity (10 minutes).

Reflect how you can use manipulatives like tangram puzzles to engage your students in learning radian and degree measure and their relationship.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

Takeaway Resources

https://www.youtube.com/watch?v=LFY5JuQ49Kg / videos.

Session 5.3: Teaching Graphs of the Sine, Cosine and Tangent Function (2hrs)

Session Objectives:

After completing this session, you will be able to:

- ✓ identify effective teaching strategies for teaching trigonometric values of different angles
- ✓ understand the basic characteristics of the sine, cosine, and tangent functions.
- ✓ recognize the patterns and symmetries in the graphs of the trigonometric functions.
- ✓ explore the relationships between the graphs of sine, cosine, and tangent functions and their reciprocal functions (cosecant, secant, cotangent).
- ✓ analyze how changes in parameters (amplitude, period, phase shift) affect the shape and position of the trigonometric function graphs.
- ✓ adapt the discussion to their own situations and then plan to use it to their own classrooms

Activities:

Activity-1: Teachers Reflection on their Teaching (30 minutes)

How did you teach graphs of the sine, cosine and tangent function to your students? (you can frame your reflection in terms of the following components of instruction)

- ✓ Activating students' prior knowledge
- ✓ Nature of tasks/activities provided (context, multiple representation, routine/non-routine, etc.)

✓ Students classroom discussion and teacher's role in the discussion

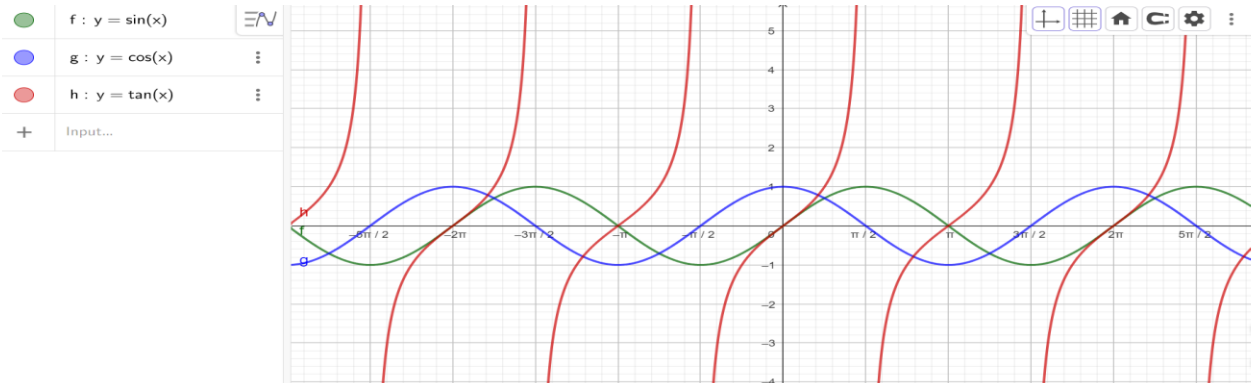
✓ Summary/consolidation

✓ Challenges you face in teaching

Activity-2: Teaching graphs of the sine, cosine and tangent functions with GeoGebra (1hrs)

Discuss how you teach graphs of the sine, cosine and tangent functions using GeoGebra based on the following steps.

1. open GeoGebra on their devices and creating a new graphing window.
2. input the equations of sine, cosine, and tangent functions into GeoGebra and plot their graphs. Use this link to input the equation https://www.youtube.com/watch?v=w92g_9a7i7o or videos:



3. manipulate the parameters (amplitude, period, phase shift) of the trigonometric functions using sliders in GeoGebra.
https://www.youtube.com/watch?v=CgWypDdAC4Q: or videos
4. explore how changing the parameters affects the shape and position of the graphs.
https://www.youtube.com/watch?v=Szafgr5wff4 or videos
5. observe the similarities and differences between the graphs of sine, cosine, and tangent functions.

Key Ideas

1. Sine Function (sin (x)):

- The sine function is a periodic function that oscillates between -1 and 1.
- It has a period of 2π (or 360 degrees) and repeats itself every 2π units.

- The graph of the sine function starts at the origin (0, 0) and passes through ($\frac{\pi}{2}$, 1) and ($\frac{3\pi}{2}$, -1).
- It is an odd function, which means that $\sin(-x) = -\sin(x)$.

2. Cosine Function (cos(x)):

- The cosine function is also a periodic function that oscillates between -1 and 1.
- Similar to the sine function, it has a period of 2π (or 360 degrees).
- The graph of the cosine function starts at the maximum value of 1 at (0, 1), and passes through the minimum value of -1 at (π, -1).
- It is an even function, which means that $\cos(-x) = \cos(x)$.

3. Tangent Function ($\tan(x)$):

- The tangent function is not periodic like the sine and cosine functions.
- It has vertical asymptotes at odd multiples of $\frac{\pi}{2}$ (e.g., $\frac{\pi}{2}$, $\frac{3\pi}{2}$, $-\frac{\pi}{2}$, etc.).
- The graph of the tangent function crosses the x-axis at these vertical asymptotes.
- It has a repeating pattern where it oscillates between negative and positive infinity as x approaches the vertical asymptotes.
- Trainees can create interactive lesson plans that integrate dynamic visualizations of graphs. They can design activities that allow students to explore and experiment with the functions, helping them develop a deeper understanding.

Activity-3: Conceptual Challenges (20 minutes).

What are the challenges students or even teachers' face in understanding the graphs of the sine, cosine and tangent function? (*To answer this question, refer to the content in the new textbook*)

Homework Activity (10 minutes).

1. Take different examples of trigonometric functions from grade 10 mathematics textbook with different parameters and create a dynamic worksheet in GeoGebra.
2. Share your findings and insights with the group, discussing any patterns or relationships you discover.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

Unit Summery

Trigonometric ratios are mathematical functions that relate the angles of a right-angled triangle to the lengths of its sides. The three primary trigonometric ratios are sine, cosine, and tangent, which are defined as the ratio of specific sides of the triangle. The sine of an angle is the ratio of the length of the side opposite the angle to the hypotenuse, the cosine is the ratio of the length of the adjacent side to the hypotenuse, and the tangent is the ratio of the length of the opposite side to the adjacent side. These ratios are used to solve for unknown side lengths or angles in right-angled triangles, providing a powerful tool for calculating distances, heights, and angles in various real-world applications.

The graphs of sine, cosine, and tangent functions are also fundamental in trigonometry, illustrating the periodic behavior of these functions as they vary with different angles. Students learn to identify key features such as amplitude, period, and phase shift, which determine the shape and position of the curves. Understanding the relationship between angle measure and function values helps interpret and analyze the behavior of these functions over a given interval. Emphasizing connections between graphical representations and algebraic expressions enhances students' ability to solve trigonometric equations effectively. Teaching graphs of sine, cosine, and tangent functions provides students with a visual and conceptual framework for mastering trigonometry and its real-world applications.

Takeaway Resources

<u>GeoGebra software</u>

Unit 6: Teaching Coordinate Geometry and Solid Figures (9 hrs.)

Introduction

This chapter contains two big mathematical concepts: coordinate geometry and solid figures. Coordinate geometry, also known as analytic geometry, is a branch of mathematics that deals with the representation of geometric figures and their properties using a coordinate system. It provides a systematic and algebraic approach to geometry, allowing for the precise description, visualization, analysis, and manipulation of geometric objects. In coordinate geometry, points, lines, curves, and surfaces are represented by their coordinates in a coordinate system, typically using the Cartesian coordinate system (x-y plane) or the three-dimensional coordinate system (x-y-z space). This representation enables the use of algebraic equations to describe geometric relationships, such as the distance between points, the slope of lines, the area of triangles, and the volume of solids. Coordinate geometry has numerous applications in various fields, including engineering, physics, computer graphics, and architecture. It allows for the precise design and analysis of structures, the modeling of physical phenomena, the creation of virtual worlds, and the efficient solution of geometric problems.

Solid figures, also known as three-dimensional shapes, on the other hand, are geometric objects that occupy space in three dimensions. Unlike two-dimensional shapes, which have only length and width, solid figures have length, width, and height. Common examples of solid figures include cubes, spheres, cones, pyramids, and cylinders. Solid figures can be classified into two main categories: polyhedra and curved-surface figures. Polyhedra are solid figures with flat surfaces, such as cubes, pyramids, and prisms. Curved-surface figures, on the other hand, have surfaces that are not flat, such as spheres, cones, and cylinders. The properties of solid figures, such as their volume, surface area, and shape, can be calculated using various geometric formulas. Solid figures have numerous applications in various fields, including engineering, architecture, design, and manufacturing. They are used to model real-world objects, design structures, create virtual environments, and solve geometric problems. Understanding the properties and relationships of solid figures is essential for a wide range of disciplines that involve spatial reasoning and three-dimensional visualization.

In this unit, you will improve your conceptual understanding of coordinate geometry and sold figures, in addition to learning how to teach these mathematical concepts to students.

Unit Outcomes

After completing this unit, you will be able to:

- ✓ Understand the mathematical concepts of coordinate geometry and solid figures deeply.
- ✓ Appreciate how the formula for finding surface area and volume of solid figures are derived inductively through problem solving.
- ✓ Know various approaches of teaching coordinate geometry and solid figures.

Key Contents

Session 6.1: Distance between Two Points
Session 6.2: Division of a Line Segment
Session 6.3: Solid Figures: Prisms and Cubes
Session 6.4: Solid Figures: Cylinders and Cones
Unit Summary

Session 6.1: Distance between Two Points (2 hrs.)

In geometry, the distance between two points is a measure of the length of the line segment connecting them. The distance between two points can be calculated using the distance formula, which depends on the coordinate system being used. The distance formula has numerous applications in various fields, including navigation, engineering, computer graphics, and physics. It is used to calculate the length of paths, determine the positions of objects, and solve geometric problems involving distances. Understanding the distance between two points is essential for a wide range of disciplines that involve spatial reasoning and measurement.

In this session, the concept of distance between two points and its teaching strategies will be explored through your reflection and through modeling a sample lesson plan.

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Discuss various ways of teaching distance between two points.
- ✓ Identify effective teaching strategies for teaching distance between two points.
- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of distance between two points.
- ✓ Improve your conceptual understanding of distance between two points.
- ✓ Adapt the discussion to your own situations and then plan to use it to your own classrooms.

Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about distance between two points? You can frame your answer based on the following questions.

a) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

b) What teaching strategies would you use to improve the instruction?

c) How would you tackle the challenges you face in teaching the concept?

Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson as a case study that a teacher taught the concept of distance between two points to grade 9 students.

Read through the lesson and then answer the following questions.
1. Is it similar to the way that you teach the concept?
2. Do you prefer to use it in your classroom? Why?
3. Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 6.1: Distance between Two Points

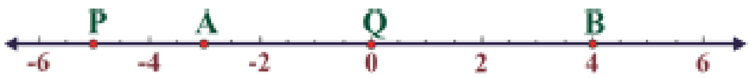
Learning Objectives:

At the end of this lesson, students will be able to:

13. Derive the formula for finding distance between any two points.
14. Find the distance between two points whose co-ordinates are given.

Activity-1: Activating Prior Knowledge

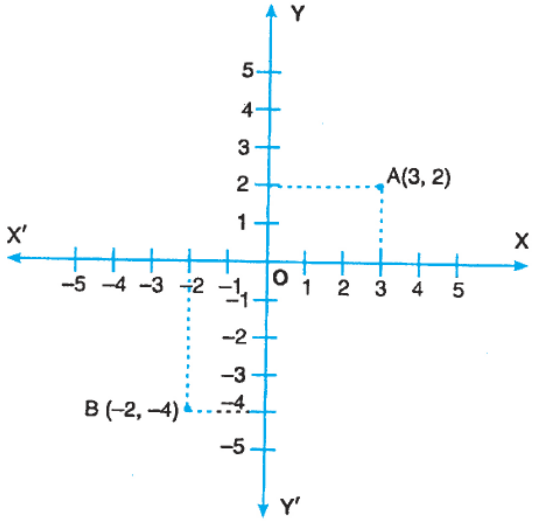
1) Consider the number line given in figure 7.2.



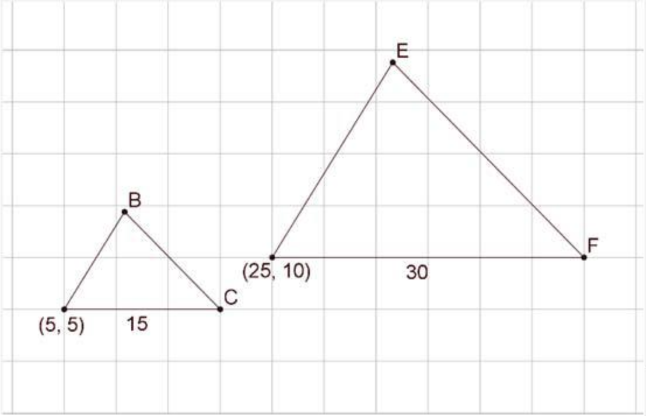
i. Find the corresponding values of points P, Q, A and B.

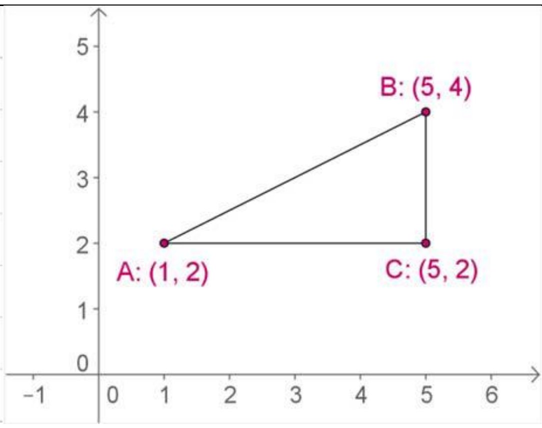
ii. Find the distance between points a) A and B b) Q and B

2) Based on the coordinate system given below, describe the positions of the points A and B.



3) Based on the figure below, write down the coordinates of C and F.

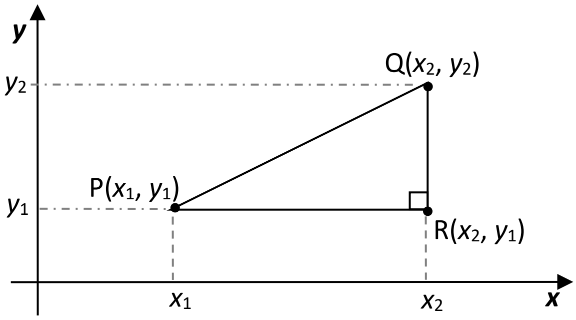




4) Based on the figure above, calculate the length of AB?

Activity-2: Deriving Distance Formula Between Two Points

The distance between any two points P(x_1, y_1) and Q(x_2, y_2) in the plane is the length of the line segment PQ.



a) Find the distance between points P(x_1, y_1) and R(x_2, y_1) on a horizontal line?
b) Find the distance between Q(x_2, y_2) and R(x_2, y_1) on a vertical line?
c) Now applying Pythagoras Theorem on a right angled triangle PQR, find PQ?
d) So what is the formula for finding the distance between the two points P and Q?

Important Ideas: distance between two points

The distance between the points P(x_1, y_1) and Q(x2, y_2) is given by the formula:

$PQ^2 = (x_2 - x_1)^2 + (y_2 - y_1)^2$

OR

$$PQ = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Check Your Understanding

Find the distance between each of the following points:

(a) P(6, 8) and Q(0, 0) (b) A(–6, –1) and B(–6, 11)

Key Ideas

To teach about distance between any two points, you need to start by introducing the concept of distance as the measure of how far apart two points are in space. Emphasize that distance is a scalar quantity that is always positive and can be calculated using various methods, such as the distance formula or Pythagorean Theorem. Then help students to derive the distance formula by using the Pythagorean Theorem. Encourage students to practice using the formula to calculate distances between different pairs of points.

Illustrate real-world applications of distance between two points, such as determining the length of a line segment, finding the shortest path between two locations, or measuring the distance traveled by an object. Engage students in problem-solving activities that require them to apply the concept of distance to practical situations. It is also good to extend the concept of distance between two points to higher dimensions beyond the traditional 2D plane. Introduce students to the distance formula in three-dimensional space and discuss how distance can be calculated in multidimensional contexts. Encourage students to visualize and work with distances in higher dimensions to deepen their understanding of spatial relationships.

Activity-3: Conceptual Challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of distance between two points? *To answer this question, you need to refer to the content in the new textbook.*

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/geometry/hs-geo-analytic-geometry/hs-geo-distance-and-midpoints/v/distance-formula#:~:text=Learn%20how%20to%20find%20the,distance%20between%20any%20two%20points.

Session 6.2: Teaching Division of a Line Segment (2 hrs.)

The division of a line segment is a geometric construction that divides a line segment into a specified ratio. Given a line segment AB and a ratio m:n, the division of AB in the ratio m:n produces two smaller line segments, AC and CB, such that, the ratio of the length of AC to the length of CB is equal to the given ratio m:n. In the activities that follow, you will learn more about how to teach division of a line segment through reflection and analysis of sample lessons.

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Discuss various ways of teaching division of a line segment.
- ✓ Identify effective teaching strategies for teaching division of a line segment.
- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of division of a line segment.
- ✓ Improve your conceptual understanding of division of a line segment.
- ✓ Adapt the discussion to your own situations and then plan to use it to your own classrooms.

Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about division of a line segment? You can frame your answer based on the following questions.

a) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

b) What teaching strategies would you use to improve the instruction?

c) How would you tackle the challenges you face in teaching the concept?

Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson as a case study that a teacher taught the concept of division of a line segment to grade 9 students.

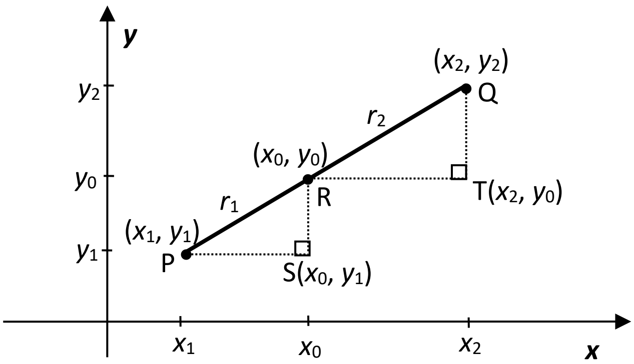
Read through the lesson and then answer the following questions.

1. Is it similar to the way that you teach the concept?
2. Do you prefer to use it in your classroom? Why?
3. Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 6.2: Division of a Line Segment
Learning Objectives: At the end of this lesson, students will be able to: 16. Drive the formula for finding the co-ordinates of a point, which divides the line segment joining two points in a given ratio internally. 17. Find the co-ordinates of a point, which divides the line segment in a given ratio. 18. Find the co-ordinates of the mid-point of a line segment joining any two points.

Activity: Given two distinct points P(x_1, y_1) and Q(x_2, y_2) in the coordinate plane, then find the coordinates (x_0, y_0) of the point R that lies on the segment PQ and divides the segment in the ratio r_1 to r_2; that is

$\frac{PR}{RQ} = \frac{r_1}{r_2}$ **,** where r_1 and r_2 are given positive numbers. (See the figure below).



To determine (x_0, y_0), we construct two right triangles ΔPSR and ΔRTQ as shown above. We then have |PS| = $x_0 - x_1$, |SR| = $y_0 - y_1$, |RT| = $x_2 - x_0$, and |TQ| = $y_2 - y_0$. Now since ΔPSR is similar to ΔRTQ, we have that

$$\frac{x_0 - x_1}{x_2 - x_0} = \frac{r_1}{r_2} \quad \text{and} \quad \frac{y_0 - y_1}{y_2 - y_0} = \frac{r_1}{r_2}$$

or $r_2(x_0 - x_1) = r_1(x_2 - x_0)$ and $r_2(y_0 - y_1) = r_1(y_2 - y_0)$.

Solving for x_0 and y_0, we obtain $x_0 = \frac{x_1 r_2 + x_2 r_1}{r_1 + r_2}$ and $y_0 = \frac{y_1 r_2 + y_2 r_1}{r_1 + r_2}$

Important Ideas: Formula of Division of a Line Segment

1) Let P(x_1, y_1) and Q(x_2, y_2) be distinct points in the coordinate plane.
If R(x_0, y_0) is a point on the line segment PQ that divides the segment in the ratio |PR|: |RQ| = r_1**:** r_2, then the coordinates of R are given by

$$(x_0, y_0) = \left(\frac{x_1 r_2 + x_2 r_1}{r_1 + r_2}, \frac{y_1 r_2 + y_2 r_1}{r_1 + r_2} \right)$$

2) The co-ordinates of the mid-point of the line segment joining two points (x_1, y_1) and (x_2, y_2) can be obtained by taking m = n in the formula above. Putting m = n in (1) above, we have the midpoint of PQ is given by: $\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right)$

Check Your Understanding

1. Given P(–3, 3) and Q(7,8),
(i) Find the coordinates of the point R on the line segment PQ such that |PR| **:** |RQ| = 2 **:** 3.
(ii) Find the coordinates of the midpoint of PQ.

2. The co-ordinates of the mid-point of a segment are (2, 3). If co-ordinates of one of the end points of the line segment are (6, 5), find the co-ordinates of the other end point.

Key Ideas

To teach division of a line segment, start by introducing the concept of ratio and proportion as the foundation for understanding division of a line segment. Explain that dividing a line segment involves splitting it into two or more parts in a specific ratio. Emphasize the relationship between the lengths of the segments and the ratios in which they are divided. Then, teach students about the midpoint of a line segment, which is the point that divides the segment into two equal parts. Encourage students to practice finding division of a line segment in a given ratio and midpoint of a line segment using the corresponding formulae. You can also engage students in real-world applications and problem-solving activities that involve dividing line segments. Provide scenarios where students need to divide a line segment in a given ratio to solve problems related to geometry, physics, or engineering. Encourage students to analyze and interpret the results of dividing line segments in various contexts to develop their problem-solving skills.

Activity-3: Conceptual Challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of division of a line segment? *To answer this question, you need to refer to the content in the new textbook.*

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/geometry/hs-geo-analytic-geometry/hs-geo-dividing-segments/v/finding-a-point-part-way-between-two-points

Session 6.3: Teaching Solid Figures: Prisms and Cubes (2 hrs.)

A prism is a three-dimensional shape with two parallel and congruent bases connected by rectangular sides. The bases can be any polygon, but the most common types of prisms are triangular prisms, rectangular prisms, and hexagonal prisms. A cube is a special type of prism with all square faces. It is a regular hexahedron, meaning that all of its faces are congruent squares. Prisms and cubes have numerous applications in various fields, including architecture, engineering, and packaging. Next, you will learn more about how to teach surface area and volume of prisms and cubes through experience sharing and analysis of sample lessons.

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Discuss various ways of teaching surface area and volume of prisms and cubes.
- ✓ Identify effective teaching strategies for teaching surface area and volume of prisms and cubes.
- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of surface area and volume of prisms and cubes.
- ✓ Improve your conceptual understanding of surface area and volume of prisms and cubes.
- ✓ Adapt the discussion to your own situations and then plan to use it to your own classrooms.

Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about surface area and volume of prisms and cubes? You can frame your answer based on the following questions.

a) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

b) What teaching strategies would you use to improve the instruction?

c) How would you tackle the challenges you face in teaching the concept?

Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson as a case study that a teacher taught the concept of surface area and volume of prisms and cubes to grade 10 students.

Read through the lesson and then answer the following questions.

1. Is it similar to the way that you teach the concept?
2. Do you prefer to use it in your classroom? Why?
3. Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 6.3: Surface Area and Volume of Prisms and Cubes
Learning Objectives: At the end of this lesson, students will be able to: • Explain the meanings of surface area and volume of a solid figure.

- Derive the formula for finding surface area and volume of prisms and cubes.
- Find the surface area of prisms and cube using their respective formula.
- Find the volume of prisms and cubes using their respective formula.
- Solve some problems related to daily life situations involving surface area and volume of prisms and cubes.

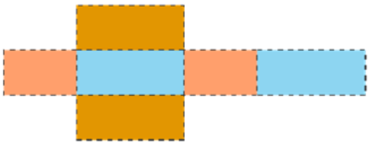
Activity-1: Activating Prior Knowledge

1) Find the area of the following plane figures.
   a) A rectangle with length 6 cm and perimeter 20 cm.
   b) A right triangle of leg 4cm and hypotenuse 5 cm.
   c) A circle with circumference 12π.
2) What is the surface of a solid? Can you sketch the surface of a solid figure as a plane figure? How?
3) What is the use of finding surface area of solids? And volume of solids?
4) If you assume the inside of a solid is empty, how much water or any liquid or anything can be filled?
5) If you rotate a rectangle about one of its sides, what shape can be generated? How about rotating a right triangle about its legs? And how about rotating a semicircle about its diameter? Find the area of the surfaces and capacity to contain of the figures obtained.

Activity-2: Nets and Surface Area

1) If you cut and unfold the 3-D shape shown in (ii) into one, flat shape, you will get a plane figure in (ii), which is referred to as a **net of the solid figure in (i).** If the figure in (ii) is folded along the dotted lines, it will take the shape shown in (i). What can you say about its surface area? Explain your solution.

Rectangular Prism



Net of a Rectangular Prism

Let us drive a formula for finding surface area of a prism

Let the length, width and height of the rectangular prism be: l, w, and h respectively.

Thus, its surface area is the sum of the areas of each face of the prism shown in the net.

That is, Surface Area = $l\times w + w\times h + h\times l + l\times w + w\times h + h\times l = 2(lw + wh + hl)$.

2) What is the formula for finding the surface area of a cube**?**

We know that cube is a special type of rectangular prism in which length = width = height.

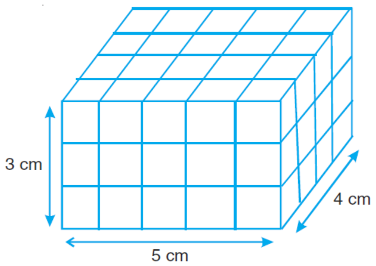
Hence, **surface area of a cube of side** a

$= 2\,(a\times a + a\times a + a\times a)$

$= 6a^2$

Activity-3: Unit Cubes and Volume

Take some unit cubes of side 1 cm each and join them to form a prism as shown in the figure below:



What is the volume of a unit cube? (Is it 1 cm^3?)

By actually counting the unit cubes, you can see that this prism is made up of 60 unit cubes.

So, its volume = 60 cubic cm or 60cm^3.

Also, you can observe that length × width × height = $5 \times 4 \times 3$ cm^3 = 60 cm^3

Hence, volume of a prism = length × width × height = lwh

Further, as cube is a special case of prism in which $l = w = h$, we have;
Volume of a cube of side $a = a \times a \times a = a^3$.

Check Your Understanding

1. Find the surface area and volume of a rectangular prism with dimensions 5cm, 6cm and 4cm.
2. Find the surface area and volume of a cube of side 5cm.
3. The length and width of a cuboidal tank are 6m and 5m respectively. If it is full of water and contains 90 m^3 of water, find the depth of the water in the tank.
4. A wooden box 1.5m long, 1.25 m broad, 65 cm deep and open at the top is to be made. Assuming the thickness of the wood negligible, find the cost of the wood required for making the box at the rate of 200 birr per m^2.

Key Ideas

As you can see from the sample lesson, you need to start by ensuring that students understand the formulas for calculating the surface area and volume of prisms and cubes. Explain the difference between surface area (total area of all faces) and volume (space occupied by the object) and provide clear explanations of the formulas for each. In addition, you need to help students develop a strong visual understanding of prisms and cubes by using manipulatives, models, and interactive tools. Encourage students to explore the relationship between the dimensions of the shapes and how they affect the surface area and volume. Provide opportunities for hands-on activities that involve building and deconstructing prisms and cubes to enhance spatial reasoning skills.

It is also good to connect the concepts of surface area and volume of prisms and cubes to real-world applications to make the learning more meaningful. Provide examples of how these concepts are used in architecture, packaging, engineering, and other fields. Encourage students to analyze and solve problems related to real-life scenarios that involve calculating surface area and volume of prisms and cubes. Finally, provide practice problems of varying difficulty levels to help students build confidence in their ability to solve problems related to surface area and volume. Encourage students to check their answers and explain their reasoning to deepen their understanding of the concepts.

Activity-3: Conceptual Challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of surface area and volume of prisms and cubes? *To answer this question, you need to refer to the content in the new textbook.*

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/geometry-home/geometry-volume-surface-area

Session 6.4: Teaching Solid Figures: Cylinders and Cones (3 hrs.)

Cylinders and cones are both three-dimensional shapes with circular bases. The main difference between the two shapes is that the height of a cylinder is parallel to the base, while the height of a cone is perpendicular to the base. Cylinders and cones are commonly used in engineering, architecture, and design. Next, you will learn more about how to teach surface area and volume of cylinders and cones through experience sharing and analysis of sample lessons.

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Discuss various ways of teaching surface area and volume of cylinders and cones.
- ✓ Identify effective teaching strategies for teaching surface area and volume of cylinders and cones.
- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of surface area and volume of cylinders and cones.
- ✓ Improve your conceptual understanding of surface area and volume of cylinders and cones.

Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about surface area and volume of cylinders and cones? You can frame your answer based on the following questions.

a) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

b) What teaching strategies would you use to improve the instruction?

c) How would you tackle the challenges you face in teaching the concept?

Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson as a case study that a teacher taught the concept of surface area and volume of cylinders and cones to grade 10 students.

Read through the lesson and then answer the following questions.

1. Is it similar to the way that you teach the concept?
2. Do you prefer to use it in your classroom? Why?
3. Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 6.4: Surface Area and Volume of Cylinders and Cones

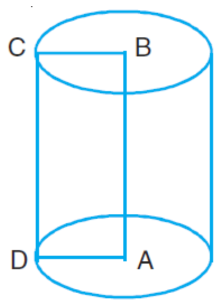
Learning Objectives:

At the end of this lesson, students will be able to:

- Derive the formula for finding surface area and volume of cylinders and cones.
- Find the surface area of cylinders and cones using their respective formula.
- Find the volume of cylinders and cones using their respective formula.
- Solve some problems related to daily life situations involving surface area and volume of prisms and cubes.

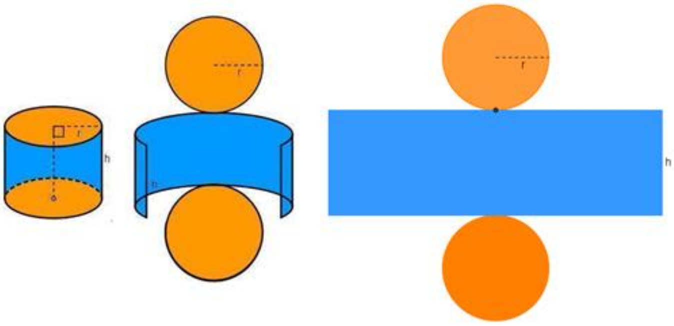
Introduction:

If we rotate a rectangle ABCD about one of its edges say AB, what is the solid generated? It is a **right circular cylinder**, right? In daily life, we come across many solids of this shape such as water pipes, tin cans, drums, powder boxes, etc.



It can be seen that the two ends (or bases) of a right circular cylinder are congruent circles.

Activity-1: Nets and Surface Area of a Cylinder



1) Once the cylinder is transformed into a net, the problem of finding the surface area is now a problem of finding the area of two polygons. Which are the two types of polygons?
2) You have enough information to find the area of the two circles, but what about the blue rectangle? You know the height (h), but what about its width?

So, curved surface area of the cylinder = area of the rectangle = $2\pi r \times h = 2\pi rh$.

The total surface area of the cylinder = $2\pi rh + 2\pi r^2 = 2\pi r\,(h + r)$

Activity-2: Volume of a Right Circular Cylinder

How can we derive a formula for finding the volume of a right circular cylinder? What is the area of the base? The base is found when the height of the cylinder is zero, right? So when the area of the base is multiplied by the height of the cylinder, it will give us the volume of the cylinder.

V = Area of the base × height = $\pi r^2 \times h = \pi r^2 h$

Example-1: Find surface area of a cylinder generated by revolving a square of side 3 about its side.

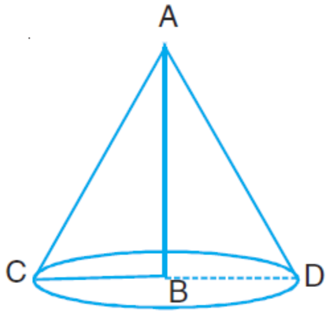
Example-2: The radius and height of a right circular cylinder are 7cm and 10cm respectively. Find its

(i) curved surface area
(ii) total surface area, and the
(iii) volume

Check Your Understanding

1) A hollow cylindrical metallic pipe is open at both the ends and its external diameter is 12 cm. If the length of the pipe is 70 cm and the thickness of the metal used is 1 cm, find the volume of the metal used for making the pipe.
2) A cylindrical bucket of base diameter 28 cm and height 12 cm is full of water. This water is poured in to a rectangular tub of length 66 cm and breadth 28 cm. Find the height to which water will rise in the tub.

Activity-3: RIGHT CIRCULAR CONE

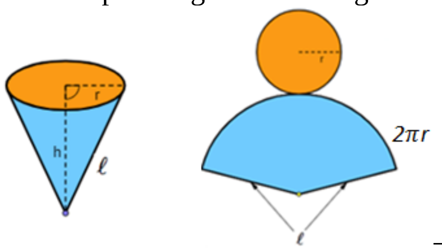


1) Let us rotate a right triangle ABC right angled at B about one of its side AB containing the right angle. What is the solid generated? It is a **right circular cone**, right? In daily life, we come across many objects of this shape, such as Joker's cap, tent, ice cream cones, etc.
2) Is the base of a right circular cone a circle? What is its radius?
3) Identify the height, vertex and slant height of the cone.
4) Write the slant height (*l*) in terms of the height (*h*) of the cone and the radius (*r*) of the base? (Use the Pythagoras Theorem.)

Activity-4: Net and Surface Area of RIGHT CIRCULAR CONE

If you transform a right circular cone into a net, you obtain a plane figure consisting of a base circle and a sector shown below.

a) What is the radius of the sector?
b) What is its arc length?
c) What is the area of the sector?
d) What is the total surface area of the cone?



Area of this sector $= \frac{Arc\ length\ of\ the\ sector}{Circumference\ of\ the\ circle\ with\ radius\ \ell} x Area\ of\ the\ circle\ with\ radius\ \ell$

$= \frac{2\pi r}{2\pi\ell} x\pi\ell^2 = \pi r\ell$

So, Area of curved surface of the cone = Area of the sector = $\pi r\ell$

Hence, the total surface area of the cone = $\pi r\ell + \pi r^2 = \pi r(\ell + r)$

Activity-5: Volume of a Right Circular Cone

Take a right circular cylinder and a right circular cone of the same base radius and same height. Now, fill the cone with sand (or water) and pour it in to the cylinder. Repeat the process three times.

a) What happens now? Do you observe that the cylinder is completely filled with the sand (or water)?
b) What is the relationship between the volume of a cone and cylinder with radius r and height h?

So, **volume of a cone** =1/3(**volume of the cylinder)** = **1/3 πr^{2}h**

Example-3: The base radius and height of a right circular cone is 7 cm and 24 cm. Find its curved surface area, total surface area and volume.

Example-4: A conical tent is 6 m high and its base radius is 8 m. Find the cost of the canvas required to make the tent at the rate of 120 birr per m^2 (Use π = 3.14)

Check Your Understanding

1. Find the curved surface area of a right circular cone of volume 12936 cm3 and base diameter 42 cm.
2. Find the length of the 3 m wide canvas required to make a conical tent of base radius 9 m and height 12 m (use π = 3.14).

Key Ideas

To better understand surface area and volume of cylinders and cones, it is good to help students develop a strong visual understanding of cylinders and cones by using manipulatives, models, and interactive tools. Encourage students to explore the relationship between the dimensions of the shapes and how they affect the surface area and volume. You can also connect the concepts of surface area and volume of cylinders and cones to real-world applications to make the learning more meaningful. Encourage students to analyze and solve problems related to real-life scenarios that involve calculating surface area and volume of cylinders and cones. Provide practice problems of varying difficulty levels to help students build confidence in their ability to solve problems related to surface area and volume. Encourage students to check their answers and explain their reasoning to deepen their understanding of the concepts.

Activity-3: Conceptual Challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of surface area and volume of cylinders and cones? (*To answer this question, refer to the content in the new textbook*)

Activity-4: Lesson Design: Surface Area and Volume of Pyramids OR Spheres and Hemispheres (1 hr.)

Now let us put into practice what we have explored in this unit. This may take more time to finalize. If it is not finalized within the given time, it can be a homework activity. Let you work in pairs.

a) Look through your previous teaching plans and redesign the lesson according to your current understanding.
b) Write a comparison between the new lesson and your previous one.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/geometry/hs-geo-solids/hs-geo-solids-intro/v/cylinder-volume-and-surface-area

Khan Academy: https://www.khanacademy.org/math/geometry/hs-geo-solids/hs-geo-solids-intro/v/volume-cone-example

Unit Summary

This unit discussed about teaching the concept of coordinate geometry including how to find the distance between two points and division of a line segment. In each of the sample lessons, the formula for finding the distance between two points and division of a line segment were derived inductively by learners them-selves. In each lesson students' prior knowledge were first activated before they are asked to derive each formula.

In addition, this unit discussed about teaching the concept of surface area and volume of three-dimensional shapes, including prisms, cubes, pyramids, cylinders, cones, and spheres. In each of the sample lessons, the formula for finding the surface area and volume of the three-dimensional shapes were derived by learners them-selves. Nets of solid figures are used to derive the formula for finding surface area of solids. The sample lessons also provide opportunities for students to apply their knowledge of surface area and volume to solve real-world problems, such as calculating the amount of paint needed to paint a room or the volume of a water tank.

Hence, this unit provided trainee teachers with a strong foundation in teaching the concepts of coordinate geometry and solid figures, which will be essential for their future teaching career.

Unit 7: Teaching Vectors (G11) (4 hrs.)

Introduction

Teaching vectors involves introducing students to fundamental concepts in mathematics and physics that represent quantities possessing both magnitude and direction. Vectors are used to describe diverse phenomena such as displacement, velocity, force, and more, making them essential tools in various fields ranging from engineering to computer graphics. By presenting vectors as directed line segments with specific properties such as addition, subtraction, and scalar multiplication, educators aim to develop students' understanding of spatial relationships and mathematical operations applied to vector quantities. Through interactive activities, visual aids, and real-world examples, students are guided to grasp the significance of vectors in representing physical quantities and solving problems involving magnitude and direction. This introduction sets the stage for students to explore the rich applications of vectors across disciplines and deepen their mathematical reasoning and problem-solving skills.

Unit Outcomes

After completing this unit, you will be able to:

- Identify effective teaching strategies for teaching vectors.
- Understand the fundamental properties of vectors.
- define vectors as mathematical entities that represent quantities with both magnitude and direction.
- visualize vectors in two-dimensional and three-dimensional space.
- Illustrate the application of vectors in physics and engineering
- Adapt the discussion to their own situations and then plan to use it to their own classrooms

Key Contents

Session 7.1: Teaching Vectors and their representations(2hrs)

Session 7.2: Teaching Vector cross product and its applications(2hrs)

Unit Summary

Session 7.1: Teaching Vectors and Their Representations(2hrs)

Session Objectives:

After completing this session, you will be able to:

- represent vectors in different forms, such as component form, magnitude and direction form, and unit vector form.
- illustrate how vector quantities differ from scalar quantities and their significance in representing physical quantities with direction
- visualize vectors in two-dimensional and three-dimensional space using diagrams and graphical representations.
- perform vector operations accurately, including vector addition, subtraction
- know how to break down vectors into their component parts along coordinate axes using the i, j, k notation in three dimensions.
- analyze vectors by decomposing them into their horizontal and vertical components.
- Adapt the discussion to their own situations and then plan to use it to their own classrooms.

Activities:

Activity-1: Teachers Reflection on their Teaching (30 minutes)

How did you teach vectors and their representations to you students? (you can frame your reflection in terms of the following components of instruction).

- ✓ Activating students' prior knowledge
- ✓ Nature of tasks/activities provided (context, multiple representation, routine/non-routine, etc.)
- ✓ Students classroom discussion and teacher's role in the discussion
- ✓ Summary/consolidation
- ✓ Challenges you face in teaching.

Activity-2: Real-life application of Vectors (20 minutes).

Be in size of 4 - 5 group and discuss why you teach vectors and their representations and reflect to the whole class.

Key Ideas

• In GPS navigation systems, vectors are used to represent the movement and direction of vehicles. Vectors help calculate the shortest route, travel distance, and estimated time of arrival by considering speed and direction changes.

• Vectors play a crucial role in air traffic control to manage aircraft movement. Vectors are used to determine the direction and speed of aircraft, ensuring safe takeoffs, landings, and flight paths.

• Vectors are utilized in engineering and architecture to represent forces, velocities, and displacements. Engineers use vectors to calculate structural loads, stress distributions, and motion dynamics in buildings and bridges.

• Vectors play a crucial role in physics to describe motion, forces, and physical phenomena accurately.

• Trainees can promote a deeper understanding of vector concepts by illustrating how they are used in various contexts beyond the classroom.

• Trainees can highlight the interdisciplinary nature of vectors and their relevance in multiple academic and professional domains.

Activity-3: Teaching Vectors Representations using GeoGebra (50 minutes).

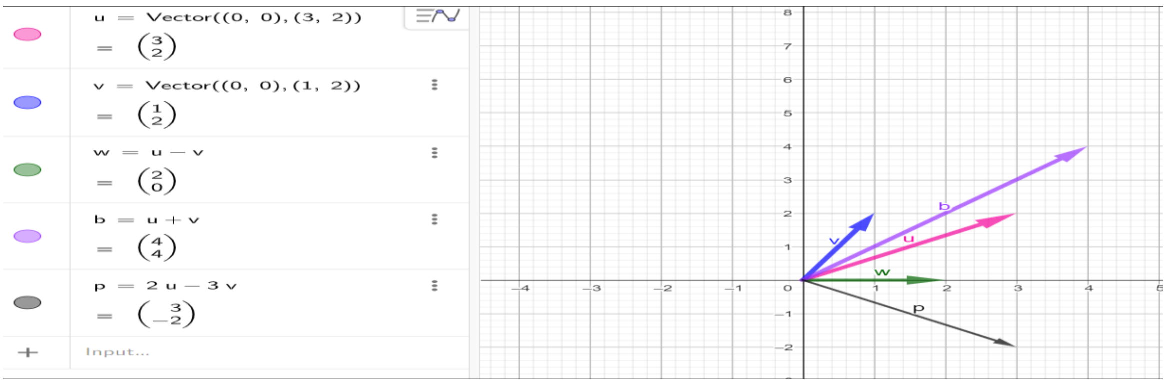
Be in group of size five and discuss how you teach vectors representations using GeoGebra by the following steps.

1. Open GeoGebra software and create a new coordinate plane and Show students how to input vectors using GeoGebra's vector tool.

2. add two vectors graphically using GeoGebra and practice adding vectors on your own using GeoGebra.

3: subtract vectors graphically using GeoGebra and practice subtracting vectors.

4. perform various vector operations (addition, subtraction, scalar multiplication) using GeoGebra.



Use the following link to perform the activity 3:

https://www.youtube.com/watch?v=FKwJXD7yZIY

https://www.youtube.com/watch?v=h-p8Lxp4Gf0

Key Ideas

- Vectors are quantities that have both a numerical value (magnitude) and a specific direction in space.
- Vectors are typically represented by an arrow pointing in a specific direction, with the length of the arrow indicating the magnitude of the vector.
- A vector can be broken down into its components along different axes (e.g., x-axis and y −axis in a 2D plane), which represent the contributions of the vector in each direction.
- Vectors can be added or subtracted by combining their magnitudes and directions according to specific rules, such as the parallelogram law or the head-to-tail method.
- Vectors can be multiplied by a scalar (a real number), which results in a new vector with the same direction but a scaled magnitude.
- Vectors are used in various fields such as physics, engineering, computer graphics, and mathematics to represent physical quantities like force, velocity, displacement, and more.
- GeoGebra allow trainees to create dynamic and interactive visualizations of vectors, making abstract concepts more tangible and engaging for students. Trainees can demonstrate vector addition, subtraction, and scalar multiplication in real-time, enhancing students' understanding through visual representations.

Trainees can create activities where students manipulate vectors, change their magnitudes and directions, and observe how these changes affect vector operations. This exploration can deepen students' conceptual understanding of vectors.

Activity-4: Conceptual Challenges (20 minutes).

What are the challenges students or even teachers' face in understanding vectors representations? (*To answer this question, refer to the content in the new textbook*)

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

Takeaway Resources

- https://www.youtube.com/watch?v=750mrClLknM
- https://www.youtube.com/watch?v=2YZWcQrmHQI
- https://www.youtube.com/watch?v=KBSCMTYaH1s
- https://www.youtube.com/watch?v=18W7HGADPLI

Session 7.2: Teaching Vector Cross Product and its Applications(2hrs)

Session Objectives:

After completing this session, you will be able to:

- understand the geometric interpretation of the cross product in 3D space.
- demonstrate the properties of the cross product, such as orthogonality and magnitude.
- apply the cross product to calculate areas of parallelograms and volumes of parallelepipeds.
- Explore the relationship between the cross product and the sine of the angle between vectors.
- solve problems involving moments of force, torque, and angular momentum using the cross product.
- investigate applications of the cross product in physics, engineering, and other fields
- Adapt the discussion to their own situations and then plan to use it to their own classrooms.

☞**Activities**

Activity-1: Teachers Reflection on their Teaching (30 minutes)

How did you teach vector cross product and its applications to your students? (you can frame your reflection in terms of the following components of instruction).

- ✓ Activating students' prior knowledge
- ✓ Nature of tasks/activities provided (context, multiple representation, routine/non-routine, etc.)
- ✓ Students classroom discussion and teacher's role in the discussion
- ✓ Summary/consolidation
- ✓ Challenges you face in teaching

Activity-2: Real life Application of Vector Cross Product (20 minutes).

Discuss why you teach vector cross product in groups and reflect for the whole class?

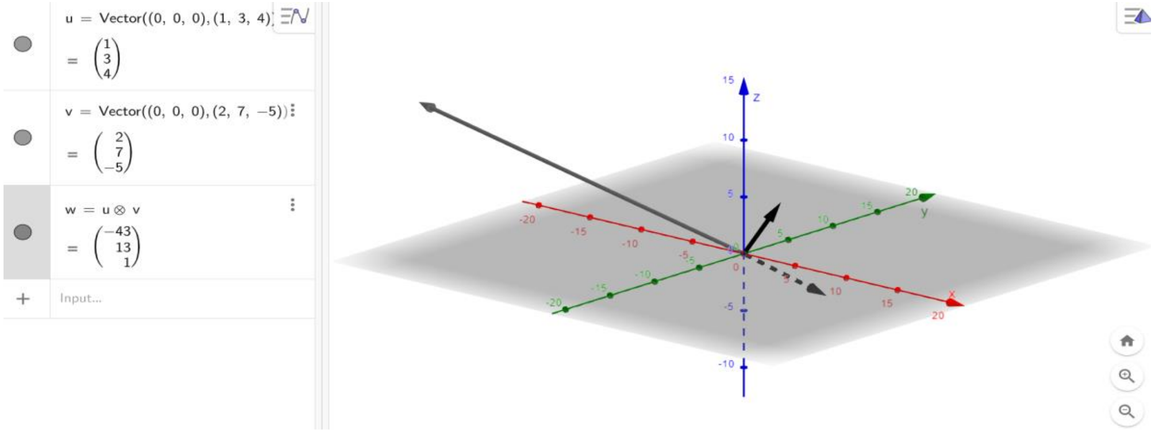
Key Ideas

- ✓ In physics and engineering, the cross product is used to calculate torque and angular momentum in rotational motion. For example, when a force is applied to a lever arm, the cross product of the force vector and the lever arm vector determines the torque generated.
- ✓ In fluid dynamics, the cross product is used to calculate vorticity, which describes the local spinning motion of fluid particles. The vorticity vector is obtained by taking the curl of the velocity field, which involves cross products of partial derivatives.
- ✓ In robotics and mechanical engineering, the cross product is used to calculate the angular velocity of robot arms and manipulators. By taking the cross product of linear velocity and position vectors, the angular velocity vector can be obtained.
- ✓ In aeronautics and navigation systems, the cross product is used in calculating aircraft orientation and navigation. The cross product of two vectors representing aircraft velocity and wind direction can determine the aircraft's heading relative to the wind.
- ✓ Incorporating real-life applications of the vector cross product can make lessons more engaging and interactive for students. By connecting theoretical concepts to practical uses in fields such as physics, engineering, and computer graphics, trainees can capture students' interest and motivate them to learn.

Activity-3: Teaching Vector Cross Product using GeoGebra(50 minutes).

Discuss how you teach vector cross product using GeoGebra in groups of size five based on the following steps.

- ✓ Open GeoGebra on a computer or tablet and create a 3D coordinate system.
- ✓ Define two vectors, u and v, in 3D space using GeoGebra's vector tool. You can specify the coordinates of the vectors or drag them to desired positions in the coordinate system.
- ✓ Use GeoGebra's built-in commands or scripting capabilities to calculate the cross product of vectors u and v.



- ✓ Display the resulting cross product vector visually in the 3D space.
- ✓ Show how the cross-product vector is perpendicular to both input vectors u and v.
- ✓ Demonstrate how the magnitude of the cross-product vector corresponds to the area of the parallelogram formed by vectors u and v.

  https://www.youtube.com/watch?v=W-3kjPFzt7U

Key Ideas

- Definition: The cross product of two vectors, denoted by $u \times v$, results in a new vector that is perpendicular to both u and v. The magnitude of the cross product is given by the product of the magnitudes of the two vectors and the sine of the angle between them.
- Direction: The direction of the cross-product vector is determined by the right-hand rule, where if you curl the fingers of your right hand from vector u to vector v, then your thumb points in the direction of the cross-product vector.
- Properties: Some important properties of the cross product include distributivity, anti-commutativity (changing the order changes the sign), and linearity. It is also non-commutative, meaning that $u \times v$ is not necessarily equal to $v \times u$.
- Magnitude: The magnitude of the cross product is equal to the area of the parallelogram formed by the two vectors being crossed. This property is useful in geometric interpretations and calculations.
- By using GeoGebra to illustrate vector concepts and operations, you can create engaging and interactive lessons that cater to different learning styles. Trainees can actively explore vector properties, experiment with cross products, and visualize abstract mathematical concepts in a tangible way.

Activity-4: Conceptual Challenges (20 minutes).

What are the challenges students or even teachers' face in understanding vectors cross product? (*To answer this question, refer to the content in the new textbook*).

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

Takeaway resources

https://www.youtube.com/watch?v=W-3kjPFzt7U

Unit summery

Teaching vectors is an essential component of mathematics and physics education, introducing students to a powerful mathematical tool for representing quantities that have both magnitude and direction. Through vector lessons, trainees guide students in understanding vector properties such as magnitude, direction, and component representation in both 2D and 3D space. By engaging students in activities that involve vector addition, subtraction, and scalar multiplication, you help students grasp the algebraic and geometric operations involved in working with vectors. This foundational knowledge sets the stage for students to apply vector concepts in diverse fields such as physics, engineering, computer graphics, and more, where vectors play a crucial role in modeling physical forces, velocities, displacements, and spatial relationships.

In teaching vectors, trainees emphasize the geometric interpretation of vectors as directed line segments connecting points in space. By illustrating how vectors can represent displacement, velocity, acceleration, and other physical quantities, you enable students to visualize vector operations and understand vector transformations. Through hands-on exercises, trainees provide students with opportunities to explore vector properties in real-world scenarios, fostering a deeper understanding of how vectors describe motion, force interactions, and spatial arrangements in a variety of contexts. By connecting abstract vector concepts to concrete applications, students develop a solid foundation in vector algebra and geometry, laying the groundwork for advanced studies in vector calculus and vector analysis.

Unit-8: Teaching Transformation of Plane (G11) (7hrs)

Introduction

Transformation in the plane is a fundamental concept in geometry that involves changing the position, size, or orientation of a figure on a coordinate plane. In the secondary school curriculum, students are introduced to various types of transformations such as translation, reflection and rotation. These transformations help trainees to understand how to manipulate geometric shapes and understand their properties.

Understanding transformations is essential for trainees as it lays the foundation for more complex mathematical concepts in geometry and algebra. By studying transformations, trainees develop spatial reasoning skills and learn how to visually interpret and analyze geometric figures. Furthermore, transformations play a vital role in real-world applications such as computer graphics, architecture, and engineering.

Trainees play a crucial role in guiding students through the process of learning about transformations in the plane. By providing examples, demonstrations, and engaging activities, you can help your students grasp the concepts of transformations and apply them to solve problems effectively. By introducing transformations in the plane effectively, you can help students build a strong foundation in geometry and prepare them for more advanced mathematical topics.
functions together!

Unit Outcomes

After completing this unit, you will be able to:

- Identify effective teaching strategies for teaching transformation.
- understand transformation concepts such as translation, reflection and rotation on the coordinate plane.
- differentiate between various types of transformations and illustrate how each type affects geometric shapes differently.
- demonstrate how transformations are used in practical contexts.
- develop students' problem-solving skills by providing them with opportunities to apply.
- Adapt the discussion to their own situations and then plan to use it to their own classrooms

Key Contents

Session 8.1: Teaching line Translation (2hrs)

Session 8.2: Teaching Reflection of a circle in the line(2hrs)

Session 8.3: Teaching Rotation when the center of rotation is about the point (2hrs)

Unit Summary

Session 8.1: Teaching line Translation(2hrs)

Session Objectives:

After completing this session, you will be able to:

✓ understand the concept of translation as a transformation that moves an object without rotating,

resizing, or reflecting it.

✓ recognize translations preserve shape, size, and orientation, emphasizing that corresponding points move the same distance and direction.

✓ describe translations using vector notation, emphasizing the direction and magnitude of the movement.

✓ Adapt the discussion to their own situations and then plan to use it to their own classrooms.

☞**Activities:**

Activity-1: Teachers reflection on their Teaching (30 minutes)

How did you teach line translation to your students? (you can frame in terms of the following components of an instruction).

- ✓ Activating students' prior knowledge
- ✓ Nature of tasks/activities provided (context, multiple representation, routine/non-routine, etc.)
- ✓ Students classroom discussion and teacher's role in the discussion
- ✓ Summary/consolidation
- ✓ Challenges you face in teaching

Activity-2: Real life application of line translation (15 minutes).

Discuss why you teach line translation in small group? Reflect to the whole class.

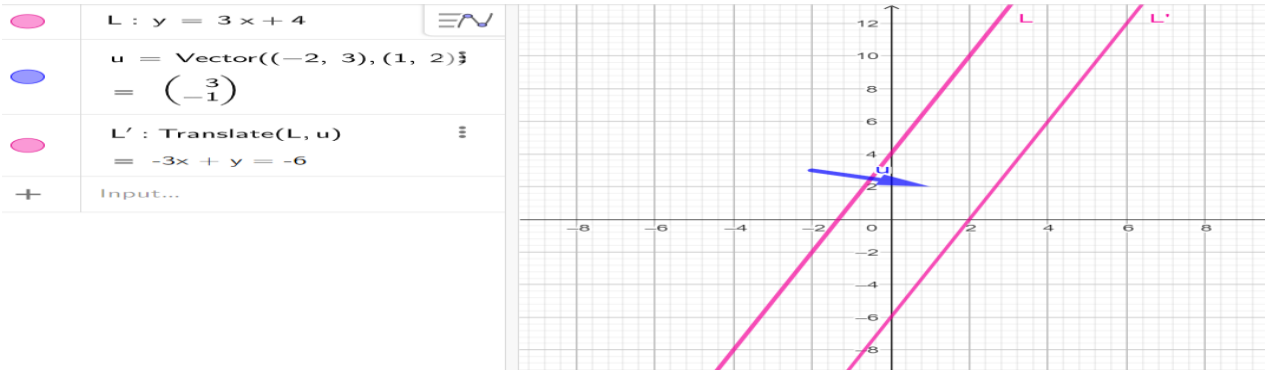
Key Ideas

- In robotics, line translation is used to program robots to move along specific paths or trajectories. By applying line translation, robots can navigate predefined routes optimally and efficiently in manufacturing, logistics, or automated systems.
- In digital art and animation, line translation is essential for creating movement in characters and objects. Animators use translation to shift elements across the screen, creating the illusion of motion in cartoons, movies, and video games.
- Mechanical engineers use line translation in designing machinery and mechanical systems. Components like conveyor belts, escalators, or robotic arms are often programmed to undergo line translations to perform tasks like material movement or part assembly.
- Traffic engineers use line translation principles to study and optimize traffic flow on road networks. By analyzing vehicle movements and adjusting road layouts, traffic signals, or lane configurations, engineers can enhance traffic efficiency and safety.

Activity-3: Teaching line translation using GeoGebra (45 minutes).

Discuss how you teach line translation using GeoGebra based on the following steps.

1. Open GeoGebra and create a new file.
2. Draw a line on the coordinate plane. Label this line as the "original line."
3. Select the original line and use the "Translate Object by Vector" tool from the toolbar.
4. Click on the original line and then specify a vector to translate the line. You can do this by clicking on two points to define the vector.



5. Observe how the original line is translated based on the vector you specified.

Key Ideas

- When a line is translated, its length and orientation remain the same. The line moves parallel to itself in the specified direction.
- Line translation can be represented using vectors. The vector specifies the direction and distance by which the line is translated.
- Translating a line is an additive operation. This means that multiple translations can be applied successively, and the final position of the line is the sum of all individual translations.
- slope of a line remains unchanged during translation. This is because the line maintains the same angle with respect to the coordinate axes.
- Line translation can be geometrically interpreted as sliding the line along a specified direction without changing its shape or size.
- Line translation can also be represented using transformation matrices in linear algebra. The translation matrix shifts the coordinates of the points on the line by a specified amount.
- GeoGebra allows trainees to create dynamic and interactive activities for teaching line translation. you can demonstrate the concept visually by showing how a line moves parallel to itself when translated.
- Trainees can show students how the direction and magnitude of a vector determine the translation of a line.

Activity-4: Conceptual Challenges (20 minutes).

What are the challenges students or even teachers' face in understanding line translation? (*To answer this question, refer to the content in the new textbook*)

Homework Activity (10 minutes).

1. Take different translations problems from grade 11 mathematics students' textbooks and translate by changing the vector or directions of translations.

2.Design activities to teach your students about line translation by taking from grade 11 mathematics students' text book.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

Takeaway resources

https://www.youtube.com/watch?v=vHc8NOYjhgE https://www.youtube.com/watch?v=Y0zfa1qQNRs.

https://www.youtube.com/watch?v=_QaOUuwuyAw

Session 8.2: Teaching Reflection of a Circle in the Line(2hrs)

Session Objectives:

After completing this session, you will be able to:

✓ understand the concept of reflection as a transformation that creates a mirror image of an object across a line.

✓ recognize reflections preserve shape and size, emphasizing that corresponding points are equidistant from the line of reflection.

✓ teach students how to reflect circles on the coordinate plane across horizontal, vertical, and diagonal lines using the rules for reflection.

✓ describe the line of reflection and understand how the circle's image is positioned relative to the original circle.

✓ Adapt the discussion to their own situations and then plans to use it to their own classrooms.

☞**Activities:**

Activity-1: Teachers reflection on their Teaching (30 minutes)

How did you teach the reflection of a circle in the line to you students? (you can frame your reflection in terms of the following components of instruction).

- ✓ Activating students' prior knowledge
- ✓ Nature of tasks/activities provided (context, multiple representation, routine/non-routine, etc.)
- ✓ Students classroom discussion and teacher's role in the discussion
- ✓ Summary/consolidation
- ✓ Challenges you face in teaching

Activity-2: Real life Application of Reflection of a Circle in the Line (15 minutes).

Discuss why you teach reflection of a circle in the line and reflect to the whole class?

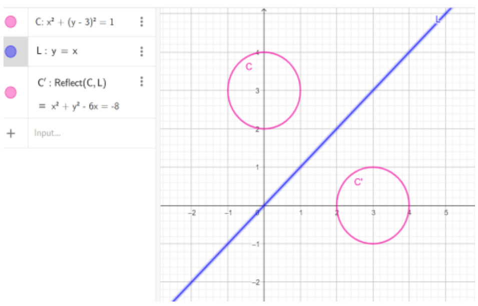
Key Ideas

- Reflection is a fundamental geometric transformation that helps students understand how shapes can be transformed while preserving certain properties.
- By teaching reflection of a circle in a line, trainees enhance their spatial reasoning skills as they visualize how the circle is mirrored across the line of reflection.
- Reflection involves analyzing the relationship between the original object and its image.
- Teaching reflection of a circle in a line encourages trainees to think critically about the properties of circles and how they change under reflection.
- Reflection is used in various real-world applications, such as in architecture, engineering, and computer graphics. Teaching reflection of a circle in a line helps trainees see the practical applications of geometric concepts.

Activity-3: Teaching Reflection of a Circle in the line using GeoGebra(45 minutes).

Discuss how you teach reflection of a circle in the line using GeoGebra based on the following steps.

1. Open GeoGebra and create a new geometry file.
2. Draw a circle by selecting the Circle tool and clicking on the center point and then on a point on the circumference.
3. Draw a line by selecting the Line tool and clicking on two points to define the line.
4. Select the circle and the line by clicking on them.
5. Go to the Transform menu and select Reflect Object.
6. Choose the line as the mirror line for reflection.
7. The reflected circle will appear on the other side of the line.
8. You can drag the circle or the line to see how the reflection changes accordingly



https://www.youtube.com/watch?v=APUH5KBC7lA&t=256s

Key Ideas

- The reflection of a circle in a line maintains the shape of the original circle. This means that the reflected circle will still be a circle, with all points equidistant from the center.
- The reflection of a circle in a line exhibits symmetry across the reflecting line. Each point on the original circle has a corresponding point on the reflected circle that is equidistant from the reflecting line.
- The distance between any point on the original circle and the reflecting line is equal to the distance between the corresponding point on the reflected circle and the reflecting line. This property is crucial in understanding the reflection process.
- The orientation of the reflected circle may differ from that of the original circle. Depending on the position of the original circle relative to the reflecting line, the reflected circle may appear in a different orientation.
- The line in which the circle is reflected, known as the reflecting line, serves as the axis of symmetry for the reflection. All points on the original circle are reflected across this line to determine the corresponding points on the reflected circle.
- Reflecting a circle in a line involves a geometric transformation known as a reflection. This transformation changes the position of each point on the circle across the reflecting line while preserving the shape and size of the circle.
- The points where the original circle intersects the reflecting line will also be points of intersection for the reflected circle. These points remain fixed during the reflection process.
- Teaching reflection of a circle in a line can help students understand the concept of symmetry. you can use GeoGebra to illustrate how the reflection preserves the shape and size of the original circle across the reflecting line.
- Reflecting a circle in a line involves geometric transformations. GeoGebra allows trainees to demonstrate how the reflection operation affects the position of points on the circle and how it relates to the properties of the reflecting line.

Activity-4: Conceptual Challenges (20 minutes).

What are the challenges students or even teachers' face in understanding the reflection of a circle in the line? (*To answer this question, refer to the content in the new textbook*)

Homework Activity (10 minutes).

Explore different examples by changing the position and orientation of the original line and mirror line from Grade 11students' text book and reflect a circle using GeoGebra.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

Takeaway Resources:

https://www.youtube.com/watch?v=_QaOUuwuyAw or videos

Session 8.3: Teaching Rotation when the center of rotation is about the point (3hrs)

Session Objectives:

After completing this session, you will be able to:

- understand the concept of the center of rotation as the fixed point around which a shape is rotated.
- understand how different angles and directions of rotation impact the final orientation of the shape
- recognize shapes that look the same after being rotated around a point.
- apply properties of rotations.
- Adapt the discussion to their own situations and then plans to use it to their own classrooms.

☞**Activities:**

Activity. 1: Teachers reflection on their teaching (30 minutes)

How did you teach rotation when the center of rotation is about the point to your students? (you can frame your reflection in terms of the following components of instruction).

- ✓ Activating students' prior knowledge
- ✓ Nature of tasks/activities provided (context, multiple representation, routine/non-routine, etc.)
- ✓ Students classroom discussion and teacher's role in the discussion
- ✓ Summary/consolidation
- ✓ Challenges you face in teaching

Activity-2: Real life Application of Rotation(30 minutes).

Discuss in small groups of five why you teach rotation when the center of rotation is about the point? Reflect to the whole class.

Key Ideas

• Rotating machinery such as turbines, engines, pumps, and motors often undergo rotational motion around a central axis. When analyzing the performance, efficiency, or structural integrity of these machines, engineers need to consider how components rotate around the origin (0,0) in a two-dimensional plane. For example, when designing a turbine blade for a jet engine, engineers use mathematical models to calculate the aerodynamic forces acting on the blade as it rotates around the turbine's central axis. By applying rotation transformations around the origin, engineers can simulate the blade's movement and predict its performance under different operating conditions.

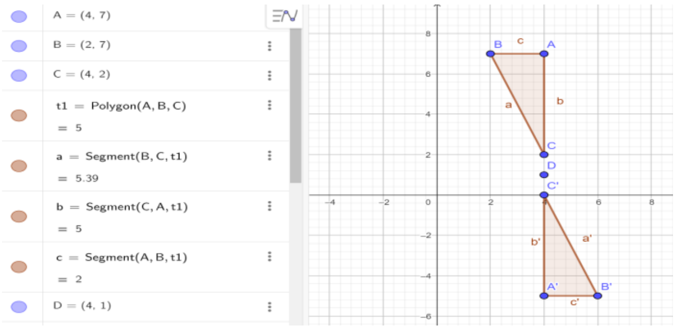
• In the design of gear systems, engineers use rotation around the origin to analyze the meshing of gears and ensure smooth and efficient transmission of power. By modeling the rotation of gear teeth around the origin point, engineers can optimize gear profiles, tooth engagement patterns, and overall gear system performance.

• Generally, rotation around the origin in a two-dimensional plane is a critical concept in mechanical engineering applications involving rotating machinery. By accurately modeling and analyzing rotational motion around the origin, engineers can design more efficient, reliable, and high-performing mechanical systems.

Activity-3: Teaching rotation when the center of rotation is about the point using GeoGebra (1.20hrs).

Discuss on how you teach rotation when the center of rotation is about the point using GeoGebra based on the following steps.

1. Open GeoGebra and create a new geometry file.
2. Draw a point on the canvas to serve as the center of rotation.
3. Draw a shape (e.g., a triangle, square, or any other polygon) on the canvas.
4. Select both the shape and the center of rotation point by clicking on them.
5. Go to the Transform menu and select Rotate Object.
6. Choose the center of rotation point as the center of rotation.



7. A rotation handle will appear on the shape, allowing you to rotate it around the center point.

8. Rotate the shape by dragging the rotation handle and observe how it rotates around the center point.

9. You can also specify the angle of rotation in the dialog box that appears when you select Rotate Object.

Key Ideas

- The center of rotation is the fixed point around which a shape is rotated. All points in the shape move in a circular path around this center point.
- The angle of rotation determines how much a shape is rotated around the center point. Positive angles indicate counterclockwise rotations, while negative angles indicate clockwise rotations.
- The direction of rotation specifies whether the shape is rotated clockwise or counterclockwise around the center point. This direction is determined by the sign of the angle of rotation.
- Rotations around a point often exhibit rotational symmetry, where the shape looks the same after being rotated a certain angle around the center point. Identifying and understanding rotational symmetry is a key concept.
- During a rotation around a point, the distance between each point in the shape and the center of rotation remains constant. This property helps maintain the shape's overall structure.

- Performing a rotation in the opposite direction (with a negative angle) reverses the original rotation. Understanding inverse rotations is important for undoing transformations and restoring the original position of a shape.
- Rotations around a point can be visualized and analyzed using coordinate geometry. Understanding how the coordinates of points in a shape change during a rotation is crucial for working with geometric transformations in the coordinate plane
- Exploring rotations around a point allows students to experiment with transforming shapes in creative ways. you can encourage students to create their own designs, patterns, or artworks using rotations, fostering creativity and self-expression.

Activity-4: Conceptual Challenges (30 minutes).

What are the challenges students or even teachers' face in understanding rotation when the center of rotation is about the point? (*To answer this question, refer to the content in the new textbook*)

Homework Activity (10 minutes).

1. How does the choice of the center of rotation affect the final position of the shape?
2. Are there any points that result in unchanged shapes after rotation?
3. Can you predict the final position of a shape when rotating around a specific point?

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

Takeaway Resources

https://www.youtube.com/watch?v=7JD6AgRqjTk

GeoGebra software.

Unit Summery

Teaching line translation involves conveying the concept of moving a geometric figure along a straight path without altering its shape or orientation. Trainees focus on helping students understand how to shift objects horizontally, vertically, or diagonally while maintaining their original properties. By emphasizing the use of coordinate grids, vectors, and directional language, trainees facilitate the visualization of how figures can be translated accurately. Through hands-on activities, interactive demonstrations, and real-world applications, students develop their spatial reasoning skills, problem-solving abilities, and mathematical communication. By mastering line translation, students build a foundation for more complex transformations in geometry and enhance their ability to analyze and manipulate shapes in various contexts.

The reflection of a circle in a line involves guiding students in understanding how to mirror a circular shape across a given line while preserving its size, shape, and orientation. Trainees introduce concepts such as the perpendicular bisector of a chord and the properties of tangents to aid students in visualizing the reflection process accurately. By utilizing symmetry, geometric constructions, and the principles of reflection, trainees help students grasp how to map points on the circle to their corresponding positions across the line of reflection. Through engaging activities, practical examples, and collaborative problem-solving tasks, students enhance their spatial awareness, analytical thinking, and geometric reasoning skills. Mastering the reflection of a circle in a line equips students with a solid foundation for more advanced concepts in geometry and prepares them to apply reflection techniques in various mathematical contexts effectively.

Rotation about a point involves transforming geometric shapes by rotating them around a fixed point while preserving their size, shape, and orientation. This concept introduces students to the idea of rotating figures in a plane, understanding the angle of rotation, and determining the new positions of the vertices after rotation. By exploring properties such as the distance from the center of rotation, the direction of rotation, and the relationship between the original figure and its rotated image, students develop a deeper understanding of rotational symmetry and angle measurements. Through engaging activities, visual aids, and interactive exercises, trainees guide students in mastering the skills needed to visualize and manipulate shapes through rotation, enhancing their spatial awareness, geometric reasoning, and problem-solving abilities in mathematics.

Unit 9: Teaching Statistics and Probability (11 hrs.)

Introduction

Statistics and probability are two closely related branches of mathematics that deal with the collection, analysis, interpretation, and presentation of data. Statistics focuses on summarizing and making inferences from data, while probability deals with the likelihood of events occurring. Statistics is used in a wide range of fields, including social sciences, natural sciences, business, and engineering. Statistical methods are used to design experiments, collect data, analyze results, and draw conclusions. Probability, on the other hand, is used in fields such as risk assessment, insurance, gambling, and finance. It allows us to quantify the likelihood of events happening and make predictions based on those probabilities. Together, statistics and probability provide powerful tools for understanding the world around us. They enable us to make informed decisions, draw meaningful conclusions from data, and predict future outcomes. A solid foundation in statistics and probability is essential for anyone seeking to work in fields that involve data analysis, decision-making, or risk assessment.

The unit contains five sessions including: measures of central tendency of raw and grouped data, mean deviation, variance and standard deviation, and finally probability of simple events. At the end of the unit, you will be able to equip yourself with necessary knowledge and skills to teach statistics and probability.

Unit Outcomes

After completing this unit, you will be able to:

- ✓ Understand the mathematical concepts of statistics and probability deeply.
- ✓ Know various approaches of teaching statistics and probability.

Key Contents

Session 9.1: Teaching Measures of Central Tendency of Raw Data

Session 9.2: Teaching Measures of Central Tendency of Grouped Data

Session 9.3: Teaching Measures of Dispersion: Mean Deviation from the Mean

Session 9.4: Teaching Measures of Dispersion: Variance and Standard Deviation

Session 9.5: Teaching Probability of Simple Events

Unit Summary

Session 9.1: Teaching Measures of Central Tendency of Raw Data (2 hrs.)

Measures of central tendency, such as mean, median, and mode, are used to describe the "center" or typical value of a data set. When working with raw data (individual data points), these measures are calculated directly from the data. These measures are widely used in statistics and data analysis to summarize and compare data sets, make inferences about populations, and support decision-making. In this session, you will learn more about teaching measures of central tendency of raw data.

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Discuss various ways of teaching measures of central tendency of raw data.
- ✓ Identify effective teaching strategies for teaching measures of central tendency of raw data.
- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of measures of central tendency of raw data.
- ✓ Improve your conceptual understanding of measures of central tendency of raw data.
- ✓ Adapt the discussion to your own situations and then plan to use it to your own classrooms.

Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about measures of central tendency of raw data? You can frame your answer based on the following questions.

a) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

b) What teaching strategies would you use to improve the instruction?

c) How would you tackle the challenges you face in teaching the concept?

Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson as a case study that a teacher taught the concept of measures of central tendency of raw data to grade 9 students.

Read through the lesson and then answer the following questions.

1. Is it similar to the way that you teach the concept?
2. Do you prefer to use it in your classroom? Why?
3. Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 9.1: Measures of Central Tendency of Raw Data

Learning Objectives:

At the end of this lesson, students will be able to:

22. Describe and illustrate the mean, median, and mode of ungrouped data.
23. Calculate the mean, median, and mode of ungrouped data.
24. Describe and interpret data using measures of central tendency.

Introduction

Statisticians analyzed data to obtain useful information from them. An important part of data analysis is to find the average value, the middle value, or the most frequent value of a set of data.

A measure of central tendency is any measure indicating the center of a set of data. The **mean, median** and **mode** are the three kinds of averages.

Activity-1: Who is Representing

A school Music club received an invitation for one person from music festival organizers. The club's seven members are very eager to go. To be fair to all, the school director decided to choose a person whose age falls within the mean age of her seven members.

She made a list such as below:

Club Members	Manager	Musician A	Musician B	Musician C	Composer A	Composer B	Cashier
Age	47	21	20	19	18	18	18

- What is the mean age of the club members?
- Is there someone in this group who has this age?
- How many persons are older than the mean age? How many are younger?
- Do you think this is the best measure of central tendency to use? Explain.

Activity-2: Who is in the middle

From our previous example, the ages of the members are given as 18, 20, 18, 19, 21, 18 and 47. Answer the following questions.

a. Arrange the ages in numerical order.
b. What is the middle value?
c. Is there a member with this representative age?
d. How many members are younger than this age? Older than this age?
e. Who is now the representative of the school's music club in the festival?
f. Compare the results from the previous discussion (how the mean is affected by the set of data). Explain.

Activity-3: The newly hired member

If at the end of the month, the music club hired another member whose age is 22, the data now consists of eight ages: 18, 20, 18, 19, 21, 18, 47 and 22, an even number. How many middle entries are there?

Let us find out by following these simple steps:

a. Arrange the member's ages in numerical order.
b. Find the two middle values (ages).
c. Get the average of the two middle values.
d. What is now the median age?
e. How many are below this age? Above this age?

Activity-6: Median of discrete frequency distribution

a. How would you find the median of discrete data given in following frequency distribution table?
b. Arrange marks in ascending order and prepare a frequency table.
c. Calculate the total number of observations.
d. The median is the 13^{th} observation. Why? How do you find the 13^{th} observation?
e. To locate the 13^{th} observation (median), you need to prepare the cumulative frequency table. Does it help?

Marks obtained	8	16	10	12	15	9
Number of students	5	8	2	2	6	2

Important Ideas: Median of raw data

Median is a measure of central tendency which gives the value of the middlemost observation in the data when the data is arranged in ascending (or descending) order. It is not affected by a few extreme values.

Median of raw data is calculated as follows:

(i) Arrange the (numerical) data in an ascending (or descending) order

(ii) When the number of observations (n) is **odd**, the median is the value of $\left(\frac{n+1}{2}\right)th$ observation.

(iii) When the number of observations (n) is **even**, the median is the mean of the $\left(\frac{n}{2}\right)th$ and $\left(\frac{n}{2}+1\right)th$ observations.

Median of discrete frequency Distribution is calculated as follows:

Step 1: Arrange the data in ascending (or descending) order.

Step 2: Find the total number of observations (n).

Step 3 : Find cumulative frequencies

Step 4: The observation whose cumulative frequency is just greater than n/2 is the median of the data.

Check Your Understanding

1) Find the median of the following data, which gives the marks, out of 15, obtained by 35 students in a mathematics test.

Marks obtained	3	5	6	11	15	14	13	7	12	10
Number of Students	4	6	5	7	1	3	2	3	3	1

2) A fair die is thrown 100 times and its outcomes are recorded as shown below:

Outcome	1	2	3	4	5	6
Frequency	17	15	16	18	16	18

Find the median outcome of the distributions.

Key Ideas

To teach about measures of central tendency, you need to start by ensuring that students have a clear understanding of what central tendency is and why it is important in statistics. Explain that measures of central tendency, such as mean, median, and mode, are used to summarize and describe the typical or central value of a dataset. Then, help students to derive the formula for finding each measure of central tendency and provide practice problems to apply the respective formula. Encourage students to understand the differences between mean, median, and mode and when each measure is most appropriate to use. Discuss how the mean is affected by outliers, how the median is less influenced by extreme values, and how the mode can be useful for identifying the most common value in a dataset. Then, discuss scenarios where the mean, median, and mode may provide different perspectives on the central tendency of the data. Encourage students to analyze how the choice of measure can impact their interpretation of the dataset and draw meaningful conclusions based on the measures of central tendency calculated. Provide opportunities for students to apply their knowledge in real-world contexts and make informed decisions using measures of central tendency.

Activity-3: Conceptual Challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of measures of central tendency of raw data? *To answer this question, you need to refer to the content in the new textbook.*

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/probability/xa88397b6:display-quantitative/xa88397b6:mean-median-data-displays/a/choosing-the-best-measure-of-center#:~:text=Mean%20and%20median%20both%20try,sometimes%20the%20median%20is%20preferred.

Session 9.2: Teaching Measures of Central Tendency of Grouped Data (2 hrs.)

When data is grouped into intervals, calculating measures of central tendency requires different approaches compared to ungrouped data. Measures of central tendency of grouped data provide valuable insights into the typical values and distribution of the data, even when the individual data points are not available. In this session, you will learn more about teaching measures of central tendency of grouped data.

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Discuss various ways of teaching measures of central tendency of grouped data.
- ✓ Identify effective teaching strategies for teaching measures of central tendency of grouped data.
- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of measures of central tendency of grouped data.
- ✓ Improve your conceptual understanding of measures of central tendency of grouped data.
- ✓ Adapt the discussion to your own situations and then plan to use it to your own classrooms.

☞ Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about measures of central tendency of grouped data? You can frame your answer based on the following questions.

a) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

b) What teaching strategies would you use to improve the instruction?

c) How would you tackle the challenges you face in teaching the concept?

Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson as a case study that a teacher taught the concept of measures of central tendency of grouped data to grade 11 students.

Read through the lesson and then answer the following questions.

1. Is it similar to the way that you teach the concept?
2. Do you prefer to use it in your classroom? Why?
3. Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 9.2: Measures of Central Tendency of Grouped Data

Learning Objectives:

At the end this lesson, students will be able to:

- Describe and illustrate the mean and median of grouped data.
- Calculate the mean and median of grouped data.

Introduction:

The data in a real-world situation can be overwhelming. However, by appropriately organizing data, it is often possible to make a rather complicated set of data easier to understand. The items in the set of data are grouped for convenience.

Activity-1: Mean of Grouped data

Consider the following grouped frequency distribution:

Daily wages (in birr)	150-160	160-170	170-180	180-190	190-200
Number of workers	5	8	15	10	2

a. What can we infer from this table?
b. There are 5 workers earning daily somewhere from birr 150 to 160 (not included 160). But, do we know what exactly the earnings of each of these 5 workers are?
c. If not, what assumptions should be made to find the mean?
d. How would you find the mean of the given data set shown in the frequency distribution?

Here, we made an assumption that frequency in any class is centered at its class mark or midpoint.
So, we can say that there are:

- 5 workers earning a daily wage of (150 + 160)/2 = 155 birr each,
- 8 workers earning a daily wage of (160 +170)/2 = 165 birr,
- 15 workers earning a daily wage of (170 +160)/2 = 175 birr and so on.

Now we can calculate mean of the given grouped data as follows, using the formula used in lesson 1.

Daily wages (in birr)	**Number of workers (f_i)**	**Class marks (x_i)**	**$f_i x_i$**
150-160	5	155	775
160-170	8	165	1320
170-180	15	175	2625
180-190	10	185	850
190-200	2	195	390
		$\sum_{i=1}^{n} f_i = 40$	$\sum_{i=1}^{n} f_i x_i = 6960$

$$Mean = \bar{x} = \frac{\sum_{i=1}^{n} f_i x_i}{\sum_{i=1}^{n} f_i} = \frac{6960}{40} = 174$$

So, the mean daily wage is 174 birr.

Important Ideas: mean of grouped data

To find the mean of grouped data using class marks, the following formula can be used:

$$Mean = \overline{x} = \frac{\sum_{i=1}^{n} f_i x_i}{\sum_{i=1}^{n} f_i}$$

Where: f_i is the frequency, and x_i is the class mark of each class.

Check Your Understanding

1) The frequency distribution below shows the height (in cm) of 50 students in a secondary school. Find the mean of the set of data.

Height (in cm)	Frequency
150-155	4
155-160	7
160-165	13
165-170	18
170-175	8

2) Calculate the mean of the Mid-semester exam scores of grade 11 students in a school.

Score	Frequency
41 – 45	1
36 – 40	8
31 – 35	8
26 – 30	14
21 – 25	7
16 – 20	2

Activity-2: Median of grouped (continuous) data

Find the median marks obtained by 50 students from the following distribution:

Marks	0-10	10-20	20-30	30-40	40-50
Number of Students	8	8	14	16	4

a. What is the total number of observations (frequencies) of the given data set?
b. **Prepare a frequency distribution table involving cumulative frequencies.**
c. Determine the class containing the median (median class)?
d. Find the lower limit of the median class?
e. How would you find the median of the data? What is formula to do it?

Important Ideas: Median

The median is the middle value in a set of quantities. It separates an ordered set of data into two equal parts. Half of the quantities is located above the median and the other half is found below it, whenever the quantities are arranged according to magnitude (from highest to lowest.)

To find median of grouped data, we use the following steps:

Step 1: Arrange the data in ascending order

Step 2: Write cumulative frequencies of the observations

Step 3: Identify the class whose cumulative frequency is just greater than N/2. Call this class interval as median class.

Note that the median class is the class that contains the N/2*th* observation. The computed median must be within the median class.

Step 4: Find median by the formula

$$\text{Median} = l + \frac{\frac{N}{2} - C}{f} \times i$$

Where

l is the lower limit of the median class

N is the number of observations: $N = \sum_{i=1}^{n} f_i$

C is the cumulative frequency of the class just preceding the median class

f is the frequency of the median class

i is the width of the median class

Activity-2: Median of grouped (but discontinuous) data

a. If the given grouped data is not continuous (like the following frequency table), how would you apply the formula to find the median?

Marks	0 – 9	10 – 19	20 – 29	30 – 39	40 – 49	50 – 59
Number of Students	3	5	8	9	13	6

b. Complete the following frequency distribution table.

c. What is the median class?

d. What is the lower limit of the median class?

e. Find the median of the data?

Marks	True class limits	Frequency (f)	Cumulative Frequency (C)
0 – 9	0.5 – 9.5	3	3
10 – 19		5	8
20 – 29		8	
30 – 39		9	
40 – 49		13	
50 – 59		6	
		N = N/2 =	

Check Your Understanding

1) Find the median of the following data :

Marks	0-5	5-10	10-15	15-20	20-25
Number of Boys	**5**	**9**	**10**	**14**	**12**

2) Calculate the median of the Mid-semester exam scores of students in a secondary school.

Score	Frequency
41 – 45	1
36 – 40	8
31 – 35	8

	26 – 30	14	
	21 – 25	7	
	16 – 20	2	

Key Ideas

To teach students about measures of central tendency of grouped data, you need to begin by ensuring that students have a solid understanding of grouped data and how it differs from raw data. Explain that grouped data organizes individual values into intervals or classes, making it easier to analyze large datasets. Discuss the importance of grouped data in statistical analysis and how it can help summarize and interpret data more efficiently. Then, help students to understand how to create a frequency distribution table for grouped data, which displays the intervals (classes) along with the corresponding frequencies (number of observations) in each interval. Explain the process of organizing and counting data into intervals to create a clear and concise representation of the dataset. Provide examples and practice problems for students to construct frequency distribution tables and understand their significance in analyzing grouped data.

Then, introduce students to methods for calculating measures of central tendency, such as the mean, median, and mode, for grouped data. Explain how to determine the midpoint of each interval, calculate the weighted mean, find the median class, and identify the modal class. Demonstrate step-by-step procedures for calculating each measure of central tendency using grouped data and provide practice exercises to reinforce the concepts.

Finally, guide students in interpreting the results of measures of central tendency for grouped data in the context of the dataset being analyzed. Discuss how the weighted mean accounts for the frequency of values in each interval, how the median class represents the central value of the dataset, and how the modal class identifies the most frequent interval. Encourage students to consider the characteristics of grouped data and choose the most appropriate measure of central tendency based on the distribution of values in the intervals. Provide opportunities for students to apply their knowledge in real-world scenarios and make informed decisions using measures of central tendency for grouped data.

Activity-3: Conceptual Challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of measures of central tendency of grouped data? (*To answer this question, refer to the content in the new textbook*)

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/in-in-grade-10-ncert/x573d8ce20721c073:statistics/x573d8ce20721c073:mean-median-mode-of-grouped-data/e/mean-of-grouped-data

Khan Academy: https://www.khanacademy.org/math/in-in-grade-10-ncert/x573d8ce20721c073:statistics/x573d8ce20721c073:mean-median-mode-of-grouped-data/e/median-of-grouped-data

Session 9.3: Teaching Measures of Dispersion: Mean Deviation from the Mean (2 hrs.)

In statistics, measures of dispersion, also known as measures of variability, are used to describe how spread out a set of data is. They provide a quantitative assessment of how much the individual data points differ from the central tendency of the data. Common measures of dispersion include range, variance, and standard deviation. Measures of dispersion are important for understanding the distribution of data. They provide insights into how consistent or variable the data is, which can be useful for making comparisons between different data sets or for identifying outliers. Measures of dispersion are widely used in various fields, including statistics, data analysis, and quality control.

Mean deviation from the mean, also known as mean absolute deviation, is a measure of dispersion that quantifies the average distance between each data point and the mean of the data set. Mean deviation from the mean is often used in conjunction with other measures of dispersion, such as range and standard deviation. It can provide additional insights into the distribution of the data and help in making comparisons between different data sets.

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Discuss various ways of teaching mean deviation from the mean.
- ✓ Identify effective teaching strategies for teaching mean deviation from the mean.

- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of mean deviation from the mean.
- ✓ Improve your conceptual understanding of mean deviation from the mean.
- ✓ Adapt the discussion to your own situations and then plan to use it to your own classrooms.

Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about measures of mean deviation from the mean? You can frame your answer based on the following questions.

a) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

b) What teaching strategies would you use to improve the instruction?

c) How would you tackle the challenges you face in teaching the concept?

Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson as a case study that a teacher taught the concept of mean deviation from the mean to grade 12 students.

Read through the lesson and then answer the following questions.
a) Is it similar to the way that you teach the concept?
b) Do you prefer to use it in your classroom? Why?
c) Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 9.3: Measures of Dispersion: Mean Deviation from the Mean

Learning Objectives:

At the end this lesson, students will be able to:

- Explain the meaning of dispersion.
- Define various measures of dispersion such as range, mean deviation, variance and standard deviation.
- Calculate mean deviation from the mean of ungrouped and grouped data.

Introduction:
You have learnt various measures of central tendency, such as mean, median and mode. Measures of central tendency help us to represent the entire mass of the data by a single value. Can the **central tendency** describe the data fully and adequately? To answer this question, let us do the following activity.

Activity-1: Analyzing the spread of data

The daily income of the workers in two factories are:
Factory A: 35 45 50 65 70 90 100
Factory B: 60 65 65 65 65 65 70

a. Find the mean income of each group?
b. Analyze the spread of the income of each group from the mean?

c. Which group has income closer to the mean?
d. Which group shows greater variability in workers income?
e. Which statistical measure is more appropriate to differentiate between the groups?

Important Ideas

Dispersion or variation is the scatter (or spread) of data values from a measure of central tendency. There are several measures of dispersion that can be calculated for a set of data. The most commonly used measures of dispersion are the range, the mean deviation, the standard deviation, and the variance.

Activity-2: Mean Deviation from the Mean

In Activity-1, we note that the income in Factory B cluster around the mean while in Factory A the scores are spread away from the mean.

a. Calculate the deviation of each observation from the mean (i.e., 65) in each group and add all such deviations?
b. Why is the sum always zero?
c. Now take only the **absolute value of the deviations** and then take their sum.
d. Is the sum (dispersion) large or small? Why?
e. Find the mean of the deviations?

Important Ideas: Mean deviation from mean

The mean deviation is the sum of the absolute values of the deviations from the mean divided by the number of items (i.e., sum of frequencies)

Mean deviation from mean of raw data = $\dfrac{\sum_{i=1}^{n}|x_i - \overline{x}|}{N}$

Mean deviation from mean of grouped data = $\dfrac{\sum_{i=1}^{n} f_i\,|x_i - \overline{x}|}{N}$

Where $N = \sum_{i=1}^{n} f_i$, and $\overline{x} = \dfrac{\sum_{i=1}^{n} f_i x_i}{N}$

The following steps are employed to calculate the mean deviation from mean.

Step 1: Make a column of deviation from the mean, namely $x_i - \overline{x}$ (In case of grouped data take x_i as the mid value of the classes.)

Step 2: Take absolute value of each deviation and write in the column headed $|x_i - \overline{x}|$.

For calculating the mean deviation from the mean of raw data use

Mean deviation from mean = $\dfrac{\sum_{i=1}^{n}|x_i - \overline{x}|}{N}$

For grouped data proceed to step 3.

Step 3: Multiply each entry in step 2 by the corresponding frequency. We obtain $f_i\,|x_i - \overline{x}|$ and write in the column headed $f_i\,|x_i - \overline{x}|$.

Step 4: Find the sum of the column in step 3. We obtain $\sum_{i=1}^{n} f_i\,|x_i - \overline{x}|$

Step 5: Divide the sum obtained in step 4 by N.

Check Your Understanding

1) Find the mean deviation from the mean of the following data:

Size of items (x_i):	4	6	8	10	12	14	16
Frequency (f_i):	2	5	5	3	2	1	4

Mean is 10.

2) Calculate the mean deviation from mean of the following distribution:

Marks (x_i):	0 - 10	10 - 20	20 - 30	30 - 40	40 - 50
No. of Students (f_i):	5	8	15	16	6

Mean is 27 marks.

Key Ideas

The mean deviation from the mean is a measure of the average distance between each data point and the mean of the data set. It helps to understand how spread out the data points are from the mean. To calculate the mean deviation from the mean, you first find the mean of the data set, then subtract the mean from each data point to find the deviation. Finally, take the absolute value of each deviation, sum them up, and divide by the total number of data points to get the mean deviation.

A smaller mean deviation from the mean indicates that the data is more clustered around the mean, while a larger mean deviation suggests that the data is more spread out. It provides a measure of variability in the data set. Teaching mean deviation from the mean can help students understand the concept of variability in data sets and how to quantify it. It can be used in various fields such as statistics, finance, and science to analyze and interpret data effectively.

Activity-3: Conceptual Challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of mean deviation from the mean? *To answer this question, you need to refer to the content in the new textbook.*

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/cc-sixth-grade-math/cc-6th-data-statistics/cc-6-mad/v/mean-absolute-deviation#:~:text=0%20energy%20points,in%20a%20data%20set%20are.

Session 9.4: Teaching Measures of Dispersion: Variance and Standard Deviation (2 hrs.)

Variance and standard deviation are two closely related measures of dispersion that quantify the spread or variability of a data set. Variance is the average of the squared differences between each data point and the mean, while standard deviation is the square root of the variance. Variance and standard deviation are important measures of dispersion because they provide insights into the distribution of the data. A higher variance and standard deviation indicate that the data is more spread out, while a lower variance and standard deviation indicate that the data is more clustered around the mean.

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Discuss various ways of teaching variance and standard deviation.
- ✓ Identify effective teaching strategies for teaching variance and standard deviation.
- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of variance and standard deviation.
- ✓ Improve your conceptual understanding of variance and standard deviation.
- ✓ Adapt the discussion to your own situations and then plan to use it to your own classrooms.

Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about measures of variance and standard deviation? You can frame your answer based on the following questions.

a) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

b) What teaching strategies would you use to improve the instruction?

c) How would you tackle the challenges you face in teaching the concept?

Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson as a case study that a teacher taught the concept of variance and standard deviation to grade 12 students.

Read through the lesson and then answer the following questions.

a) Is it similar to the way that you teach the concept?
b) Do you prefer to use it in your classroom? Why?
c) Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 9.4: Variance and Standard Deviation

Learning Objectives:

At the end this lesson, students will be able to:

- Define variance and standard deviation as measures of dispersion.
- Calculate variance and standard deviation of ungrouped and grouped data.
- Illustrate the properties of variance and standard deviation.
- Describe and interpret data using measures of variability.

Introduction:

In lesson 9.3, we took the absolute value of the deviations taken from mean to get rid of the negative sign of the deviations. Another method is to square the deviations. Let us, therefore, square the deviations from the mean and then take their sum.

Activity-1: Variance and standard deviation of raw data

The daily sale of sugar in a certain grocery shop is given below:

Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Frequency	75 kg	120 kg	12 kg	50 kg	70.5 kg	140.5 kg

The average daily sale is 78 Kg.

a. Find the difference of each value from the mean (deviation).
b. Square each of the deviations.
c. Calculate the mean of these squared deviations (called variance).

Important Ideas

The average of the squared deviations from the mean is called variance.

If there are n observations, $x_1, x_2, \ldots, x_n$, then

$$\text{var}iance(\sigma^2) = \frac{(x_1-\overline{x})^2+(x_2-\overline{x})^2+\cdots+(x_n-\overline{x})^2}{n} = \frac{\sum_{i=1}^{n}(x_i-\overline{x})^2}{n}, \text{ where } \overline{x} = \frac{\sum_{i=1}^{n}x_i}{n}$$

The standard deviation, denoted by σ, is the positive square root of the variance (σ^2). Thus

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{n}}$$

The following steps are employed to calculate the variance and hence the standard deviation of raw data.

Step 1. Calculate the arithmetic mean of the data.

Step 2: Make a column of deviations from the mean, namely, $x_i - \overline{x}$.

Step 3 (check): Sum of deviations from mean must be zero, i.e., $\sum_{i=1}^{n}\left(x_i - \overline{x}\right) = 0$

Step 4: Square each deviation and write in the column headed $\left(x_i - \overline{x}\right)^2$

Step 5: Find the sum of the column in step 4.

Step 6: Divide the sum obtained in step 5 by the number of observations. We obtain σ^2.

Step 7: Take the positive square root of σ^2. We obtain σ (Standard deviation).

Activity-2: Properties of variance and standard deviation

Consider the following data which shows the amount of rain fall in ml in the last five days.

20, 30, 50, 70, 80

The mean is 50, the variance is 650, and the standard deviation is 25.5.

In the next five days, if the rainfall increases by 5ml each, i.e. 25, 35, 55, 75, 85.

a. Find the mean of rainfall in the next five days.
b. Find the variance and standard deviation of rainfall in the next five days.
c. Compare the answers with those found in a and b above.
d. Discuss the comparison you found in c.

Important Ideas: Properties of variance and standard deviation

Property 1: If a constant k is added to each value of a data, then the new variance is the same as the old variance.

Property 2: If each value of data is multiplied by a constant c, then

a. The new variance is c^2 times the old variance
b. The new standard deviation is $|\ c\ |$ times the old standard deviation.

Check Your Understanding

1) The marks of 10 students of section A in a test in English are given below:

   7 10 12 13 15 20 21 28 29 35

   Determine the variance and the standard deviation.

2) In a study on ages of mothers at the first child birth in a village, the following data were available:

Age (in years) at first child birth	18 - 20	20 - 22	22 - 24	24 - 26	26 - 28	28 - 30	30 - 32
No. of mothers	130	110	80	74	50	40	16

Find the variance and the standard deviation.

Key Ideas

The key idea in teaching variance and standard deviation is to help students understand the concept of variability in a data set. Variance and standard deviation measure the spread of data points around the mean, providing valuable information about the distribution of the data. Then, help them to emphasize the relationship between variance, standard deviation, and the mean of a data set. Variance and standard deviation quantify how far individual data points are from the mean, providing insights into the overall spread or dispersion of the data. Students should then learn how to calculate variance and standard deviation using formulas and understand the meaning of the results. Variance is the average of the squared differences between each data point and the mean, while standard deviation is the square root of the variance. Teaching students how to interpret these values in the context of the data set is crucial. It is also good to demonstrate real-world applications of variance and standard deviation to show students how these concepts are used in various fields such as finance, science, and social sciences.

Activity-4.3: Conceptual Challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of variance and standard deviation? (*To answer this question, refer to the content in the new textbook*)

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/statistics-probability/summarizing-quantitative-data/variance-standard-deviation-population/v/range-variance-and-standard-deviation-as-measures-of-dispersion

Session 9.5: Teaching Probability of Simple Events (3 hrs.)

Understanding the probability of simple events is essential for building a foundation in probability theory. It allows us to reason about the likelihood of events occurring and make informed decisions based on those probabilities. Probability of simple events is used in a wide range of applications, including risk assessment, statistical inference, and decision theory.

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Discuss various ways of teaching probability of simple events.
- ✓ Identify effective teaching strategies for teaching probability of simple events.
- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of probability of simple events.
- ✓ Improve your conceptual understanding of probability of simple events.
- ✓ Adapt the discussion to your own situations and then plan to use it to your own classrooms.

Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about measures of probability of simple events? You can frame your answer based on the following questions.

a) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

b) What teaching strategies would you use to improve the instruction?

c) How would you tackle the challenges you face in teaching the concept?

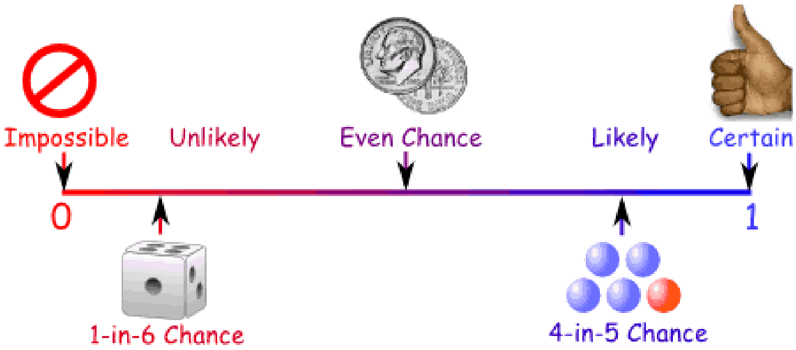
Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson as a case study that a teacher taught the concept of probability of simple events to grade 11 students.

Read through the lesson and then answer the following questions.
a) Is it similar to the way that you teach the concept?
b) Do you prefer to use it in your classroom? Why?
c) Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 9.5: Probability of Simple Events
Learning Objectives: At the end this lesson, students will be able to: • Understand the meaning of random experiment and probability. • Differentiate between outcomes and events of a random experiment. • Define probability P(E) of occurrence of an event E. • Find the probability of simple events. • Appreciate the importance of an experiment, outcome, event and probability in real-life. **Activity-1: The concept of probability**

1) Try to relate each illustration below with your day-to-day activities.



a. Are those words familiar to you?
b. What particular topic comes into your mind when you see/hear the words in the illustration?
c. How else can the possible occurrence or likelihood of an event be expressed?
d. Based on the illustration, how do you define probability?

2) Are you familiar with the game rock-paper-scissors? Let you find a partner and play the game. You have three rounds to play and record your result on the paper provided to you. Write W if you win and L if you lose.

Trial	1st Round	2nd Round	3rd Round
Student A			
Student B			

a. How many times did you win or lose the game?
b. Now, compare your result with your classmate.
c. What is the chance or probability of winning or losing the game?
d. If you repeat this game several times, do you think that the probability of winning the game is increased? Why?

Important Ideas: Probability

- **Probability** is the chance that something will happen, that is, how likely an event is to occur.
- The more likely an event is to occur, the higher its probability. The less likely an event is to occur, the lower its probability.
- Sometimes you can measure a **probability** with a number like "10% chance of rain", or you can use words such as impossible, unlikely, possible, even chance, likely and certain. For example: "It is unlikely to rain tomorrow".

Activity-2: Random Experiment and its Outcomes

1) What do you know in advance about the following situations? Explain.
   a. Tossing a fair coin.
   b. Throwing a fair die.
   c. Drawing a ball from a bag containing identical balls of different colors without looking into the bag.
   d. Drawing a card at random from a well shuffled deck of playing cards.
2) What are the possible outcomes of the situations in Q.1 above? Are the outcomes equally likely? Is there an unequally likely experiment that you know?

Important Ideas: Random Experiment

- In the above situations, tossing a coin, throwing a die, drawing a ball, drawing a card, each is an example of a random experiment.
- A random experiment always has more than one possible outcome (result). For example, the possible outcomes of tossing a coin are: Head (H) and Tail (T). Here, we assume that the two outcomes H and T are **equally likely (i.e.,** each outcome is as likely to occur as the other)**.** Similarly, when we throw a die, there are six equally likely outcomes (1, 2, 3, 4, 5, and 6).
- We cannot predict any particular outcome before the experiment is performed. However, when the experiment is performed only one outcome out of all possible outcomes comes out. Repeating the experiment may lead to different outcomes.

Check Your Understanding

1) Which of the following is a random experiment?
   a. Suppose you guess the answer to a multiple-choice question having four options A, B, C, and D, in which only one is correct.
   b. The natural numbers 1 to 20 are written on separate slips (one number on one slip) and put in a bag. You draw one slip without looking into the bag.
   c. You drop a stone from a height.
   d. Each of Hana and Hikma chooses one of the numbers 1, 2, 3, independently.
2) What are the possible outcomes of the random experiments in Q. 1 above?

Activity-3: Probability of an event

Consider tossing a coin experiment.

a) How many possible outcomes do we have?
b) How many favorable outcomes do we have?
c) What is the probability of getting a Head?
d) What is the probability of getting a Tail?
e) How are you going to compute for the probability of an event?

Important Ideas: Finding probability of an even

Before we come to the formula of probability of an event, let us understand the meaning of key words: **Sample space** and **Event**.

- Sample space (***S)*** of a random experiment is the set of all possible outcomes of the random experiment. For example, if a coin is tossed, the sample space becomes S = {Head, Tail} = {H, T}.
- Event is a subset of the sample space which contains a collection of some of the possible outcomes of random experiment. For example, in tossing a coin experiment, "the coin shows up a head" or "the coin shows up a tail" each is an event, i.e., E = {H} or E = {T}. When a die is rolled, then the possibility of getting an even number is an event containing outcomes 2, 4 and 6. So., E = {2, 4, 6}.
- The probability of an event E, written as P(E), is defined as:

$$P(E) = \frac{\text{Number of outcomes favourable to E}}{\text{Number of all possible outcomes of the experiment}}$$

(Assuming the outcomes to be equally likely).

In Activity-1, for example, the probability of winning the game is 1/2 and losing the game is 1/2. Similarly, in Activity-3, the probability of getting a Head is 1/2.

Activity-4: Further on probability of events

1) Consider rolling a die experiment.
   a. What is the probability of getting a 4?
   b. What is the probability of getting an 8
   c. What is the probability of getting a number less than 7
   d. Find the sum of the probabilities of getting each number (1, 2, 3, 4, 5, 6)?

2) Answer the following questions by performing an experiment of tossing two coins at a time.
   a. What is the sample space?
   b. What is the event of obtaining at least one head?
   c. What is the probability of getting at least one head?
   d. Find the probability of getting one tail?

Important Ideas: Property of probability

From Activity-4, we learned that probability has the following property:

a. The probability is a number between 0 and 1.

b. The probability of the certain event is 1.

c. The probability of the impossible event is 0.

d. The sum of the probabilities of all outcomes in the sample space is 1.

Check Your Understanding

1) A die is thrown once. What is the probability of getting
   a) an even number
   b) an odd number
   c) a prime number
   d) a number less than 4
2) Two dice are thrown simultaneously and the sum of the numbers appearing on them is noted. What is the probability that the sum is: a) 7 b) 8 c) 12
3) 8 defective toys are accidentally mixed with 92 good ones in a lot of identical toys. One toy is drawn at random from this lot. What is the probability that this toy is defective?
4) A ball is drawn at random from a bag containing 2 red balls, 3 blue balls and 4 black balls. What is the probability of this ball being of
   a) red color b) blue color
   c) black color d) not blue color?

Key Ideas

To teach students about probability, you need to start with explaining the concept of probability as a measure of the likelihood of an event occurring. Introduce the idea that probabilities range from 0 (impossible event) to 1 (certain event), and values in between represent varying degrees of likelihood. Then, focus on teaching students about simple events, which are events with only one possible outcome. Help students understand how to identify and define simple events in different scenarios, such as flipping a coin, rolling a die, or selecting a card from a deck. Then, help students to understand how to calculate the probability of simple events using the formula: Probability of an event = Number of favorable outcomes / Total number of possible outcomes. Provide examples and practice problems to help students grasp the concept and develop their problem-solving skills.

Activity-3: Conceptual Challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of probability of simple events? *To answer this question, you need to refer to the content in the new textbook.*

Activity-4: Lesson Design: Fundamental Principles of Counting (1 hr.)

Now let us put into practice what we have explored in this unit. This may take more time to finalize. If it is not finalized within the given time, it can be a homework activity. Let you work in pairs.

a) Look through your previous teaching plans and redesign the lesson according to your current understanding.
b) Write a comparison between the new lesson and your previous one.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/cc-seventh-grade-math/cc-7th-probability-statistics/cc-7th-basic-prob/v/basic-probability

Khan Academy: https://www.khanacademy.org/math/statistics-probability/probability-library/basic-theoretical-probability/a/probability-the-basics

Khan Academy: https://www.khanacademy.org/math/cc-seventh-grade-math/cc-7th-probability-statistics/cc-7th-basic-prob/v/simple-probability

Unit Summary

This unit provided trainee teachers the opportunity to explore the fundamental concepts of statistics and probability and their real-world applications, together with the effective teaching strategies teachers can use in their own classrooms. Sample lesson plans as case studies and other relevant activities are included to support teachers to focus on effective teaching approaches which are suitable for students' learning. All the activities included in this unit encourage group work and discussions to help trainee teachers to learn from each other and develop their communication skills. Overall, this unit provided trainee teachers with a strong foundation in the concepts of statistics and probability and the corresponding teaching strategies. This knowledge and experiences will be essential for their future teaching career in mathematics.

Unit 10: Teaching introduction to Linear Programming (G-12) (8hrs.)

Introduction

Linear programming is a mathematical method that helps in optimizing complex decision-making processes by maximizing or minimizing a linear objective function while abiding by a set of linear constraints. This powerful tool is widely used in various fields such as economics, business, engineering, and operations research to make efficient use of resources and achieve specific goals. By introducing trainees to linear programming, we can equip them with the knowledge and skills to teach students how to tackle real-world problems systematically and make informed decisions based on quantitative analysis.

Understanding linear programming involves grasping key concepts like objective functions, decision variables, and constraints. Trainees can illustrate these concepts through engaging examples and interactive activities to demonstrate how linear programming can be applied to solve practical problems. By incorporating linear programming into their lesson plans, trainees can not only enhance students' mathematical skills but also nurture their critical thinking, problem-solving, and decision-making abilities, preparing them for success in an increasingly data-driven world. Empowering teachers with the tools and strategies to teach linear programming can open up new possibilities for innovative and impactful learning experiences in the classroom.

Unit Outcomes

After completing this unit, you will be able to:

- Identify effective teaching strategies for teaching linear programming.
- analyze constraints, formulate objective functions, and determine the optimal solution through mathematical modeling.
- evaluate multiple variables, constraints, and trade-offs to reach an optimal solution.

- make informed decisions based on quantitative analysis and optimization.
- understand how to balance competing objectives and constraints.
- connect theoretical concepts to real-world problems.
- Adapt the discussion to their own situations and then plan to use it to their own classrooms

Key Contents

Session 10.1: Teaching graphical Solutions to the System of Linear Inequalities (2 hrs.)

Session 10.2: Teaching Graphical method of solving linear programming problems (3 hrs.)

Session 10.3: Teaching solving Linear Programming Problems Using Microsoft Excel (3 hrs.)

Unit Summary

Session 10.1: Teaching graphical Solutions to the System of Linear Inequalities (2 hrs)

Session Objectives:

After completing this session, you will be able to:

✓ identify the feasible region by graphing the constraints of the system of linear inequalities.

✓ understand the concept of feasible solutions and the significance of points within the feasible region.

✓ understand how to find optimal solutions.

✓ interpret the graphical representation of constraints

✓ understand how changes in constraint equations impact the feasible region and optimal solutions.

✓ apply graphical solutions to systems of linear inequalities in real-life scenarios.

✓ Adapt the discussion to their own situations and then plan to use it to their own classrooms.

☞**Activities:**

Activity-1: Teachers Reflection on their Teaching (30 minutes)

A. Discuss how to solve a system of linear inequalities in two variables?

B. How did you teach graphical solutions to the system of linear inequalities to your students? (you can frame your reflection in terms of the following components of instruction).

  ✓ Activating students' prior knowledge

  ✓ Nature of tasks/activities provided (context, multiple representation, routine/non-routine, etc.)

  ✓ Students classroom discussion and teacher's role in the discussion

- ✓ Summary/consolidation
- ✓ Challenges you face in teaching

Activity-2: Real life application of graphical solutions to the system of linear inequalities (15 minutes).

Discuss in small group why you teach graphical solutions to the system of linear inequalities? reflect to the whole class.

Key Ideas

✓ Manufacturing companies use graphical solutions to optimize production planning by graphing constraints such as production capacities, labor hours, and material costs.

✓ Decision-makers can visually analyze the feasible production levels that maximize output while adhering to resource limitations.

✓ Retailers apply graphical solutions to manage inventory levels efficiently by graphing constraints like storage space, demand fluctuations, and order lead times.

✓ Transportation companies utilize graphical solutions to plan optimal routes and distribution networks based on constraints like vehicle capacities, travel times, and fuel costs.

✓ Financial analysts apply graphical solutions to manage investment portfolios by graphing constraints like risk tolerance, expected returns, and asset allocations.

✓ Agricultural planners use graphical solutions to plan crop rotations and land use by graphing constraints such as soil conditions, crop yields, and seasonal requirements.

✓ Healthcare administrators employ graphical solutions to allocate resources in hospitals and healthcare facilities based on constraints such as staffing levels, patient demand, and treatment capacities. Graphing healthcare constraints helps in optimizing resource allocation, scheduling appointments, and improving patient care efficiency within specified limitations.

✓ By incorporating real-life applications of graphical solutions, you can demonstrate the practical relevance of mathematical concepts to students. Connecting classroom learning to everyday scenarios helps students appreciate the value of mathematics in solving real-world problems.

Activity-3: Teaching graphical solutions to the system of linear inequalities using GeoGebra(45 minutes).

Be in a group of size five and discuss how you teach to find graphical solutions to the system of linear inequalities using GeoGebra based on the following steps.

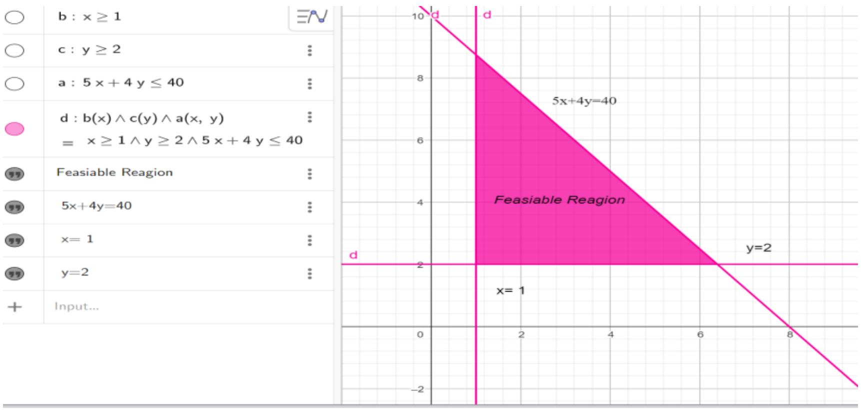
1. Open GeoGebra and create a new file. Add a coordinate plane to the file.

2. Create multiple linear inequalities on the coordinate plane using the "Inequality" tool in GeoGebra. You can have 2-3 inequalities to start with.

3. manipulate the inequalities by moving the lines or changing the coefficients to find the feasible region where all inequalities overlap. observe how the shading changes as they adjust the inequalities.

4. Once the feasible region is identified, shade the region using the "Shade" tool in GeoGebra. This will visually represent the area where all inequalities are satisfied.

5. identify the vertices of the feasible region by finding the intersection points of the lines representing the inequalities. These vertices are critical points that help determine the optimal solution.



6. Discuss how to find the optimal solution within the feasible region by evaluating the objective function at each vertex and determining which point maximizes or minimizes the function.

Key Ideas

- Graphical solutions to systems of linear inequalities involve plotting the inequalities on a coordinate plane to determine the feasible region where all inequalities are satisfied simultaneously.
- Each linear inequality can be graphed as a boundary line on the coordinate plane. The region above or below the line, depending on the inequality sign ($<, >, \leq, \geq$), represents the side of the line that satisfies the inequality.
- The feasible region is the area where all inequalities overlap or intersect. This region is often a bounded polygon or unbounded area in the coordinate plane.
- To find the feasible region, shade the areas that satisfy all inequalities. The overlapping shaded region is the solution to the system of linear inequalities.

- The vertices (corners) of the feasible region are key points to check when determining the optimal solution to a linear programming problem associated with the system of inequalities.
- If the feasible region is bounded and the objective function is linear, the optimal solution can be found at one of the vertices of the feasible region by evaluating the objective function at each vertex.
- Graphical solutions provide a visual representation of the feasible region and help in understanding the relationships between different inequalities in a system. They are particularly useful for systems involving two variables.
- Teaching graphical solutions to systems of linear inequalities using GeoGebra enables you to enhance visual learning experiences for students.
- Teaching graphical solutions using GeoGebra provides you with the opportunity to connect abstract mathematical concepts to real-world applications.

Activity-4: Conceptual Challenges (20 minutes).

What are the challenges students or even teachers face in understanding the graphical solutions to the system of linear inequalities? (*To answer this question, refer to the content in the new textbook*).

Homework Activity (10 minutes).

1.Add more inequalities into the system of GeoGebra and analyze how it affects the feasible region and optimal solution by taking from G-12 mathematics students' text book.

2. What you learned from the above activity, including how graphical solutions can help visualize complex systems of inequalities and how GeoGebra can be a powerful tool for exploring mathematical concepts.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

-------------**Takeaway Resources:**

https://www.youtube.com/watch?v=I7p6euz5Leo

https://www.youtube.com/watch?v=lPF57DGipSY

or Videos.

Session 10.2: Teaching Graphical method of solving linear programming problems (3 hrs.)

Session Objectives:

After completing this session, you will be able to:

✓ understand how constraints and objective functions intersect on a coordinate plane visually.

✓ analyze constraints, identify feasible regions, and optimize objective functions by visually manipulating lines on a graph.

✓ analyze the relationships between variables and make strategic decisions to maximize or minimize the objective function within the feasible region.

✓ interpret graphs, understand geometric relationships, and make connections between mathematical concepts and real-world applications.

✓ Adapt the discussion to their own situations and then plan to use it to their own classrooms.

☞**Activities:**

Activity-1: Teachers Reflection on their Teaching (30 minutes)

How did you teach graphical method of solving linear programming problems to your students? (you can frame your reflection in terms of the following components of instruction).

- ✓ Activating students' prior knowledge
- ✓ Nature of tasks/activities provided (context, multiple representation, routine/non-routine, etc.)
- ✓ Students classroom discussion and teacher's role in the discussion
- ✓ Summary/consolidation
- ✓ Challenges you face in teaching.

Activity-2: Real life Application of Graphical method of solving linear programming problems (30 minutes).

Be in small group and discuss why you teach graphical method of solving linear programming problems? Reflect to the whole class.

Key Ideas

o In manufacturing industries, the graphical method can be used to optimize production planning by determining the optimal mix of products to produce based on constraints such as available resources, production capacity, and demand.

o Retailers and wholesalers can use the graphical method to optimize inventory levels by determining the right balance between stocking enough inventory to meet demand while minimizing holding costs.

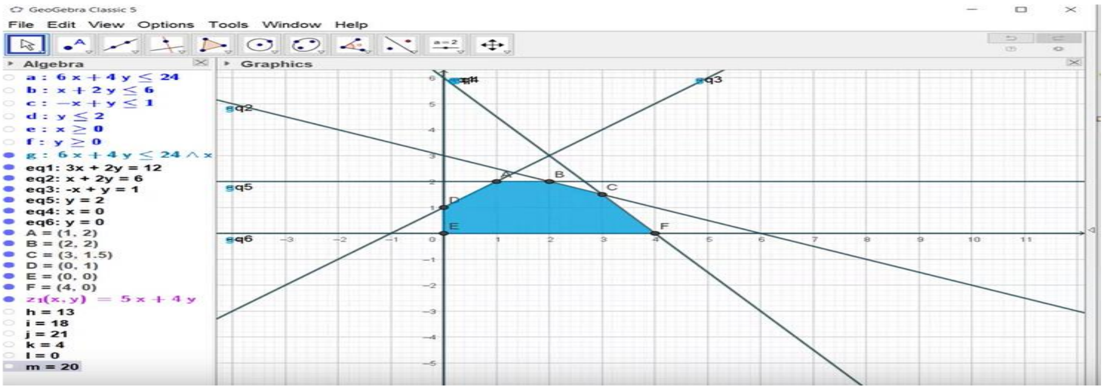
o Organizations in various sectors, such as healthcare, transportation, and energy, can use the graphical method to allocate resources effectively. For example, hospitals can use linear programming to optimize staff scheduling, bed utilization, and resource allocation to ensure efficient operations and quality patient care.

o In financial planning and investment management. For instance, portfolio managers can use linear programming to optimize asset allocation strategies based on risk tolerance, return objectives, and market conditions.

Activity-3: Teaching graphical method of solving linear programming problems using GeoGebra(1.40hrs).

Discuss how you teach graphical method of solving linear programming problems using GeoGebra in group of size 3 based on the following steps.

1. Open GeoGebra and create a new geometry file.
2. Define the constraints of the linear programming problem by drawing the corresponding lines on the coordinate plane. For example, if the constraints are represented by the inequalities: $6x + 4y \leq 24, x + y \leq 6, -x + y \leq 1, x \geq 0$, and $y \geq 0$, draw the lines $6x + 4y = 24, x + y = 6, -x + y = 1, x = 0$, and $y = 0$ on the coordinate plane.
3. Shade the feasible region that satisfies all the constraints. This region is the area where all the shaded regions overlap.
4. Define the objective function by drawing a line representing the equation to be maximized or minimized (e.g., $z = 5x + 4y$).
5. Move the objective function line parallel to itself in a direction that optimizes the objective function (maximizes or minimizes it) while still intersecting the feasible region.
6. The point where the objective function line intersects the feasible region at its optimal value is the solution to the linear programming problem.



7. You can use GeoGebra's Intersect tool to find the coordinates of the optimal point. You can watch the following link or Vidoes for these steps.
https://www.youtube.com/watch?v=wOhDGwyH1N8
https://www.youtube.com/watch?v=eLS5tjcl8S4

Key Ideas

- ✓ The graphical method involves plotting the constraints of a linear programming problem on a graph to visually represent the feasible region, which is the area where all constraints are satisfied simultaneously.
- ✓ The objective function is also graphically represented as a line on the same graph. This line represents the values of the decision variables that optimize the objective function.
- ✓ The optimal solution is found by identifying the point of intersection between the objective function line and the feasible region. This point represents the values of decision variables that maximize or minimize the objective function.
- ✓ The optimal solution of a linear programming problem is typically found at one of the corner points (vertices) of the feasible region. By evaluating the objective function at each corner point, the optimal solution can be determined.
- ✓ The graphical method allows for sensitivity analysis, where changes in the coefficients of the objective function or constraints can be visually analyzed to understand how they affect the optimal solution and feasibility of the problem.
- ✓ Teaching the graphical method of solving linear programming problems using GeoGebra is to leverage its interactive visualization capabilities. GeoGebra allows trainees to animatedly plot constraints, objective functions, and feasible regions, helping them visualize the problem and understand the relationships between variables.

Activity-4: Conceptual Challenges (30 minutes).

What are the challenges students or even teachers' face in graphical method of solving linear programming problems? (*To answer this question, refer to the content in the new textbook*).

Homework Activity (10 minutes).

1. Demonstrate the graph on GeoGebra by inputting different linear programming problems from G-12 mathematics text book and see how they affect the solution of linear programming problems using GeoGebra.

2. Reflect on what you learned about graphical method of solving linear programming problems and how GeoGebra can be a useful tool for visualizing mathematical concepts.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

Takeaway Resources:

https://www.youtube.com/watch?v=wOhDGwyH1N8

https://www.youtube.com/watch?v=eLS5tjcl8S4

or Videos

Session 10.3: Teaching solving linear programming problems using Microsoft Excel(3hrs)

Session Objectives:

After completing this session, you will be able to:

- ✓ optimize a given objective function subject to a set of constraints using Microsoft Excel.
- ✓ solve complex decision-making problems by formulating them as linear programming models.
- ✓ perform sensitivity analysis on linear programming models to understand how changes in parameters, constraints, or coefficients impact the optimal solution.
- ✓ Analyze different scenarios by modifying input parameters or constraints in a linear programming model.

☞**Activities:**

Activity-1: Teacher Reflection on their Teaching (30 minutes)

How did you teach solving linear programming problems using spreadsheet to your students? (you can frame your reflection in terms of the following components of an instruction).

- ✓ Activating students' prior knowledge

- ✓ Nature of tasks/activities provided (context, multiple representation, routine/non-routine, etc.)
- ✓ Students classroom discussion and teacher's role in the discussion
- ✓ Summary/consolidation
- ✓ Challenges you face in teaching.

Activity-2: Real life application of linear Programming Problems (30 minutes).

Be in to small group and discuss why you teach linear programming problems? Reflect to the whole class.

Key Ideas

❖ Linear programming can be used to optimize supply chain operations, such as determining the most cost-effective way to transport goods from suppliers to manufacturers to retailers.

❖ Linear programming can be used to determine the optimal production levels for different products in order to maximize profits while meeting demand and resource constraints.

❖ Linear programming can be used in finance to optimize investment portfolios, considering risk and return objectives, as well as constraints on asset allocation.

❖ Linear programming can be used to optimize transportation routes and schedules, minimizing costs such as fuel consumption and travel time while meeting demand and capacity constraints.

Activity-3: Teaching Linear Programming using Microsoft Excel(1.40hrs).

Be in group of size three and discuss how you teach solving linear programming using Microsoft Excel based on the following steps.

1. Open Microsoft Excel.
2. Take one linear programming problem from G-12 students' textbook including the objective function and constraints. Translate the problem into an Excel spreadsheet format, with decision variables, coefficients, and constraints clearly defined.
3. Input the necessary data into an Excel spreadsheet, organizing the decision variables, coefficients, and constraints in separate cells or columns. Use clear labels and formatting for easy reference.
4. Demonstrate how to access the Solver tool in Excel and configure it to solve the linear programming problem. Specify the objective function, constraints, and optimization settings (e.g., maximizing or minimizing the objective).

5. Run the process using running Solver to find the optimal solution to the linear programming problem. Discuss the results generated by Solver, including the optimal values of decision variables and the maximum or minimum value of the objective function.

6. Interpret the results obtained from Solver, explaining how to make sense of the optimal solution in the context of the original problem. Moreover, watch this video about solving linear programming problems with Excel Solver and reflect what you have understood from it.

https://www.youtube.com/watch?v=ByxUKKtZqFU&t=19s with videos

Key Ideas

- Data Entry: Input decision variables, coefficients, and constraints into separate cells or columns in an organized manner.
- Objective Function: Define the objective function to be maximized or minimized using Excel formulas.
- Constraints: Input constraints as inequalities or equalities in Excel, ensuring they are properly formatted.
- Solver Tool: Access the Solver tool in Excel to set up and solve the linear programming problem.
- Solver Settings: Specify the objective function, constraints, decision variable cells, and optimization settings in Solver.
- Solver Solution: Run Solver to find the optimal solution that maximizes or minimizes the objective function while satisfying the constraints.
- Interpretation: Interpret the results generated by Solver, including the optimal values of decision variables and the maximum or minimum value of the objective function.
- Sensitivity Analysis: Conduct sensitivity analysis to explore how changes in coefficients or constraints affect the optimal solution.
- Scenario Analysis: Use Excel's What-If Analysis feature to explore different scenarios and evaluate their impact on the optimal solution.
- Documentation: Document the Excel spreadsheet setup, Solver configuration, and results for future reference and analysis.
- Teaching linear programming with Excel can improve students' problem-solving skills by providing them with a tool to analyze complex problems, formulate constraints, and find optimal solutions. Excel's Solver tool allows students to explore different scenarios and make informed decisions based on quantitative data.

- Integrating Excel into the classroom allows trainees to leverage technology to enhance the learning experience. you can develop proficiency in using spreadsheet software for data analysis, modeling, and decision-making, which are valuable skills in today's digital age.
- Excel's flexibility allows trainees to differentiate instruction based on students' learning styles and abilities. you can tailor assignments and activities to meet individual needs, providing opportunities for students to work at their own pace and level of understanding.

Activity-4: Conceptual Challenges (30 minutes).

What are the challenges students or even teachers' face in solving linear programming using Microsoft Excel? (*To answer this question, refer to the content in the new textbook*).

Homework Activity (20 minutes).

1. Take additional linear programming problem from G-11 Math text book and solve using Excel and Solver.
2. Reflect the challenges faced and lessons learned from solving linear programming problems using Excel and share your strategies, insights, and areas for improvement.

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

Takeaway Resources:

- ✓ https://www.youtube.com/watch?v=ByxUKKtZqFU&t=19s with videos

Unit Summary

Teaching trainees about the introduction of linear programming involves explaining the fundamental concepts and techniques used to optimize a linear objective function subject to linear constraints. Teachers should understand that linear programming is a valuable tool for decision-making and resource allocation in various fields such as business, economics, and engineering. Emphasizing the graphical method, simplex method, and interpretation of results is crucial. It's essential to showcase real-world applications of linear programming to help teachers convey the relevance and importance of these concepts to their students. Encouraging teachers to incorporate hands-on activities and problem-solving tasks can enhance student engagement and understanding of linear programming principles. By equipping trainees with the knowledge and tools to effectively introduce linear programming concepts in their classrooms, students can develop critical thinking skills and problem-solving abilities that are applicable beyond the realm of mathematics.

Teaching graphical solutions to the system of linear inequalities involves visually representing and analyzing the intersection of multiple inequality constraints on a coordinate plane. By graphing each inequality as a boundary line and shading the feasible region, students can visually determine the optimal solution that satisfies all constraints. This approach helps students develop a deeper understanding of linear inequalities, graphing techniques, and how to interpret graphical solutions in real-world contexts. Through hands-on activities and visual representations, students can enhance their problem-solving skills, critical thinking abilities, and mathematical reasoning while gaining practical insights into optimization and decision-making processes.

The solving linear programming problems using graphical method involves visually representing constraints and the objective function on a graph to identify the feasible region and optimal solution. Trainees learn to plot constraints as inequalities, draw the objective function line, and locate the optimal solution at the intersection of the objective function line and feasible region. Emphasis is placed on understanding the corner point principle, where optimal solutions are typically found at vertices of the feasible region, and conducting sensitivity analysis to explore the impact of changes in coefficients. By engaging in hands-on graphing and interpretation, students develop a practical understanding of linear programming concepts and problem-solving techniques.

Solving linear programming problems using Microsoft Excel involves utilizing the Solver tool to optimize objectives subject to linear constraints. By setting up a spreadsheet model with decision variables, constraints, and an objective function, users can leverage Excel's Solver add-in to find the optimal solution that maximizes or minimizes the objective while satisfying the constraints. Through this process, Excel iteratively adjusts the values of decision variables to achieve the best possible outcome based on the specified mathematical conditions. By utilizing Excel for linear programming problem-solving, individuals can streamline the optimization process, conduct sensitivity analyses, and make data-driven decisions efficiently. This approach offers a practical and accessible way to apply mathematical optimization techniques in various fields, enhancing decision-making skills and enabling users to tackle complex real-world challenges effectively.

Unit 11: Teaching Introduction to Calculus (6 hrs.)

Introduction

Calculus is concerned with comparing quantities which vary in a non-linear way. It is used extensively in science and engineering since many of the things we are studying (like velocity, acceleration, current in a circuit, etc.) do not behave in a simple, linear fashion. If quantities are continually changing, we need calculus to study what is going on. It is divided into two main branches: differential calculus and integral calculus. Differential calculus focuses on the rate of change of functions, while integral calculus deals with the accumulation of functions. Differential calculus is used to find the slope of curves, the velocity and acceleration of moving objects, and the rate of change of physical quantities over time. Integral calculus is used to find the area under curves, the volume of solids, and the work done by forces over distances.

Understanding calculus is essential for anyone pursuing a career in STEM fields or other disciplines that involve quantitative reasoning and problem-solving. It provides a deep understanding of how functions behave, how quantities change over time, and how to make accurate predictions based on mathematical models.

Unit Outcomes

At the end of this unit, you will be able to:

- Understand the mathematical concepts of differential and integral calculus deeply.
- Know various approaches of teaching differential and integral calculus.
- Use GeoGebra to demonstrate the concepts of differential and integral calculus.

Key Contents

Session 11.1: Rates of Change

Session 11.2: Teaching the Derivative –The Slope Function

Session 11.3: Teaching the Integral-Riemann Sum Investigation

Unit Summary

Session 11.1: Rates of Change (2 hrs.)

In this session, we will focus on the branch of mathematics called differential calculus which is concerned with rates of change. A rate of change describes the speed at which one variable changes with respect to another variable. Rates of change are used in various fields such as physics, economics, and biology to analyze and predict trends and behaviors. Understanding average and instantaneous rates of change can help in making informed decisions and predictions based on data. Calculus provides tools such as derivatives to calculate instantaneous rates of change more precisely. Teaching students how to differentiate functions and interpret the results can deepen their understanding of rates of change.

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Discuss various ways of teaching rates of change.
- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of rates of change.
- ✓ Improve your conceptual understanding of rates of change.
- ✓ Adapt the discussion to your own situations and then plan to use it to your own classrooms.

Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about rates of change? You can frame your answer based on the following questions.

d) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

e) What teaching strategies would you use to improve the instruction?

f) How would you tackle the challenges you face in teaching the concept?

Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson as a case study that a teacher taught the concept of rates of change to grade 12 students. Read through the lesson and then answer the following questions.

1. Is it similar to the way that you teach the concept?
2. Do you prefer to use it in your classroom? Why?
3. Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 11.1: Rates of Change

Objectives:

At the end of this lesson, you will be able to:

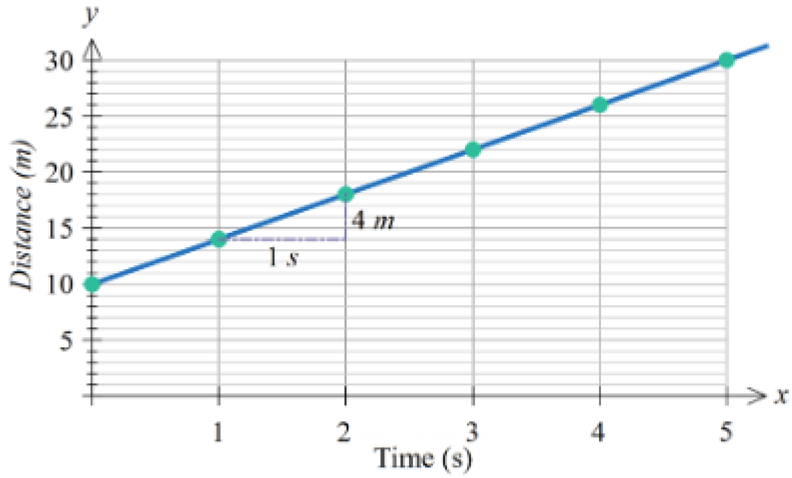
- Describe and illustrate average and instantaneous rates of change.
- Calculate average rates of change of a function between any two points.
- Calculate instantaneous rates of change of a function at a particular point.

Activity-1: Constant rates of change

The table below shows a constant rate of change. As the time increases by 1 second the distance increases by 4 meters. So, the graph of distance against time would form a straight line.

Time, seconds (x)	0	1	2	3	4	5
Distance, meters (y)	10	14	18	22	26	30

How can we calculate the rate of change, in this case the speed? Take any two points from the table or graph.



Important Ideas: Rate of change

The rate of change (in this case, speed) is given by the change in distance divided by the change in time. This can be calculated as:

$$\text{Rate of Change} = \frac{\text{change in dependent variable}}{\text{change in independent variable}}$$

$$= \frac{y_2 - y_1}{x_2 - x_1}$$

If we take, for example, the points (1,14) and (2,18), then:

$$\text{Rate of Change (speed)} = \frac{\text{change distance}}{\text{change in time}}$$

$$= \frac{(18-14)m}{(2-1)s}$$

$$= 4 \text{ m/s}$$

The rate of change of a linear function is given by the slope (or gradient) of the line. You can use any two points and the result is the same constant speed.

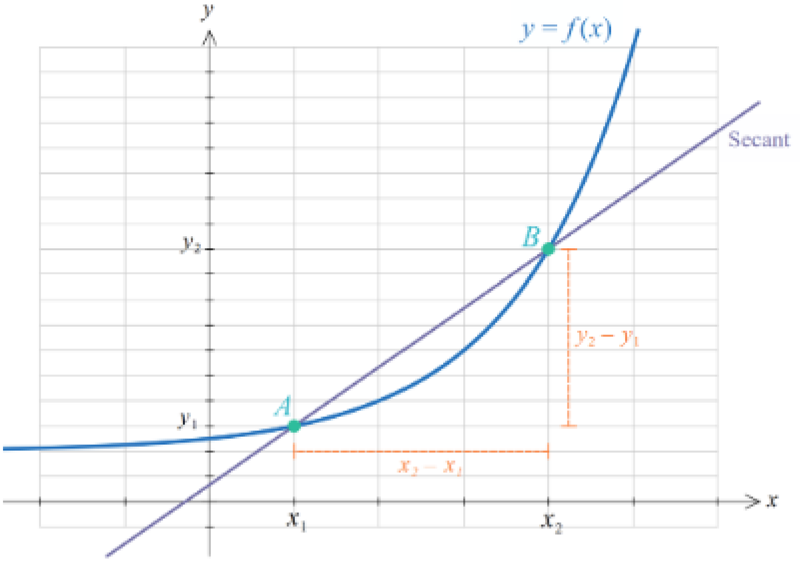
Activity-2: Average rates of change

In many situations, the rate of change may vary rather than stay constant. For example, cars are not likely to drive at a constant rate for very long. What would the distance-time graph of a typical drive around town look like? So, how do we calculate the rate of change in this case with the variable speed?

Important Ideas: Average rate of change

We can calculate the change in distance divided by the change in time between two points for a journey with a variable speed. This calculation will now give us the average rate of change.

To calculate the average rate of change between two points $A(x_1, y_1)$ and $B(x_2, y_2)$, we calculate the change in the dependent variable divided by the change in the independent variable. This is equivalent to calculating the slope of the secant line passing through points A and B.



$$\text{Average rate of change} = \frac{y_2 - y_1}{x_2 - x_1}$$

The equivalent average rate of change of a function, $f(x)$, from $x = a$ to $x = b$, is given by:

$$\text{Average rate of change} = \frac{f(b) - f(a)}{b - a}$$

Check Your Understanding

1) A population of rabbits is growing according to the function: $P(t) = 200 \times 1.08^t$, where t is time in months.
   a) Find the average rate of change in the population between 2 and 4 months.
   b) Find the average rate of change in population between 4 and 7 months.
2) Consider a function which takes certain values, as shown in the table below.

x	3	6	8	13
y	−12	−15	−17	−22

   a) Find the average rate of change between $x = 3$ and $x = 6$.
   b) Find the average rate of change between $x = 6$ and $x = 8$.
   c) Find the average rate of change between $x = 8$ and $x = 13$.
   d) Do the set of points satisfy a linear or non-linear function?

Activity-3: Instantaneous rates of change

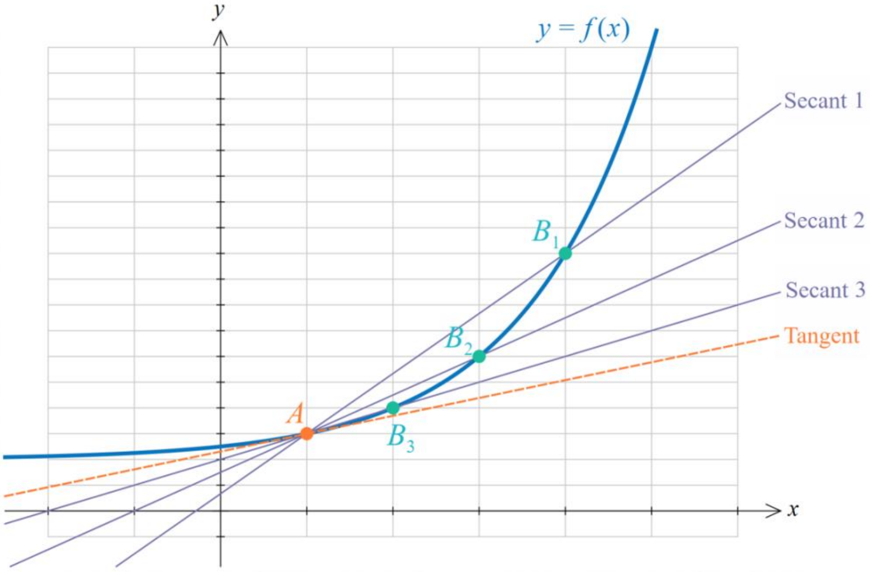
Having just looked at the average rate of change, it's time now to look at another type of rate of change, called instantaneous rate of change. Instantaneous rate of change is the rate of change at a particular point, (not the average over a range of points).

If we think about the formula for average rates of change of a journey, we have: Average speed = change in distance/change in time. However, in any particular instant, no distance has been changed and no time has elapsed, so we need a new method. How do we calculate instantaneous rates of change at a particular point?

Important Ideas: Instantaneous rates of change

To find instantaneous rate of change of a function, f, at a particular point A, we need to have another point B on f, very close to *A*.
So, the average rate of change between *A* and *B* will give us an approximate value of instantaneous rate of change at A (which is the slope of the tangent line passing through A). The closer we

make point B to A, the closer the secant through A and B will approximate the tangent at A. If we calculate the average rate of change for points as they get closer to A, we may see that these rates are becoming closer to a particular value. We could make our estimate for the instantaneous rate of change the limiting value. The diagram below shows the tangent at point A and three secants at progressively closer points B.



Activity-3: Calculating instantaneous rate of change

Find an estimate for the instantaneous rate of change of the function $f(x) = 3x^2$ at $x = 2$ by calculating the average rate of change between $x = 2$ and each of the following values 2.5, 2.1, 2.01, 2.001.

Setting up the calculations in a table we obtain:

a	b	$b-a$	$\frac{f(b)-f(a)}{b-a}$
2	2.5	0.5	13.5
2	2.1	0.1	12.3
2	2.01	0.01	12.03
2	2.001	0.001	12.003

We can see that as b comes closer to a, the average rate of change appears to be getting closer to 12. We could try a very close point to see if this pattern continues. We could also try points that get closer from below 2, such as 1.9, 1.99, 1.999, ... and see if the average rate of change again appears to approach this value. This can be a tedious process and can we be sure the limiting value is in fact 12? Hence, our estimate for the instantaneous rate of change of $f(x)$ at $x = 2$ is 12.

Check Your Understanding

1) Consider the function $f(x) = x^3$

a) Complete the following table.

a	b	h =b−a	$\frac{f(b)-f(a)}{b-a}$
1	2	1	
1	1.5		
1	1.1		
1	1.05		
1	1.01		
1	1.001		
1	1.0001		

b) Find the instantaneous rate of change of $f(x)$ at $x = 1$?

2) Consider the function $f(x) = x^3 - 3x^2 + 2x - 1$

a) Calculate the average rate of change between $x = 2$ and $x = 3$.

b) A tangent line has been drawn at $x = 2$. Use the tangent to calculate the instantaneous rate of change at $x = 2$.

3) Find the slope of the line tangent to the curve $f(x) = 5x^2 + 7$ at $x = 2$.

Key Ideas

To teach students about rates of change, you need to emphasize the idea that: the average rate of change of a function over a specific interval represents the average rate at which the function is changing over that interval. However, the instantaneous rate of change of a function at a specific point is the rate at which the function is changing at that exact moment.

Help students grasp the intuitive meaning behind rates of change as the ratio of the change in one quantity to the change in another quantity. Rates of change can be thought of as slopes of secant lines (average rate of change) and tangent lines (instantaneous rate of change) on a graph. The slope represents how steep or flat the function is at a given point. Provide examples and practice problems to help students apply the concept of rates of change effectively. Illustrate how rates of change can be applied to analyze and solve practical problems involving growth, decay, optimization, and other real-life situations.

Activity-3: Conceptual Challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of rates of change? *To answer this question, you need to refer to the content in the new textbook.*

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy:
https://www.khanacademy.org/math/algebra/x2f8bb11595b61c86:functions/x2f8bb11595b61c86:average-rate-of-change/v/introduction-to-average-rate-of-change

Session 11.2: Teaching the Derivative –The Slope Function (2 hrs.)

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Identify effective teaching strategies for teaching derivative of a function.
- ✓ Grasp the fundamental concept of derivative as the instantaneous rate of change or slope of a function at a specific point.
- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of derivative.

Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about derivative of a function? You can frame your answer based on the following questions.

a) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

b) What teaching strategies would you use to improve the instruction?

c) How would you tackle the challenges you face in teaching the concept?

Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson (which uses GeoGebra) as a case study that a teacher taught the concept of derivative to grade 12 students. Read through the lesson and then answer the following questions.

a) Is it similar to the way that you teach the concept?

b) Do you prefer to use it in your classroom? Why?

c) Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 11.2: The Slope Function

Objectives:

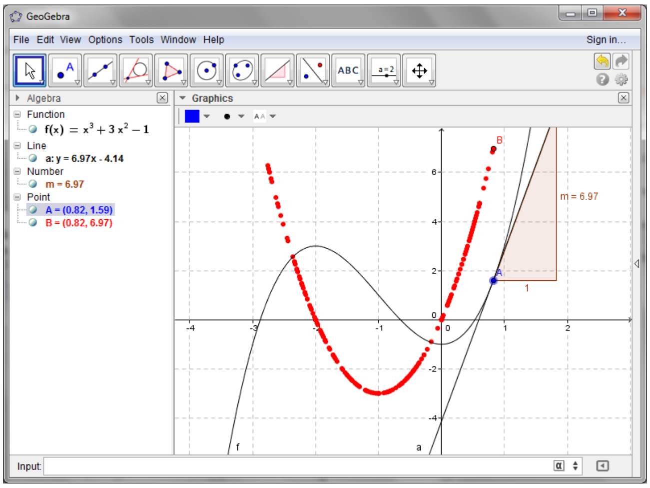
At the end of this lesson, you will be able to:

- Find the slope of a tangent line to the graph of a function as a derivative of the function at the point of tangency.
- Find the derivative of a function.

Activity-1: The slope function

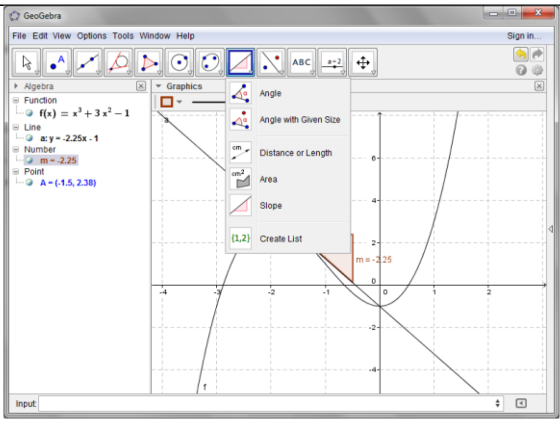
Suppose two points $P(x_0, y_0)$ and $Q(x_1, y_1)$ be on the curve of a continuous function f(x). Can you find the slope of a line tangent to f through P and a secant line through P and Q? What happens to the slopes when Q moves to P along the curve of f?

In this activity, we will use GeoGebra to demonstrate the derivative and tangent functions of a given continuous function f.



Procedure

1. Open a new GeoGebra window and Switch to *Perspectives - Algebra & Graphics*.
2. Enter a function ***f(x)*** **=** $\boldsymbol{x^3 + 3x^2 - 1}$ in the **Input** bar at the bottom of the window.
3. Add a new point on the curve by selecting the **Point** tool and clicking on the curve. GeoGebra automatically labels this point **A**.
4. Put a tangent line on the curve at point A. Once the **Tangents** tool is selected, click on the curve and click on the point of tangency (point **A**), in no particular order. If you click and hold point A with the move tool, you can slide it along the curve and watch the tangent line change. At this point think of the concept of the horizontal tangent lines (critical points) as well as changes in concavity (inflection points).
5. Now we can measure the slope of the tangent line. Select the **Slope** tool and, click on the tangent line and GeoGebra will add a rise/run triangle and display the slope. The value of the slope gets added to the algebra pane as **m**.



6. Finally add one more point to the sketch, using the **Input** bar again by typing **(x(A),m)** to define this last point, which GeoGebra will call point **B**. This tells GeoGebra to use the *x*-value from point A (the point on the curve) and to plot the slope of the curve as the *y*-value. This point displays the value of the graph's derivative at any *x*-value.
7. By right-clicking on point **B**, select **Trace On** and move point *A* along the function graph and make a conjecture about the shape of the path of point *B*, which corresponds to the slope function
8. We now change the color of point ***B***. To do this, right click point ***B***, and click *Object Properties* from the context menu. In the dialog box, select the *Color* tab and select a color you want from the color palette, then click the **Close** button.
9. Move point *A* along the function. What do you observe about the traces of point *B*?
10. What is the shape of the graph created? Is it the derivative of f(x)? Find the equation of the resulting slope function. Enter the function and move point *A*. If it is correct the trace of point *B* will match the graph?
11. Check this by drawing the graph of f'(x) in the input box. To graph the derivative of *f(x)*, type f'(x) = derivative[f], or simply f'(x), then press the ENTER key.
12. Based on the activity above, how will you describe the derivative of a function at a particular point and derivative in general?
13. Right click to delete the function or the graph of **f '(x).**
14. Hold **Alt** and **click** on the equation of **f(x)** to copy it into the input bar. Change the formula to **f(x) = 3sin(x/2)**. *(*You can change the graph of the function by double clicking f(x) in the algebra window without altering any of the other features of the sketch). Points **A** & **B** and the tangent line should still be there, but ignore them for the next step.
15. Now, slowly drag A as B leaves a record of its path along the derivative. Stop and think! Why does the derivative have these values at various locations?
16. Type **f '(x)** into the input bar again. Study each section of the **f '** graph. Do you understand why it rises and falls and hits zero where it does?
17. Delete the function or the graph of **f '(x) again and Press Alt** and **click** on the equation of **f(x)** to copy it into the input bar. Change the formula to **f(x) = Abs(x)**. *(Hint: This is the absolute value function). Move point A and observe the trace of points of B.*
18. Type **f '(x)** into the input bar again. Is there a point on the derivative when x = 0?
19. Practice this activity by changing the graph of the function to be any polynomial, a trigonometric function, exponential or logarithmic function, etc.

Key Ideas

To teach students about the derivative of a function at a point, you need to emphasize the idea that the derivative of a function represents the rate at which the function is changing at that given point. Help them to grasp the intuitive meaning behind derivatives as slopes of tangent lines or rates of change. Show students how derivatives are used in real-world applications, such as optimization problems, related rates, and curve sketching.

Activity-3: Conceptual Challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of derivative? *To answer this question, you need to refer to the content in the new textbook.*

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/differential-calculus/dc-diff-intro

Session 11.3: Teaching the Integral-Riemann Sum Investigation (2 hrs.)

Session Objectives:

Upon completion of this session, you will be able to:

- ✓ Identify effective teaching strategies for teaching introduction to integration.
- ✓ Grasp the fundamental concept of integration from Riemann sums.
- ✓ Describe the key conceptual challenges students and teachers face in understanding the concept of integration.

Activity-1: Teacher Reflection (30 minutes)

How would YOU teach students about introduction to integration? You can frame your answer based on the following questions.

a) What types of tasks/activities can be used to better support students learning? (Context, multiple representations, routine/non-routine, etc.)

b) What teaching strategies would you use to improve the instruction?

c) How would you tackle the challenges you face in teaching the concept?

Activity-2: Lesson Analysis (1 hr.)

Consider the following lesson (which uses GeoGebra as a case study that a teacher taught the concept of Riemann sums to grade 12 students.

Read through the lesson and then answer the following questions.

a) Is it similar to the way that you teach the concept?

b) Do you prefer to use it in your classroom? Why?

c) Does it allow for meaningful construction of ideas? Explain your answer.

Lesson 11.3: The Riemann sums using GeoGebra

Objectives:

At the end of this lesson, you will be able to:

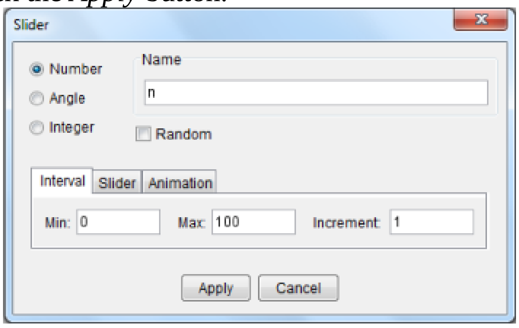
- Identify the connection between Riemann sums and integral of a function over an interval [a, b].
- Find the integration of a given function over an interval [a, b].

Activity: Riemann sums

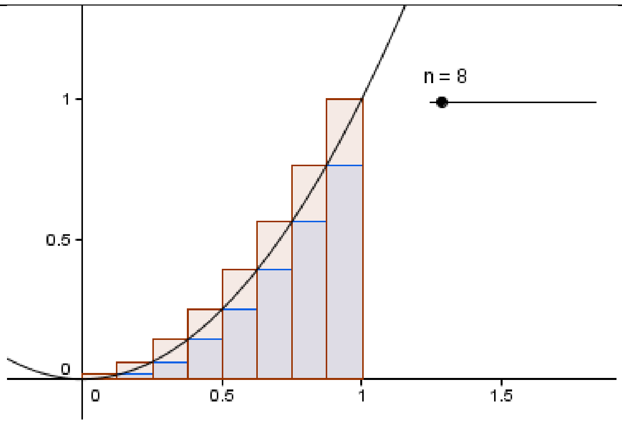
In this activity, we will demonstrate how the number of rectangles used in a Riemann sum affects the accuracy of the area estimate. Use this conclusion as an introduction to a definite integral (defined as the limit of the sum of an infinite number of rectangles).

Procedure

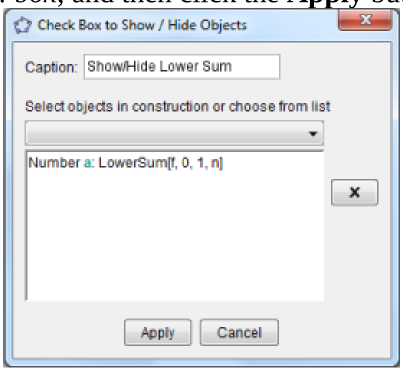
1. Save your work in the above activity as derivative in your working GeoGebra folder.
2. Now open a new GeoGebra window and select Algebra and Graphics from the *Perspectives* menu.
3. Graph $f(x) = x^2$ by typing f(x) = x^2 in the Input bar and press the ENTER key on your keyboard.
4. We now create a slider for the number of rectangles. Select the **Slider** tool and click on the *Graphics view*.
5. In the *Slider dialog box*, change the name to *n*, set the minimum to 0, maximum to 100, and increment of 1, then click the *Apply* button.



6. To construct the lower sum (rectangles whose upper left corners are on the curve), type lower sum[f,0,1,n] and then press the ENTER key on your keyboard. That is, the lower sum (sum of the areas of rectangles) under the function *f* from 0 to 1 with *n* number of rectangles.
7. Move Slider *n*. What do you observe? Move *n* to the extreme right. What is the value of the lower sum or the total are of the rectangles under the curve?
8. To construct the upper sum, type upper sum [f,0,1, n] in the drawing pad, and press the ENTER key
9. Right click *a* (the value of the lower sum) in the *Algebra window*, and click *Object Properties* to show the *Preferences window*.
10. In the *Preferences* window, select the *Color* tab, choose a different color, then click the *Apply* button. This will make it easier to distinguish the two sums.



11. Move the slider to 100. What do you observe about the values of the the upper sum and the lower sum. Explain why your observation is such.
12. To get the actual area under the curve, we need the integral of the function *f* from 0 to 1. To do this, type integral [f, 0, 1] in the *Input bar*, and press the ENTER key.
13. Next, we construct a check box that will show/hide the three objects. To do this, select the *Check box* tool and click anywhere on the *Graphics view*.
14. In the Caption text box, type Show/Hide Lower Sum**,** select *Number a: Lower Sum[f,0,1, n]* in the Select objects… *box*, and then click the **Apply** button.



15. Using steps 13-14, create two more *Show/Hide Check boxes* for the Upper Sum and the actual area (integral of f from 0 to 1).

Questions

a. How are the lower sum, upper sum and area under the curve related?
b. Compare the values of the upper sum / lower sum to the value of the integral for different values of slider *n*. What do you notice?
c. What happens to the difference of the upper and lower sum (a) if *n* is small (b) if *n* is big?

Key Ideas

To teach the concept of integration, start by explaining the fundamental concept of integration as the accumulation of quantities over an interval and can be interpreted geometrically as the area between the curve and the x-axis. Introduce Riemann sums as an approximation method for calculating integrals by dividing the interval into subintervals and using the areas of rectangles to estimate the total area under the curve. Help students understand the connection between Riemann sums and the definite integral. Show how taking the limit of Riemann sums as the number of subintervals approaches infinity leads to the exact value of the integral.

Provide examples and practice problems that involve using Riemann sums to approximate integrals of functions. Guide students through the process of setting up Riemann sums, choosing appropriate partition points, and calculating the areas of rectangles to estimate the integral. Encourage students to practice using Riemann sums to gain a deeper understanding of integration and develop their problem-solving skills.

Activity-3: Conceptual Challenges (30 minutes)

What are the challenges students or even teachers face in understanding the concept of integration? *To answer this question, you need to refer to the content in the new textbook.*

Implications to Teaching

What did you learn from this session and how will you apply the notion of this session to your real classroom? How would you help your students benefit from this? Write a short paragraph summarizing the key things you learned and things that you want to apply.

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Takeaway Resources

Khan Academy: https://www.khanacademy.org/math/ap-calculus-ab/ab-integration-new/ab-6-1/v/introduction-to-integral-calculus

Unit Summary

This unit provided trainee teachers the opportunity to explore the basic concepts of differential and integral calculus together with the effective teaching strategies teachers can use in their own classrooms. Sample lesson plans as case studies and other relevant activities are included to support teachers to focus on effective teaching approaches which are suitable for students' learning. All the activities included in this unit encourage group work and discussions to help trainee teachers to learn from each other. Overall, this unit provided trainee teachers with a strong foundation in the concepts of calculus and the corresponding teaching strategies. This knowledge and experiences will be essential for their future teaching career in mathematics.

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Part II – Educational Technology

Part II – Educational Technology

Introduction

This Educational Technology training manual is developed by EdTech Hub ET in collaboration with the Ministry of Education (MOE) to empower general education teachers to leverage technology effectively in their teaching and learning practices. Built upon the UNESCO ICT Competency Framework for Teachers (2018), MoE Digital Competency Framework and the TPACK model of technology integration as its conceptual framework, the manual provides practical guide on how to integrate technology in secondary school teachings. Further contextual factors have been considered, and several consultative workshops were conducted to develop the material.

This professional development resource aims at entrenching digital literacy in teaching and learning, equipping teachers, and learners with ICT skills, and enhancing their capacity to use technology in their day-to-day activities. Above all, it helps teachers to consider and use any locally available technologies for teaching and learning purposes.

The manual helps teachers and practitioners in secondary schools to practice creative use of technology in their classrooms. However, the material is not a comprehensive how-to guide, rather it provides initial possible strategies and practical exercises for schools to consider integrating technology in their lessons. Teachers are encouraged to further explore on EdTech subjects to have a detailed knowledge and skills in their efforts to leverage technology in their lessons through participating in continuous professional development activities.

The first unit of the material details educational technology related concepts, locally available digital resources and their practical implication at the school level. The second unit looks at the basic digital skills needed in our daily life which encompasses through navigating computer and smartphones, connecting to the internet, using the worldwide and web and google educational apps. The subsequent units' contents (units three through five) are intended to help teachers explore various digital tools and resources that will assist them in incorporating technology into their lessons. The emphasis has been on how to help teachers improve both subject knowledge and digital literacy simultaneously. Each unit's sessions feature practical suggestions for the classroom and out-of-school practices, as well as explorations of free web-based resources and activities for preparing. The final unit focuses on the safety and security procedures that should be implemented when using digital resources and working online to preserve teacher data and safety.

The module is suitable for both new and experienced general education teachers, offering comprehensive coverage of essential topics such as an introduction to educational technology, digital technology tools, open educational resources, and digital citizenship. To fully grasp the material, participants can expect to invest approximately two full days in face-to-face setting or two weeks of online teaching in completing the course.

Pedagogical Approach

The pedagogical approach employed in developing this module aligns with the experiential learning model**.** Learners actively engage with new information through a variety of interactive methods, including discussions, demonstrations, question-and-answer sessions, and other activities. These experiences serve as the foundation for their learning journey, providing concrete encounters that facilitate understanding.

After these initial experiences, learners enter a reflective phase. During this stage, they contemplate their encounters, draw connections to existing knowledge, and conceptualize the newly acquired concepts. Often, this reflective process leads to the understanding of the educational implication and development of novel ideas based on their experiences. Finally, learners are encouraged to engage in a self-assessment to measure and test their understanding and skills within their own context, reinforcing the learning process.

The sessions within this module are thoughtfully organized. They include a brief introduction to the topic, expected learning outcomes, specific activities, key ideas, implications for learning, and takeaways. Teachers are prompted to respond to key questions and note down activity points for future reference. Consider recording these insights in your portfolio using the provided handout. This structured approach serves as a quick reference for understanding digital literacy and its practical application in teaching and learning. The key ideas highlight essential information related to the topic, enabling educators to apply their learning effectively. Additionally, supplementary reading resources are provided for offline activities and further practice. Overall, this process reflects the experiential model of learning.

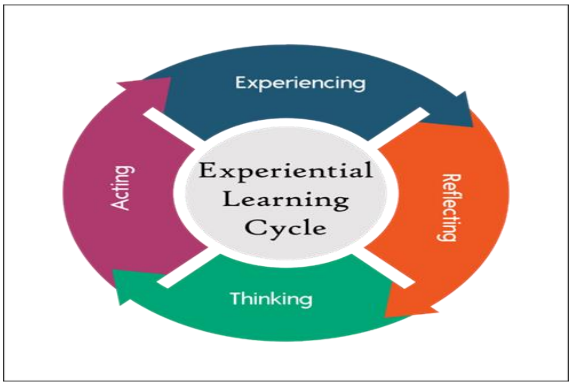


Figure 1: Experiential Learning Cycle; Source: Bing

Training Delivery Methods

In this digital skills training, we leverage a variety of online platforms to facilitate our sessions. Engaging in numerous activities across these platforms offers dual advantages. Firstly, it enhances the interactivity and user-friendliness of our training sessions. Secondly, it grants participants hands-on experience with diverse educational tools, which they can then seamlessly integrate into their teaching practices upon returning to their respective schools. Facilitators are advised to familiarize themselves with these digital tools in advance, ensuring a smooth guidance process for the participants. Facilitators are also required to complete the online EdTech course in advance as it enables them practice with different online training tools and the content of the training. A link to the online training is provided in unit five of this material.

Materials needed to during the Training

As a trainee, you'll require a copy of the trainees' guide (this document), a general lesson plan for each day and an accompanying PowerPoint slideshow to deliver this course. During the training, refer to the relevant slides in the manual. Many of the notes from the manual are also included directly in the slides. Ensure that participants have access to an internet connection for optimal course delivery. Some parts of the course will require participants to use a computer (PC or laptop) with a slideshow program and internet access. Encourage participants to bring tablets or smartphones. Ideally, all participants should have smartphones, but if not, at least one internet-connected tablet or smartphone should be available in each group setting, as practical exercises are an integral part of the course.

Before starting the course, create a working Telegram Group among participants. The group page will serve as our online dashboard for sharing documents and information. We strongly recommend utilizing all available digital resources during course delivery and minimizing paper use.

Learning Outcomes

After completing this module, you will be able to:

- Explain importance of educational technology and its applications their subjects.
- Design technology enhanced lesson plans that can address specific learning objectives.
- Take advantage of locally available digital tools to increase student engagement and active participation.

- Engage in different online and offline educational tools to enhance students' learning outcomes and professional development.
- Use digital resources safely and securely to ensure operational efficiency and data security.

Total Allotted Time to Each Unit (Face-to-Face)

S/N	Unit	Content	Number of Sessions	Allotted Time	Remark
1	One	Understanding Educational Technology	Two	1hr 5'	
2	Two	Basic Digital Skills	Two	1hr 10'	
3	Three	The use of social media for Education Purpose	One	1hr 25'	With practice
4	Four	Online Educational Tools	Three	3hr 20'	With practice
5	Five	Accessing and Creating Digital Content	Three	3hr 50'	With Practice
6	Six	Digital Citizenship	Two	1hr 10'	

UNIT ONE: UNDERSTANDING EDUCATIONAL TECHNOLOGY

Introduction

This unit provides you with a set of activities designed to explore the concept of educational technologies and digital literacy. It supports you to understand digital literacy in light of its implications for classroom teaching and learning. You will delve into the concept of educational technology and discuss its impact on how students learn and how you can teach. In addition, you will also explore any possible technologies available in their local areas. Further, it will enable you to explore the concept of Teaching and Larning Using Locally Available Resource (TALULAR) as a framework for identifying technology-based learning resources. This includes digital resources within your schools and towns, tech-savvy colleagues, and even relevant institutions. Think of this session as a springboard for seamlessly integrating technology into your learning environments.

Learning Objectives

At the end of this unit, you will be able to:

- Explore digital resources in your school and consider their use for teaching and learning activities.
- Explain the concept of educational technology and its application in teaching and learning practices.
- Identify key digital literacy skills and its implication for teaching and learning.

Key Topics

Session One: Locally available digital resources and their function

Session Two: The concept of educational technology and digital literacy

Session One: Locally available digital resources and their function.

Introduction

This session contains activities that are designed to provide you with an opportunity to explore any possible technologies available in your school and local areas. It will provide a useful starting point to think of using locally available digital resources in your classroom instruction and professional development. They will further explore the concept of TALULAR for technology-related learning resources. TALULAR is an acronym that stands for Teaching and

Learning Using Locally Available Resources. There are different technological resources available in your local context that can be used for teaching and learning. These resources might include any digital resource in your schools.

Activity 1.1. Individual Task (10 minutes)

Individually, list down all digital resources you might know and their possible uses in our daily lives. Consider how technologies are being used in your town, country, and the world at large.

NB: Use Slido/Menti.com to respond (your facilitator will give you a link to Slido.com or Menti.com). After all your peers share their answers on a link shared by your trainer a word cloud will be created as shown figure 1.

Facilitator Notes

Generate a link to https://www.slido.com/ or https://www.mentimeter.com/ and distribute it to participants. Then direct them to submit their responses via the chosen platform. They will also learn how to create word clouds and use the platforms by doing so. In the event of offline sessions or connectivity issues, provide participants with sticky notes to jot down their responses.

You can create a word cloud like the below one through different online tools like menti.com, kahoot.it, and other related apps. Step-by-step guidelines have been provided in the digital tools' session.

Figure 2: Word Cloud

Activity 1.2. Group Discussion on your digital experience (15 minutes)

In groups of four to six, share your experience of using digital content or resource in your classroom or elsewhere for teaching and learning purpose.

- What was the topic of your lesson?
- How you use digital content or digital resource?
- How do you prepare or from where did you get the content or the resource?

NB: Share your response to the wider team (whole class) through one of the interactive online tools or use a flipchart to share your group discussion.

Facilitator Notes

Provide participants with a link to an online collaboration dashboard, such as Padlet or Jamboard, and instruct them to post their group discussions on the platform. In cases of connectivity issues, participants may use a flipchart to present their discussions. However, they are encouraged to utilize digital platforms for their presentations to foster creativity. Emphasizing the educational benefits of technology, such as reducing paper usage, encourages participants to employ all available digital resources to disseminate their discussion outcomes. For instance, they could photograph their discussion and upload it to the Telegram group page. The facilitator can then display these images via a projector for the entire class to view.

Activity 1.3. Explore Digital Experience of a Teacher (15 minutes)

Case Story 1

At Sendafa Secondary School, Mr. Menberu, a dedicated physics teacher, sought to enhance student engagement through interactive learning. Despite resource constraints, his ambition to incorporate technology into his teaching led him to utilize locally available digital tools. Mr. Menberu identified several underused assets within the school, including desktop computers, plasma TVs, tablets, and his personal smartphone. Conversations with the school principal, Mr. Aman, and the ICT teacher, Mr. Naol, revealed that these tools could be effectively employed for educational purposes with minimal maintenance. Recognizing Mr. Menberu's enthusiasm, the school also provided him with complimentary Wi-Fi access to facilitate the use of online educational resources. To Mr. Menberu's surprise, he discovered that many students had access to smartphones and TVs at home. After assessing all available digital resources, he collaborated with Mr. Naol and his department colleagues to devise strategies for leveraging these technologies to make physics more engaging and understandable. Mr. Menberu's initiatives included:

- ✓ ***Establishing a Telegram group for his class to distribute educational content and maintain communication with students and parents.***
- ✓ ***Offering downloadable video lectures for students to view on any accessible device.***
- ✓ ***Encouraging students to engage with educational TV programs, providing them with specific channel recommendations.***
- ✓ ***Introducing students to physics simulations via the PhET app in the school's digital hub.***
- ✓ ***Utilizing the classroom's plasma TVs to display images and videos that complemented his lessons.***
- ✓ ***Creating PowerPoint presentations to further enrich his teaching materials.***

Mr. Menberu's Educational Technology use not only revitalized his physics lessons but also ignited a newfound appreciation for the subject among his students. The positive shift in student performance was evident, and his classroom soon became an exemplar for

fellow educators, inspiring them to harness the power of technology in their teaching practices.

Read case story 1 and reflect on the following questions based on Mr. Menberu's experiences:

- What did you learn from his approach to digital integration in his teaching?
- Identify the types of digital content/tools he discovered to aid his students' learning?
- What are the effects of Mr. Memberu's using of digital resources in his classroom?
- How can you apply his experience to your own teaching and learning context within your subject areas?

Session Two: The Concept of Educational Technology

Introduction

In this session, you will investigate various definitions of educational technology and interpret the concept through practices. You will also explore what does not constitute Educational Technology and address common misconceptions within the educational context. They will formulate their personalized definition of educational technology, having examined different concepts in the area. Finally, they will explore key concepts of digital literacy and their implication for teaching and learning.

Activity 2.1. Individual activity on myths about Educational Technology (10 minutes)

This activity helps trainees to identify and explore what is commonly referred to as digital literacy or educational technology but in actual teaching and learning, they are not. Post agree and disagree signs on the wall and read aloud the below sentences then ask participants whether they agree or not. Then, ask them why they agree or disagree.

Facilitator Notes

Read out the below statements one at a time and ask participants to agree or disagree giving reason for their choice. Alternatively, you can attach 'agree' and 'disagree' signs on the opposite walls and conduct the activity in groups. Participants need to have a clear understanding of the various concepts of educational technology particularly as they relate to teaching and learning practices.

Educational Technology

- Educational Technology is merely the ability to use digital technologies (disagree)

- Being able to understand how a tool works do not tell us how effect it is being used, or the value or purpose for which it is being used.

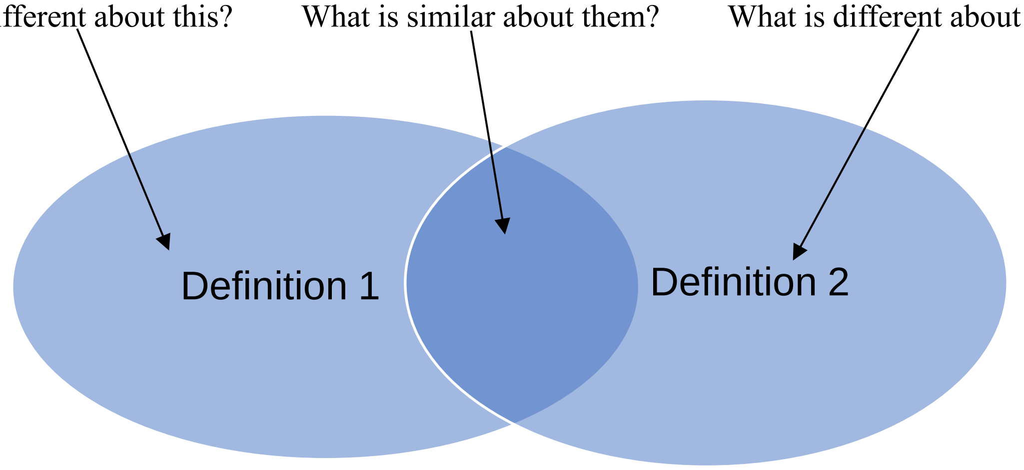
- Educational Technology is just a set of basic computer skills related to the use of hardware, software, and online resources (disagree). EdTech is the use of hardware, software, and online resources to improve students learning outcomes.
- Digital literacy includes the ability to use digital technology safely and securely (agree). But, while e-safety and security are essential aspects of digital literacy, this is far from the whole picture; it also encompasses the use of technology as methodology, assessment tools, classroom management and to access to digital contents.

- The ultimate purpose of Educational Technology practices is to use different online and offline educational resources (disagree). The ultimate purpose of EdTech is to improve students' learning outcomes through using any available technology. We use technology not for the sake of using it, but only to improve learning outcomes.

Activity 2.2. Define Educational Technology (Individual task 10 minutes)

Individually go to the list of definitions in the 'key ideas' below, then choose two of the definitions provided, the one you are most drawn to and the one which you think is more related to teaching and learning. Then, compare the two definitions. Take the parts of each definition that make the most sense to you and write your definition of educational technology. Share your definition on https://jamboard.google.com/. A specific link to Jamboard will be provided by the facilitator. You might also share your definitions on Telegram group page.

What is different about this? What is similar about them? What is different about this



Take the parts of each definition that make the most sense to you and write your own definition of educational technology.

My definition---------------------------

Facilitator Notes

This activity provides practitioners with several definitions of educational technology and supports them to identify common futures among the definitions. They will review the definitions considering their usefulness in teaching and learning. Finally, they will develop their definition of digital literacy.

Key Ideas

In today's digital age, educators have access to a variety of resources, but it's essential to recognize that not all schools or educational settings have equal access to high-tech gadgets or sophisticated digital tools. In many cases, locally available resources play a crucial role in enhancing the teaching and learning experience. Traditional media such as television and radio remain relevant even in the digital era. For instance, Plazma TVs allow teachers to display visual content by project educational videos, animations, or slideshows to enhance explanations and engage students. Again, almost every teacher carries a smartphone these days, even including students. Teachers can use their phones to look up information on the spot, for capturing photos or videos during field trips or experiments and other activities as well. Besides, teachers might also consider using radios for audio-based learning and access to educational broadcast programmes. Similarly, teachers might consider using other digital resources to improve their teaching and learning practices. let's not overlook the value of familiar tools like TVs, radios, and mobile devices. By thoughtfully harnessing these resources, teachers can create dynamic and engaging learning environments that benefit all students.

Definitions of Educational Technologies

- Educational Technology is the use of technology in the instructional processes to enhance both teaching and learning.
- Educational Technology is the use of multimedia to create engaging, effective learning experiences.

- Educational technology is the use of available technological tools for pedagogical purposes and motivation.
- Educational technology is the l use of technology, such as computers, digital technology, and networked digital devices as well as theories for educational purpose in ethical way.
- Educational technology is the use of digital technology in teaching and learning as methodologies, classroom management, formative assessments, teachers' training, etc tools.

Implication to Teaching

Record your responses to the following questions as your key learning areas and future consideration on your handout.

- What did you learn about Educational Technology and how are you going to apply it in your practice?
- What digital resources are easily available in your school and how are you going to use them next year?
- What adjustment you would do to your practice to integrate technology into your lesson based on the above activities?

Self-Assessment (Unit One)

1. What is the acronym TALULAR and how does it relate to technology-based learning resources?
   A. Teaching And Learning Using Locally Available Resources; it helps identify technology-based learning resources
   B. Technology And Learning Using Local Applications; it focuses on digital literacy skills
   C. Teaching And Learning Using Advanced Resources; it emphasizes online educational resources
   D. Technology And Learning Using Global Tools; it highlights the use of international digital resources

2. What is the importance of digital literacy in navigating the digital landscape?
   A. It equips individuals to evaluate information critically
   B. It focuses on technical proficiency only
   C. It enhances personal and professional development
   D. It is a luxury rather than a necessity

3. How can teachers leverage digital literacy skills to enhance their teaching and learning activities?
   A. By accessing a vast library of online content

B. By collaborating with students on digital platforms
C. By sharing engaging resources
D. All of the above

4. What is the role of technology in our daily life?
   A. Technology is irrelevant in our daily routines
   B. Technology enhances connectivity and productivity
   C. We can live without technology
   D. Technology benefits only specific group of people

5. One of the following is very important to integrate technology into lesson?
   A. Level of advance of technology
   B. Availability of online resources
   C. Learning outcomes
   D. None of the above

Reference Materials

Type	Resources
Read	Making Teaching from Locally available resources
Read	We are Teachers online Resources
Read	Definition of Educational Technology
Watch	What is Digital Literacy?
Watch	Why Digital Literacy matters?

UNIT TWO: BASIC DIGITAL SKILLS

Introduction

This unit delves into basic digital skills such as basic organisation of computers, connecting to the intermate, using search engines, and email account creation. The sessions in this unit provides you an overview of the fundamental components of a computer followed by bridging the gap between your computer and the vast world of information. Mastering internet connectivity helps you to access a universe of resources at your fingertips. No exploration of the digital world is complete without harnessing the power of search engines. Here, you'll gain the expertise to navigate these powerful tools effectively, allowing you to locate information with precision and efficiency.

Finally, you will build the skills to create and manage email accounts, transforming them into valuable tools for communication with students, colleagues, and anyone in your professional network. You will also explore the role of email as a tool for teaching and learning.

Learning Objectives

At the end of this chapter, you will be able to:

- Identify different parts of computers and their functions.
- Use the Internet, the World Wide Web, and search engines.
- Create your own personal email account and start using it to improve your teaching and learning practices.
- Exercise using Google Educational Apps for classroom instruction.

Key Topics

Session One: Computers and Smartphones

Session two: Using Web Browser and Email

Session Three: Google Educational Apps

Session One: Computers and Smartphones

Both computers and smartphones are powerful tools that have revolutionized the way we live, work, and communicate. However, they have distinct differences in terms of functionality, portability, and processing power. In this session, you will explore different parts of a computer and its function. Computers, including desktops and laptops, offer greater processing power and storage capacity compared to smartphones. They are ideal for demanding tasks like video editing, gaming, and running complex software.

Smartphones on the other hand, are small, portable devices that offer a wide range of features, including communication, entertainment, and productivity tools. They are powered by mobile operating systems like Android and iOS, and their processing power has significantly increased in recent years.

Activity 1. 1. Navigating Computer (Peer work – 15 minutes)

Take a moment to observe the computer or laptop you are currently using at school or plan to use in the future. Answer the following questions by discussing with your peer.

- What are the different parts of your computer/laptop/desktop? Categorize the hardware parts of the computer into input, process, and output devices.
- What do you do with your computer (Desktop or laptop) you bring with you or find at your schools?
- Are you using computers as teaching and learning tools in your teaching and learning? For what purpose did you use them in teaching and learning?

Activity 1.2. Navigating your phone (Think Pair Share – 10 minutes)

Mobile phones are emerging to be strong learning tools if used appropriately. Still, some educators believe that using cell phones might be a distraction in schools and classrooms as students might use them inappropriately. While still, this remains true, educators and teachers found that phones can be turned into learning tools by putting in place good school rules and policies. Phones have evolved over the years into powerful teaching aids that, when used appropriately, can improve learning outcomes.

Take a time to observe your phone's functions. Consider how you could use your cell phone to assist your students learn better in class. (Consider your local environment) What types of tasks can you complete with your phone as a teacher? Pair your answer with your peer sitting next to you, then share with the whole class what you both have discussed and matched.

Session Two: Using Web Browsers

In this session, you will explore the internet and its use to connect you with a global network which allows for communication and resource sharing across the world. World Wide Web, also known as the web, is a system which contains resources that are accessed through the internet.

The World Wide Web uses website sites to create virtual spaces on the internet where videos, files, images, and other digital resources are stored so that you can view, store and retrieve them.

Activity 2.1. Connecting to the Internet (Individual Practice – 5 minutes)

- How would you connect to the internet through your phone or computer?
- Using any digital device you have on your hand, please connect to the internet, and do something. And then show it to your friend or Facilitator?

Facilitator Note:

Conclude the discussion by mentioning that we can connect to the internet in different ways including through data on your phone, WIFI or cables. Wi-Fi is a wireless technology that enables electronic devices with wireless adapters such as laptops, mobile phones, TVs, and tablets to connect to the internet.

Activity 2.2. Using a Web Browser (Group discussion – 15 minutes)

In a group of four to six, engage in a discussion about the following questions:

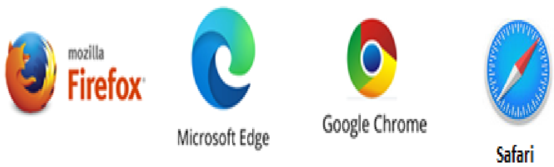


Figure 3: Different Browsers

- What is a web browser?
- Which web browsers do you typically use?
- How have you utilized web browsers to enhance your teaching and learning processes?

NB: Share your response to the wider team (whole class) through one of the interactive online tools or use a flipchart to share your group discussion.

Activity 2.3. Use of Emails (Group Discussion – 10 minutes)

This activity introduces participants to email ultimately aiming at helping them use email as a communication tool.

Figure 4:Email; Source@pixabay

Group Discussion (10 minutes)

In groups of four to six, discuss the following questions.

- What is email and how does it function?
- What are the benefits of using email in educational settings?

- What are your current email habits and challenges? How often do you check your emails?
- With whom do you usually use emails and for what purposes?
- How can teachers use email for teaching and learning?

Activity 2.4. Create your email (Demonstration - 25 minutes)

Click on this [(How to create a gmail account)]() and watch the video about email creation and then create your email. You can also follow the steps provided in the box below as you create your email. Once, you watch the demonstration, create at least two email accounts on Gmail and Outlook email platforms.

What to do: **To create gmail account follow the following steps.** • **Go to the Google Account sign in page.** • **Click Create account.** • **Enter your name.** • **In the "Username" field, enter a username.** • **Enter a secured password and confirm your password.**	What to do: To create an Outlook email account, you need to follow these steps. • Go to the Microsoft Outlook website and select Create free account. • Click Get a new email address. You can choose between @outlook.com or @hotmail.com as your domain name. • Choose a username that is unique and easy to remember. If your username is already taken, you will need to pick another one. • Create a password that is strong and secure. You can use a combination of letters, numbers, and symbols. • Enter your personal information, such as your name, birthdate, and country or region.

- Verify your account by entering the code that is sent to your phone number or alternate email address.

Activity 2.5. Send email messages (Individual Task - 15 minutes)

Now you have already created an email account, please send a message to at least five participants including your facilitator. Then in a group, reflect on the following questions:

- How do you find your experience? Was it difficult or easy?
- What are the common features you saw on the email page? List down all the features on the email page?

Facilitator Notes

Following participants reflection, please show them the main features on email page such as new email (compose new email), inbox, outbox, sent items, delete, etc.

Activity 2.6. Accessing and Navigating Google workspace

Google Workspace for Education provides free educational apps for students and educators. These tools cover various learning needs and include popular options like Google Docs, Sheets, and Slides for collaborative document creation; Google Classroom for managing online classes, Google Search for finding information, and Google Scholar for academic resources. In this activity, you'll learn how to access these tools easily. Later, we'll explore the use of some of these tools in more detail.

Figure 5: Google Apps

Open the Google Chrome website (Google website) and explore the page. Specifically, open the nine dots you see in the top right corner of the Google Chrome browser which represent the app launcher or app grid. When you click on these dots, it opens a menu that provides access to various Google apps. You can find shortcuts to apps like Gmail, Google Drive, Google Form, and more. This is a convenient way to quickly access your favourite Google tools.

Demonstration- 20 Minutes

Use the following what to instruction and access different google apps using the app grid, Navigate the app, list different apps you accessed and state their function. Practice adding and removing different apps into the app launcher.

What to do:

Follow the below guide to access different Google apps either on your computer or phone.

- **Make sure you have a Google account: If you use Gmail, YouTube, or other Google services, you already have one.**
- **Open Chrome browser and go to a Google website.**
- **Log in to your Google account (if not already signed in)**
- **Look for the App Launcher icon: It's a grid of nine small squares, usually located in the top right corner of the webpage.**
- **Click on the App Launcher icon. This will display a list of various Google Apps you can access.**
- **Choose the Google App you want to use: Click on the icon for the desired app (like Docs, Sheets, Slides, Classroom, etc.) to launch it within the Chrome browser window.**

Facilitator Note (Optional): *Show participants a five-minute video taken from the reference section. Then ask participants to access google apps through app launcher or app grid on chrome/google website either through their phone or laptop. Give them some time (10 minutes) to do this.*

Key Ideas

Computers

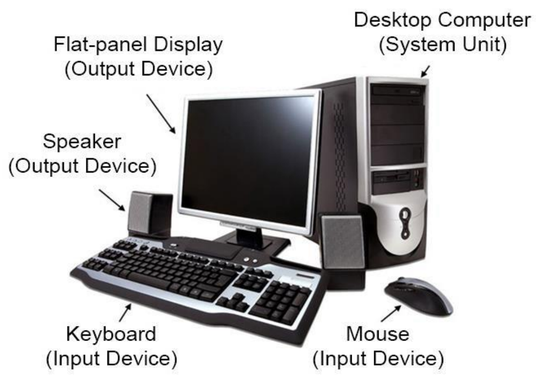


Figure 6; Source @Google Image

A computer, typically positioned on a desk, is specifically crafted for individual use. It comprises various interconnected components, functioning as a cohesive unit. Computer hardware parts are categorised into three parts:

- Input Devices: These are the tools that allow you to interact with your computer. Think keyboards, mice, touchscreens, webcams, and microphones. How do you use these to provide instructions and information to your computer?
- Processing Unit: Imagine this as the brain of your computer. It receives your instructions from the input devices, processes them, and generates the desired results.
- Output Devices: These are the components that display the results of your computer's work. Monitors, printers, and speakers fall into this category. How do they translate the computer's calculations into a form you can understand and interact with?

Computers can be powerful tools that can revolutionize teaching and learning, offering a range of benefits for both students and educators. From providing access to information to fostering collaboration and developing digital skills, computers have become an integral part of the modern educational landscape.

Smartphones

Smartphones serve as powerful educational tools, providing a portable repository of information and interactive learning possibilities. Smartphones can be utilized both in the classroom and for personal learning for the following activities:

- Access to Information: Students and teachers can instantly tap into the vast internet resources for research, answering questions, and exploring new topics.
- Educational Apps: Numerous subject-specific apps cater to various age groups and learning styles. These apps offer interactive exercises, simulations, and engaging games.
- Collaboration Tools: Communication apps allow students to form study groups, collaborate on projects, and share ideas beyond the classroom.
- Creative Learning: Teachers can use smartphones to create educational videos, presentations, or podcasts, reinforcing their understanding and showcasing their learning.

World Wide Web and Browsers

The World Wide Web, commonly known as the web, is a vast system that houses resources accessible through the internet. Websites create virtual spaces on the web where videos, files, images, and other digital content are stored. As users, we can view, store, and retrieve these resources. Connecting to the internet via Wi-Fi, data, or cable allows our electronic devices such as laptops, mobile phones, TVs, and tablets to access this wealth of information.

As educators, the internet provides us access to information on nearly any subject matter. Whether you're researching, learning, or exploring, the web is a treasure trove of knowledge. Beyond information, the internet enhances our ability to communicate and collaborate with people worldwide.

Web Browsers

A web browser is application software that enables you to access resources and websites on the World Wide Web. Several popular browsers include Google Chrome, Mozilla Firefox, Apple Safari, and Microsoft Edge. These browsers operate similarly and share common controls. Once you master one browser, you'll find it easier to navigate others as well.

Email

Email (electronic mail) is the exchange of computer-stored messages from one user to one or more recipients via the internet. Emails are a fast, inexpensive and accessible way to communicate for business or personal use. Users can send emails from anywhere as long as they have an internet connection. Emails are a great way to communicate with colleagues, students, and parents, as well as to share information, resources, and feedback.

Besides communication, you need an email to access and use the majority of educational tools. Therefore, it is advisable for teachers to have two email accounts: one on Gmail and one on Microsoft. The Gmail account allows you to use Google's free products, while the Microsoft account enables you to access Microsoft's products.

Implication to Teaching

Please note down your reflections on the following prompts, which will serve as key takeaways and future action points:

- Reflect on the insights gained from the session, including any new abilities and knowledge acquired. How do you intend to integrate these into your teaching methods?

- Share your discoveries about the use of email. How do you foresee implementing email communication moving forward?
- List down at least five educational applications provided by Google.
- How would you intend to use different web browsers for educational purposes?

Self-Assessment

1. How does a monitor help you interact with your computer?
   A. It translates calculations into a visual form.
   B. It allows you to type instructions.
   C. It processes information.
   D. It stores data.
2. Smartphones can be used for educational purposes by:
   A. Restricting access to certain websites.
   B. Downloading social media apps.
   C. Providing access to educational apps and the internet.
   D. Making phone calls.

3. Web browsers allow you to access:
   A. Your computer's files
   B. Websites on the World Wide Web
   C. Only educational resources
   D. Video games

4. Which of the following is NOT a popular web browser in Ethiopia?
   A. Google Chrome
   B. Mozilla Firefox
   C. Microsoft Edge
   D. None of the above

5. Email is primarily used for:
   A. Storing documents online
   B. Sending messages electronically
   C. Playing games
   D. Watching videos

6. Why might a teacher need two email accounts (Gmail and Microsoft)?
    A. To separate personal and professional emails.
    B. To access specific educational tools.
    C. Because Gmail is free and Microsoft is not.
    D. There is no specific reason; one account is sufficient.

Reference Materials

Type	Resources
Watch	Components of Computer System
Watch	Usage of Smartphones
Read	Computer Organisation and Design Books
Read	Set up Google Workspace on an Android device - Google Workspace Learning Center
Read	Microsoft Support
Watch	What is Web Browser?
Watch	How to create email account on Outlook?
Watch	Google Workspace Beginner Guide

UNIT THREE: THE USE OF SOCIAL MEDIA FOR EDUCATIONAL PURPOSES

Introduction

In this unit, you will explore the possibility of leveraging social media platforms, specifically Telegram and Facebook, for educational purposes. These platforms offer a myriad of possibilities for enhancing teaching and learning experiences. By harnessing their features, educators can engage with students, foster collaborative learning environments, share resources, and facilitate discussions. Whether it's creating study groups, disseminating course materials, or encouraging peer interaction, these social media channels hold immense potential to enrich educational practices. Participants will explore strategies, best practices, and activities that demonstrate how these platforms can be effectively integrated into the teaching and learning process, ultimately contributing to improved learning outcomes.

Learning Objectives

At the end of this chapter, you will be able to:

- Explore the use of social media for educational purposes.
- Utilize social media platforms such as Telegram and Facebook to improve your teaching and learning practices.

Session One: Social Media for Educational Purpose

Introduction

In this session, we will explore the use of social media like Facebook and Telegram to facilitate communication between teachers, students, and parents. Using such platforms facilitate discussions, Q&A sessions, and announcements.

Social media can also liven up learning with interactive features like polls and quizzes, while sharing educational resources like videos and articles keeps students engaged. By integrating social media strategically in their teaching and learning, teachers can create a dynamic and engaging learning environment that fosters collaboration, critical thinking, and engagement

Activity 1.1. Using Telegram as Educational Tool (Group work – 10 minutes)

In group of four to six, discuss on the following questions.

Figure 7;Source@Google Image

- What are the benefits of using Telegram in educational settings?
- How can teachers use Telegram for teaching and learning?

Demonstration (20 minutes)

Use the following Instruction and create a Telegram group. Add your peers or contacts from you address book as a member. Please practice sharing questions, videos and create poll in your telegram group.

What to do:

Step 1: Create Telegram Account

- **Connect to the Internet/Turn on mobile phone data.**
- **Click on play store/App store.**
- **Download Telegram on your phone Step.**
- **Install Telegram application.**

Step 2: Form Telegram Group

- **Launch Telegram application.**
- **Select new group.**
- **Add your students by selecting from phone book.**
- **Name the group.**
- **Start posting learning materials in the form of images, documents or texts to the group.**

Facilitator Note

Create a group of four participants (group them by subject matter) and take them through the telegram app. Assist them to create group, post assignment, videos, create poll and complete other functionalities on the app.

Optional: Show them the five-minute video on the use of the Telegram app and then ask participants to create group, post assignment, videos, create poll and complete other functionalities on the app.

Activity 1.2. Using Facebook for educational purposes (Group Work - 10 minutes)

Facebook can be utilized for educational objectives in various ways, enhancing interaction, involvement, and a sense of community beyond the traditional classroom setting. By establishing private groups for your classes, you can encourage ongoing discussions, host question-and-answer sessions, and share educational materials outside of regular school hours.

Figure 8;Source Google Image

In groups of four to six discuss on the following questions:

- Do you have Facebook account? What is your experience of using Facebook?
- Have you used it for educational purposes? How Facebook will be used for educational purposes?

Demonstration (10 minutes)

Demonstrate how to create private groups on Facebook and then support your trainees to do the same in groups. Follow the below steps as you create closed group on Facebook.

Activity 1.3. Creating Group or Page on Facebook (Group Work - 30 minutes)

Use the following instruction and create a Facebook Group Page in your specific subject matter expertise and share relevant resources, initiate chat among your students, run live Facebook videos and complete other activities which you might think are relevant for your teaching and learning.

What to do:

- **Make sure you have a personal Facebook account.**
- **On your Facebook homepage, navigate to the "Groups" section if you want to open Facebook group or navigate to the “pages” section if you want to open Facebook page on the left-hand menu and click the ‘create group’ button on the page.**

- **Group Name: Choose a clear and appropriate name that reflects the class or subject.**

- **Privacy: Select "Closed" from the privacy options. This ensures only approved members can see the group's content.**

- **Description (Optional): Provide a brief description outlining the group's purpose and intended audience (e.g., students enrolled in Biology class).**

- **Start by inviting your students who have Facebook accounts (with parental permission if necessary). You can search for them by name or email address.**

- **As the group admin, you can approve membership requests, monitor discussions, pin important announcements, and manage content within the group.**

Key Ideas

Telegram

Telegram is a software used for communication and instant messaging and offers many possibilities such as sending various media files, in addition to making voice or video calls. The Telegram program can be used in education in many ways and means, some of which can be mentioned as follows:

- Send assignments, reading materials and tasks by students to the teacher.
- Create groups and channels for classroom.
- Create polls and quizzes
- Communicate with students from other school.
- Parents communicate with teachers to follow their children performance
- Provide e-content for the home side in the reverse learning strategy.
- Make video, audio and text announcement, lecture, and resources, etc.

Facebook

Teachers might also consider using Facebook for educational purposes in several ways, fostering communication, engagement, and community outside the classroom. You can create private groups for your students to facilitate discussions, Q&A sessions, and sharing of resources beyond classroom hours. Through private group on Facebook, we will encourage the following activities among students.

- Collaborative Projects: Encourage students to work together on projects by using Facebook groups for brainstorming, sharing research findings, and coordinating tasks.
- Sharing Learning Resources: Post links to educational websites, articles, videos, or even create online document folders within the group for students to access relevant materials.
- Polls and Quizzes (informal): Conduct quick polls or quizzes (using third-party apps within Facebook) to gauge student understanding or gather feedback on topics.
- Announcements and Reminders: Share important updates, homework reminders, or upcoming events with the entire group or specific students through private messages.
- Virtual Field Trips and Events: Utilize Facebook Live or pre-recorded videos to share virtual tours of museums, historical sites, or connect with guest speakers remotely.
- Digital Citizenship Lessons: Facebook provides real-world context for teaching online etiquette, responsible content sharing, and critical thinking about information found online.

Important Considerations:

- Privacy is Key: Ensure groups are private and only accessible to students and parents/guardians with permission.

- Set Clear Guidelines: Establish ground rules for respectful communication and appropriate content sharing within the group.

- Parental Involvement: Keep parents informed about the group's purpose and encourage their involvement if necessary.

Additional Tips to create a Closed Facebook Group for educational purposes.

- Consider creating a separate Facebook account specifically for educational purposes, keeping it separate from your personal profile.

- Encourage students to add their full names for easier identification.

- Regularly post relevant resources and discussions to keep the group active and engaging.

Implication to Teaching

Please note down your reflections on the following prompts, which will serve as key takeaways and future action points:

- Reflect on the insights gained from the session, including any new abilities and knowledge acquired. How do you intend to integrate these into your teaching methods?
- Identify the features of Telegram that could be beneficial for educational activities?
- Outline your strategy for utilizing social media platforms like Facebook and Telegram to enhance educational experiences in the forthcoming period?

Self-Assessment

1. Telegram Group Engagement Task: Post a welcoming message on your previously created Telegram group page or channel. Here's a suggested greeting: "Welcome, students! This is our dedicated space for learning and growth. Let's embark on this educational journey together with enthusiasm and curiosity." Share the Telegram link with your facilitator and peers.
2. Facebook Interaction Task: Initiate a discussion on your Facebook page by posting a topic related to your subject discipline.

Reference Materials

Read	Social Media in Education
Watch	The Use of Telegram for Educational Purposes
Watch	The Use of Facebook for instruction
Watch	Social Media in Education

UNIT FOUR: ONLINE EDUCATIONAL TOOLS

Introduction

This chapter will empower teachers to leverage technology in their classrooms. You will explore a variety of online educational tools that are suited for diverse subjects and learners. The session in this unit will help you to develop the ability to select the most appropriate platforms and resources for specific learning objectives. Teachers practice how the tools might be used appropriately and incorporated into teaching and learning in a way that supports students in developing both subject knowledge and digital literacy. You will need internet access to practice these tools. But you are encouraged to critically analyse the tools in terms of developing critical thinking, problem-solving, analytical skills, etc among students. As you review each tool, please think about how possibly you apply them in your classrooms or outside all aims at improving learning outcomes.

Learning Objectives

By the end of this chapter, you will be able to:

- Identify different types of online educational technology tools that suits for teaching and learning.
- Select appropriate online tools and platforms for different purposes and audiences.
- Utilize communication, assessment and creative tools in their teaching and learning.
- Participate in online learning communities that foster digital skills among teachers, and other stakeholders.
- Utilize artificial intelligence tools during the preparation of lesson plans, assessments, and instructional materials.

Key Topics

Session One: Communication and Collaboration Tools

Session Two: Assessment Tools

Session Three. Creative Tools

Session One: Virtual Communication and Collaboration Tools

In this session, you will explore different communication and collaboration tools that help you facilitate online discussion and collaboration among students. These tools provide you with various functionalities such as live meetings, document sharing, collaborative works and many more tasks. In addition, you will explore possibilities of creating and managing your groups, and channels, share files and documents, and communicating with students.

Activity 1.1. Using Google Meet

Google Meet allows educators to easily connect and collaborate with students through links or codes, making it perfect for both planned lessons and quick discussions. This fosters remote learning by enabling online classes and virtual tutoring, regardless of location. Engagement is boosted through features like screen sharing and presentations. Google meet is accessible from both web browsers and mobile apps.

Figure 9. Google Meet; Source @Google Image

Question and Answer (5 Minute)

Could you share your experience and familiarity with Google Meet? Have you used it before or observed others using it? Have you participated in online meetings organized through the Google Meet platform? What was your experience?

Facilitator Notes:

Encourage participants to discuss their experiences with Google Meet. While it's not essential to pose every question listed previously, consider using them to guide the conversation and extract detailed insights regarding the participants' usage of Google Meet.

Demonstration (25 minutes)

Use the following instruction and demonstrate how to organize and schedule online meetings using Google Meet. Once you completed the demonstration, create your own instant meeting using Google Meet. Then allow share the meeting link with others/your peers and allow them to join the meeting and practice how you would potentially run an online meeting.

What to do: Starting a Google Meet Meeting:

There are two ways to start a Google Meet meeting:

1. **From the Google Meet website:**

- **Go to https://meet.google.com/.**
- **Click "New meeting."**
- **Choose an option:**
  - **Create a meeting for later: Get a meeting link to share and schedule the meeting for a specific time (optional).**
  - **Start an instant meeting: Join a meeting directly without needing a link beforehand.**
    - **You'll be the host of the meeting, and others can join using the meeting link or code.**

2. **From Google Calendar (if integrated):**

- **If Google Meet is integrated with your Google Calendar, you can schedule a meeting directly within Calendar.**
- **Create a new event or edit an existing one.**
- **Click "Add video conferencing" and choose "Google Meet."**
- **A meeting link will be automatically added to the event details.**
- **Invite participants to the event, and they can join the meeting using the link at the scheduled time.**

3. **Basic Controls During a Google Meet Meeting:**

- **Microphone: Mute or unmute your microphone by clicking the microphone icon.**
- **Camera: Turn your camera on or off by clicking the camera icon.**

- **Chat: Send text messages to other participants in the chat window.**
- **Screen share: Share your entire screen or a specific window with other participants.**
- **Presentation: Present content from your computer (slides, documents, etc.).**
- **Leave meeting: End the meeting for yourself (if you're the host) or leave the meeting as a participant.**

Additional Tips:

- **You can adjust your meeting settings (background blur, captions, etc.) by clicking on the three dots in the bottom right corner.**
- **Google Meet works on most web browsers and also has mobile apps for Android and iOS.**

Facilitator Notes

Please take few minutes to discuss about Google Meet and how to access the app with participants. While the trainees are trying to demonstrate and create an instance meeting or schedule using google meet please round about and assist them.

Activity 1.2. Group Discussion about your Google Meet Experiences (15 minutes)

Discuss the following questions with your group members.

- What are your thoughts on the app?
- In what ways do you intend to integrate Google Meet into your educational practices?
- Could you share your experiences with setting up and conducting an online session? Do you find Google Meet user-friendly?
- Would you be willing to take a lead in organizing concurrent online meetings via Google Meet within your department to facilitate the exchange of experiences and collaborative learning among your friends?

Activity 1.3. Exploring Padlet (Question and Answer - 10 minutes)

Padlet is a digital dashboard tool designed for online collaboration and information sharing. It works like a virtual wall where users can post various content, making it an asset in the educational landscape.

Figure 10;Padelt; Source @Google Image

- What is your experience of using Padlet as a teacher? Have you used the app before or seen others use the app for educational purposes?
- How can teachers use Padlet to foster collaborative and engaging learning experiences?
- What tasks are well-suited for an online tool like Padlet in educational settings or during instructional processes?

Facilitator Notes:

Encourage participants to discuss their experiences with Padlet. After the discussion, summarize the session with the below information about the use of Padlet for instructional purposes. Demonstrate how to set up a free padlet account and share the link with your trainees. Then ask each participant to write two personal goals on the link provided. Setting personal learning goals is an important way to guide your progress and set expectations for yourself throughout this course. write two personal goals you hope to achieve while taking this course. (Click on the + sign to write your personal goals)

Example of Personal Goals:

1. Learn about education technology and its use in classrooms

2. Practice different online educational tools

Activity 1.4. Practising using Padlet (Individual Task 15 minutes)

Using your mobile phone, create free Padlet account and use the Padlet as online presentation board to discuss a topic or assignment from your specific subject area (If your mobile phone is not functional; please work in pairs or groups).

What to do:

- **Go to https://padlet.com/ and create a free account with your email address or sign in if you already have one.**

- **Click on "Create a Padlet" button.**

- **Choose a layout for your Padlet (Wall, List, Stream, etc.) based on your content and purpose.**
- **Give your Padlet a title and description (optional).**
- **Click "Create Padlet."**
- **Click the "+" button on your Padlet to add content.**
- **Choose how you want to add content:**
  - **Text: Write directly on the Padlet.**
  - **File: Upload an image, document, or other file.**
  - **Link: Include a link to a website or resource.**
  - **Video/Audio: Embed a video or audio clip from YouTube, Vimeo, etc.**
- **Add a title and description to your content (optional).**
- **Click "Save" or press "Enter" to add the content to your Padlet board.**
- **Click the "Share" button in the top right corner.**
- **Choose a sharing method:**
  - **Copy Link: Share the link with anyone who has access.**
  - **Embed Code: Embed the Padlet on a website or learning management system.**
  - **Social Media: Share the Padlet on social media platforms.**
  - **Set privacy options for your Padlet (public, private, password-protected).**

Session Two: Assessment Tools

Introduction

In this session, we delve into a variety of online assessment tools designed to support teachers in the development of both formative and summative assessment questions for your classroom. Specifically, you will gain an understanding of diverse assessment tools and articulate their applications within an educational context. You'll also get hands-on practice with these tools, integrating them into your lesson planning. Additionally, you'll be guided through the process of creating accounts to access and utilize these various assessment tools effectively.

Activity 2.1. The use of Quizizz (Question and Answer - 5 minutes)

Figure 11;Source @Google Image

Quizizz is an online interactive tool to assign homework and provide feedback, present quizzes in the form of games and have a real-time understanding of students' academic progress.

- What is your experience of using QUIZIZZ as a teacher?
- Have you use the app before or seen others use the app for educational purpose or in a training setting?

Activity 2.2. Online live activity using QUIZIZZ (20 minutes)

How much do you know about Educational Technology? Run the below assessment using Quizizz platform (https://quizizz.com/admin/quiz/6403b3ddfe08dd001db7681d?source=quiz_share)

Facilitator Notes

During the session, ensure to comprehensively demonstrate the app's functionalities, including its ability to generate complete graded reports for each student and how to access and edit premade questions from Quizizz library. Additionally, acquaint participants with the various modes of conducting the session, such as the 'assignment' feature and the paper mode, to provide a thorough understanding of the app's functionality in different contexts.

Activity 2.3. Create your personal free QUIZIZZ account (Individual task - 15 minutes)

Use your mobile phone to create a free quizizz account and explore resources in your subject area (If your mobile phone is not functional; please work in pairs or groups). You can also download the app from Play Store or App Store for optimal use of the app.

What to do:

- **Go to https://quizizz.com and log in, or if you are a new user, click 'Get started' and create a new account by using your email address.**
- **To use an existing quiz, select the 'Search for quizzes' box and browse. If you want to create your own quiz, select 'Create a new quiz', enter a name for the quiz, and choose the relevant subjects. Choose a type of question and fill in the question, as well as answers.**
- **Add a title image if desired. Select the appropriate language and grade range and add tags to make it easier to search for.**

- **Either select 'Play live' or 'Assign HW' and choose the desired attributes. Then share the quiz with your students by sending them the link and 6-digit code.**
- **Students can go to https://quizizz.com/join, click 'Join a game', and type in the 6-digit code to participate in the live quiz or complete it at homework. Once the students are finished, the teacher can refresh the page to view the results.**
- **You can also access to several quizzes and assignments in the library. You just need to review the questions and use for yourself.**

Activity 2.4. Introducing Slido (Question and answer – 5 minutes)

Slido is the ultimate Q&A and polling platform for live and virtual meetings and events. It offers interactive Q&A, live polls and insights during your meetings/events. What is your experience in using slide for educational purpose or in any other setting?

Activity 2.5. Create free slido account (Demonstration - 15 minutes)

Using the following what to do instruction and create a free slido account and explore the different functionality of the app. Then, support trainees to create their accounts. After participants create their account ask them to design audience questions and provide answer links with their groups.

What to do:

- **To create slido account follow the below easy steps:**
- **Go to https://www.slido.com/Links to an external site.**
- **Sign up for free**
- **Start using slido**

Activity 2.6. Exploring Survey Collection Tools (Google Form)

From time to time, educators engage in research or action research to enhance their teaching methods and contribute to educational progress. Google Forms provides a convenient platform for creating online forms and surveys, complete with various question types. You can easily share these forms with your audience. Additionally, Google Forms facilitates result analysis, allowing you to gain insights from your audience's responses. Furthermore, it's a useful tool for preparing quizzes for your classroom.

Question and answer (5 minutes)

Have you used Google Form before? When did you use it and for what purpose? What was your experience in using Google Forms?

Create survey or quiz with Google Form (Demonstration - 20 minutes)

Follow what to do instruction given below and please demonstrate how to create a survey or quiz using Google Forms or you can show participants a demonstration video. Once you completed the demonstration, ask participants to do the following:

- work in pairs and prepare a quiz using Google Forms; share it with at least 10 participants and present the result of your survey with your group members.
- Prepare a short survey using Google Forms and share it with your facilitator and students, then present the result of the survey to whole class (As you prepare the survey refer your specific learning area or subject matter).

What to do:

- **Go to https://docs.google.com/forms in your web browser. You'll need a Google account to access it (same as Gmail or YouTube).**
- **Click the "+" button or choose "Blank form" to start from scratch.**
- **You can also choose a template for specific purposes like event registration or contact forms.**

- **Click on the "Untitled Question" box and type your question.**
- **Select the question type from the dropdown menu (multiple choice, short answer, checkbox, etc.).**
- **Customize the question further by adding answer choices, making it mandatory, or shuffling options.**
- **Drag and drop questions to rearrange their order.**
- **Add sections with titles to categorize related questions.**
- **Use images, videos, or descriptions to provide additional context.**
- **Click on the "Settings" tab to configure options like:**
    - **Who can access: Choose whether anyone can submit the form or require a Google account.**
    - **Collecting responses: Decide how to collect responses (one response per person or allow multiple submissions).**
    - **Quiz settings (if applicable): Set grading options, time limits, and feedback for quizzes.**
- **Click on the "Send" button to share your form. You can:**
    - **Copy and paste the link to share anywhere.**
    - **Embed the form directly on a website.**
    - **Send the form via email with a personalized message.**
- **All responses to your form are automatically collected in a Google Sheet.**
- **Access the sheet by clicking the "Responses" tab.**
- **You can view individual responses, analyze data with charts and graphs, and even export the data to other formats.**

Facilitator Notes

Support participants as they create their own survey/quiz. Encourage them also to share the form through varies platforms like Facebook and Telegram pages.

Activity 2.7. Practicing Using EvalBee Application

EvalBee apk.

1. Assume a mathematics teacher who teaches three sections of grade ten and two sections of grade eleven, for a total of five sections with an average of 45 students in each class. How long will it take the teacher to check a student answer sheet in an examination that encompasses 40 objective-type questions out of 50?

2.Using your smart phone download the Eval Bee android app from the Play Store, create account and Sign in. Then using the Instruction below practice using EvalBee Optical mark readers App.

What to do:

- **Go to google play or app store on your smartphone and download Evalbee apk or https://evalbee.com on web browser and create an account.**

Steps to create optical mark reader or recognition (omr)

- **Decide the roll number digits (Make it 2)**
- **Insert an exam set (exam codes).**
- **Decide Exam Sets (Codes) and**
- **The number of subjects Make it 1**
- **Write the subject name in the subject box**
- **Decide the number of types of items on the section box**
- **Insert type of the item in sections 1,2 and 3**

Section 1 **:- Replace it with I. True or False**

- **True or False items in section 1**
  - ✓ **Decide number of questions for True or False items**
  - ✓ **Decide possible options from question type box**
- **You can allow partial marks (if necessary)**

Section 2 **:- Replace it with II. Matching**

- **Decide number of matching items**
- **Decide possible options**
- **You can allow partial marks**

Section 3**:- Replace it as III. Multiple Choice**

- **Decide number of matching items**
- **Decide possible options**

- **You can allow partial marks**
- **SAVE**
- **Write class name e.g Grade 10**
- **Exam Name:- Mathematics**
- **Select Exam Date It is mandatory**
- **Finally SAVE.**
- **Once you set answer sheet click on exam**
- **Go to Exam management**
- **Click on Answer Key and set it**
- **Finally Save it**
- **Download and print the answer sheet**
- **Administer the Exam**
- **Scan each answer sheet**
- **Go to report**
- **Record the each student result**

Session Three: Creative Tools (Artificial Intelligence)

Introduction

Artificial Intelligence (AI) is a branch of computer science that deals with the creation of intelligent agents, which are systems that can reason, learn, and act autonomously. AI research has been highly successful in developing effective techniques for solving a wide range of problems, from game playing through enhancing services in varies sectors such as education, agriculture and health.

Activity 3.1. Understanding AI (Question and Answer -10 minutes)

- What is Artificial intelligence?
- Have you used it so far or seen while others use it for different purpose including teaching and learning?

Facilitator Notes

Show them AI videos on power point slides and provide highlight of the current development of AI globally. AI is bringing exciting possibilities to classrooms around the world. There are various AI tools available to help teachers with their tasks. We will explore some of the commonly used AIs in the below activity. As conclusion show the AI video on the power point.

Activity 3.2. Stream your task through AI (Gemini and Bing) Lecture – 5 minutes

Copilot/Bing and Bard/Gemini are the two popular apps easily accessible in Ethiopia for varies tasks. Copilot/Bing is developed by Microsoft and Bard is created by Google AI respectively. Both AIs focuses on generating text, translating languages, and answering questions in an informative way.

These AI tools can be a game-changer for teachers by:

- Simplifying lesson planning: Generate ideas, find relevant resources, and outline learning objectives with AI assistance.

- Crafting engaging assignments: Design interactive exercises, propose different question types, and personalize learning pathways for each student.

- Exploring innovative teaching methods: Discover new approaches to explain concepts, spark creativity in activities, and create a dynamic learning environment.

- Provide Educational resources such as images and videos for your lesson and other activities.

By harnessing the power of AI tools like Copilot and Bard, teachers can free up valuable time and focus their expertise on what matters most: guiding their students and fostering a love of learning.

Activity 3.3. Demonstrate how AI works for schools/teachers - 10 minutes

Demonstrate the use of Bing and Bard through performing the following activities:

- Prepare lesson plans, assessment questions and instructional resources for one of the subject matters using Bard?

- Prepare instructional resources for the above topic using Bing AI – ask the AI to provide you with pictures or simulation activities for the above topic?

Facilitator Notes

As you showcase the capabilities of AI, emphasize that it's incredibly user-friendly. Teachers can conveniently access the service via a mobile app, making it even more accessible. Encourage them to download the Bing app on their phones for future use.

Activity 3.4. Practicing the use of AI (Individual Activity - 20 minutes)

Go to Edge or Chrome browsers and use either Bing or Bard as you prepare your next week plan, please generate the following and share it with your group members.

- Lesson Plan for your next week classes.
- Assessment Questions for your next week classes.
- Ask Advise for Methodologies and Teaching aids you might use in your class.

Key Ideas

Communication and Collaboration Tools

Virtual classrooms can be transformed by online communication and collaboration tools, fostering richer educational experiences for students. Platforms like Google Meet, Microsoft Teams, and Zoom create virtual meeting spaces for live video sessions, real-time interaction, screen sharing, and even breakout rooms for focused group discussions.

These tools empower educators to conduct engaging lectures and discussions, address student queries, and facilitate collaborative projects where students can work together on assignments, share ideas, and develop teamwork skills. Additionally, inviting guest speakers from various fields becomes a possibility, enriching students' learning with diverse perspectives. Virtual field trips further broaden horizons, allowing students to explore museums, historical sites, or natural wonders from anywhere in the world. Assessment is also streamlined, with online quizzes, tests, and even oral exams conducted effectively.

Beyond video conferencing platforms, online tools like Padlet offer a dynamic digital canvas. Imagine a virtual bulletin board where students can brainstorm ideas, organize thoughts, create mind maps, share research findings, project summaries, and creative works. It's a space for collaboration, visual presentations, and receiving peer feedback or reflecting on learning experiences.

Similarly, Jamboard, Google's interactive whiteboard tool, fosters a collaborative environment for drawing, writing, and brainstorming. Students can use it to visualize complex concepts, problem-solve across various subjects, dissect scientific phenomena through visual aids, or even create engaging storyboards. From brainstorming sessions to collaborative problem-solving and visual storytelling, these online tools unlock new possibilities for enriching virtual classrooms. Below are easy guide on how to use some of these tools.

Assessment Tools

Interactive tools like Quizizz gamify quizzes, transforming them into game shows with competition and immediate feedback. Google Forms offer versatility, allowing the creation of quizzes, surveys, polls, and even short-answer assessments, with easy data analysis for personalized learning. Slido and Mentimeter prioritize real-time participation. Students can submit questions, participate in polls, and contribute to word clouds, keeping them engaged in lectures and presentations. Finally, Kahoot! takes gamification a step further, turning assessments into fast-paced game shows where students compete for the top spot. These are just a few options that can create a more engaging and data-rich learning environment, fostering interactive assessment platforms.

Artificial Intelligence

The ultimate purpose of using AI in education should be to improve student learning outcomes. AI can be a powerful tool in this journey, but it's crucial to use it wisely. Here are some key points for teachers:

- **Supportive Partner, not a Substitute:** AI can assist with various tasks, from crafting lesson plans and designing exams to assessing student work and managing records. However, it shouldn't replace teacher expertise. Review and adapt AI-generated materials to fit your specific classroom context.

- **Combating Plagiarism:** Simply submitting student work generated by AI can lead to plagiarism. If you suspect AI use, consider using AI plagiarism detection tools to verify the originality of student responses.

- **Empowerment, not Automation:** AI is here to enhance, not replace, teachers. Be creative! Explore AI-powered apps to streamline grading and free up valuable time. This allows you to focus on what matters most: guiding your students and fostering a love of learning.

- **Strategic use of AI:** By using AI strategically and maintaining a critical eye, educators can leverage its potential to personalize learning, streamline processes, and ultimately, improve student outcomes.

- The Eval Bee application is designed to help teachers create and scan Optical Mark Recognition (OMR) answer sheets for objective types of examinations such as True or False, Matching, and Multiple Choice and generate result reports in real time by scanning the OMR sheet using their phone's camera. It is an Efficient App for Teachers that makes assessment Easy & Effective in No time. Creating answer sheet design in a few clicks, Scan answer sheets in real-time. Using Eval Bee allows the error-free scan and evaluation of printed OMR answer sheets through pre-trained AI and machine learning-based algorithms in real-time. This saves a lot of time and energy for teachers and makes it easy for students and parents to get quick evaluation results.

Implication for Teaching

Record your responses to the following questions as your key learning and future considerations on your handouts.

- What did you learn about communication and collaboration tools?
- What is your plan to communication and collaboration tools in your teaching and learning or any other related task in your school?
- What did you learn about online assessment tools?
- What did you learn about Artificial Intelligence?
- What is your plan to use AI like Bard and Bing in your teaching and learning or any other related task in your school?
- What new skills, experience, knowledge have you got?
- How would you like to apply the new skills in your subject teaching learning activities (consider also exploring anything you took as a learning apart from the platform)?

Self-Assessment

1. Which of the following is NOT a benefit of using online communication and collaboration tools in virtual classrooms?
   A. Streamlined assessment through online quizzes and tests
   B. Increased difficulty for students to brainstorm ideas
   C. Enhanced real-time interaction with teachers and classmates
   D. Broader learning experiences with virtual field trips
2. Platforms like Google Meet and Zoom primarily enable:
   A. Individual research and writing assignments
   B. Collaborative brainstorming and project work
   C. Accessing and reading online textbooks
   D. Taking timed multiple-choice quizzes
3. Jamboard, an interactive whiteboard tool, is most useful for:
   A. Conducting live video sessions with guest speakers
   B. Administering online polls and surveys
   C. Visualizing complex concepts and problem-solving collaboratively
   D. Providing individual feedback on written assignments

4. Which of the following statements accurately describes Quizizz?
   A. It's a tool for creating traditional written quizzes.
   B. It offers a game-show style format for assessments with immediate feedback.
   C. It's primarily used for conducting online surveys.
   D. It requires students to write code to answer questions.

5. Google Forms allows teachers to create all of the following EXCEPT:
   A. Multiple-choice quizzes
   B. Open-ended essay questions
   C. Live word cloud activities
   D. Short answer response assessments

6. The primary benefit of using tools like Slido and Mentimeter in the classroom is:
   A. To assign homework for students to complete independently.
   B. To facilitate real-time interaction and participation during lectures.
   C. To provide in-depth feedback on written assignments.
   D. To create static presentations for students to view at their own pace.

7. Which one of the following is true about Artificial Intelligence (AI) in education?
   A. AI will replace teachers altogether in the future classroom.
   B. AI tools like Gemini and Copilot will provide additional support to educators.
   C. AI is not currently relevant to the field of education.
   D. Students should be trained in AI development as the primary learning objective.

8. 8. Which one the following is not true about Eval Bee?
   A. It generates error free or 100% accurate reports
   B. Saves a lot of teachers time and Energy
   C. It has room for various fractional markings
   D. It has very limited contribution on avoid exam cheating

Reference Materials

Watch	Using Google Meet
Watch	Online Educational Communication Tools
Watch	The use of padlet for educational purposes
Watch	Online Assessment Tools for Teachers
Watch	The use of Quizziz for teaching and learning
Watch	AI for Educational Purposes
Watch	(690) HOW TO MAKE ANSWER SHEET IN EVALBEE - YouTube

UNIT FIVE: CREATE AND ACCESS TO DIGITAL CONTENTS

Introduction

In this chapter you will discuss on how to access, use, and create digital resources and contents for your teaching and learning. Digital contents can be accessed either online or through hard disks like CDs or flash cards. You will also cover different subject specific Open Educational Resources (OERs) and Ministry of Education digital library portals.

Learning Objectives

By the end of this chapter, you will be able to:

- Create engaging digital content using different platforms for your lesson.
- Explore basic Word and PowerPoint processers functions.
- Learn how to navigate the Ministry of Education's online library and find subject-specific digital resources that will enrich your teaching.
- Explore innovative ways to integrate digital content both for classroom and remote teaching.
- Access different subject specific Open Educational Resources (OERs) for their classes.

Key Topics

Session one: Create Digital Contents

Session Two: Access Digital Contents

Session Three: Ministry of Education Digital Libraries

Session Four: Open Educational Resources (OERs)

Session One: Digital Contents

In this session, you will comprehend about digital content and explore your digital content experience on how to access authenticated resources from online sources.

Activity 1.1. What is Digital Content? (Question and Answer - 10 minutes)

Discuss with the whole class on the following questions:

- What is digital content?
- Give examples of digital contents?

Facilitator Notes

Ask participants the above questions; the objective of this activity is to provide some general understanding of digital content among participants. Finally, conclude the session by mentioning that digital contents can be produced and accessed in various ways and it encompasses materials published, distributed, and stored in electronic formats, including text, voice recordings, video clips, photographs, and animations.

Activity 1.2. Exploring your digital content experience (Group discussion - 15 minutes)

In group of four to six, discuss the following questions:

- Share your experience of using digital content in your classroom?
- What was the topic of your lesson? How you used the digital content?
- Where did you get the content (source)?

Activity 1.3. A Teacher's Journey

Case Scenario 2: Enhancing Learning with Digital Content (20 minutes)

Scenario: Mrs. Almaz's Biology Class

Mrs. Almaz, an experienced biology teacher, is passionate about creating engaging and effective lessons for her students. She believes that integrating digital content can enhance learning experiences and foster student engagement. Here's how she approaches this:

Mrs. Almaz starts by identifying the learning objectives for her lesson. She considers why the topic is important for her students and how digital content can support those objectives. She selects digital materials that align with the curriculum and provide relevant information. For example, she might use interactive maps, videos, or online simulations to illustrate cell concepts from MoE digital Library or authenticated open educational resources such as Khan

Acadamy. Mrs. Almaz evaluates the quality and accuracy of the digital resources. She checks the credibility of the sources, ensuring that the information is up-to-date and reliable. Mrs. Almaz believes that active student participation is crucial. She chooses digital materials that encourage interaction, such as quizzes, polls, or virtual field trips.

She ensures that the chosen digital content is accessible to all students. She considers factors like internet connectivity, device compatibility, and any necessary accommodations. She provides alternative formats (e.g., transcripts for videos) to accommodate diverse learning needs. After the lesson, Mrs. Almaz seeks feedback from her students. Did the digital content enhance their understanding? Was it engaging?

In small group, discuss about the criteria Mrs. Almaz took into account when selecting digital contents for her lesson? List down all the consideration she has made.

Facilitator Notes:

During the discussion on factors to be considered during digital content selection, inform participants to refer to a similar exercise in Chapter one. As you conclude the discussion, emphasize that teachers need to assess digital content based on at least the following criteria:

- *Accessibility: Ensure that the content is accessible to all students.*
- *Relevance: Consider whether the content aligns with the learning objectives.*
- *Interactivity: Evaluate the level of engagement and interaction among students.*
- *Production Quality: Check for high-quality visuals, audio, and overall presentation.*
- *License Information: Be aware of the content's licensing terms.*

Session Two: Creating Digital Contents

Digital content can be considered as any type of media that exists in the form of digital data, including text, images, audio, video, and more. It can be accessed and distributed through electronic devices and online platforms. In this session you will learn different mechanism to create digital contents for your classroom instruction.

Activity 2.1. Preparing PowerPoint Slideshow

Slideshows are very good way to present information in a visually engaging way. They can be used for anything from showcasing visual display of teaching and learning materials to delivering a compelling presentation at work. In education, we don't use slideshow for only sake of presenting information, rather the goal is to enhance the learning experience, not to overwhelm students with too much information or distract them with overly complex slides.

Questions and Answers (5 minutes)

What is your experience of using slides for teaching and learning? When did you use it? For what purpose? What was the challenge?

Lecture (10 minute)

Present the development of an educational slideshow (PPT). Creating a slideshow for teaching and learning purposes involves several key steps to ensure that the presentation is effective and engaging. Here's a guide to help you create an educational slideshow.

- Define the Objectives: Set clear learning goals for your presentation.
- Know the context: Understand the strengths, weaknesses, and needs of your students. Consider their age, language skills, accessibility and ability to interpret concepts.
- Plan Your Content: Think of what you want to put on your slide - tables, charts, diagrams, or timelines, etc.
- Design the Slides: Use a clean and simple design. Use your placeholder wisely.

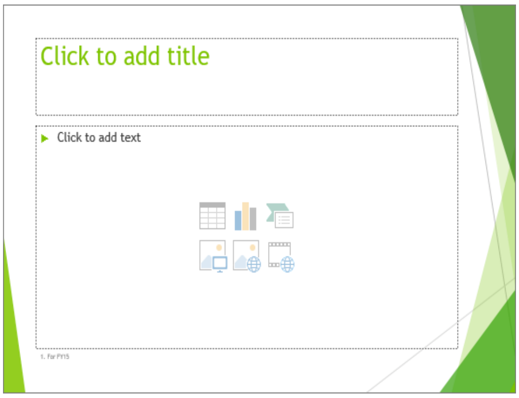


Figure 12. Placeholder

- Make It Interactive: Engage your students by incorporating questions, discussions, or problems to solve.
- Make it short: Don't overwhelm students with too much information or distract them with overly complex slides; use the general rule of 5/5/5. 5 words in each line, 5 lines in each slide, 5 text heavy slide on a subject.
- Practice and Delivery: Rehearse your presentation to ensure smooth delivery.

Demonstration (20 minute)

Demonstrate what you have explained. Open your slideshow, select a topic and create PowerPoint presentation; find an image and paste it as well. Add a caption to your image too. If you have time and think they are ready for it, you could show animation, design options and other functionality for the power point at this point too. Design options on PowerPoint will suggest designs for your slide given what you have put on it already. Alternatively, you can also show participants a five-minute video.

Once you completed demonstration, ask participants to create their slideshow with text and images. They should make no more than 3-4 slides here. Give them some time (10 minutes) to do this. Additionally, please ask participants to **record** themselves while presenting the slideshow. After recording, they should share the recordings with their respective groups.

Activity 2.2. Using Google Slide to Create a Presentation (10 minutes)

If you don't have access to a laptop or desktop; you can create PowerPoint using Google Slides with your phone. Follow the following steps to download and create PowerPoint using Google slide.

Creating a PowerPoint presentation using Google Slides on your phone is a convenient option when you don't have access to a laptop or desktop. Here's a simple guide to get you started:

- Go to your phone's app store (Google Play Store for Android or App Store for iOS).
- Search for "Google Slides".
- Download and install the app.
- Open the Google Slides app.
- Sign in with your Google account. If you don't have one, you'll need to create it.
- Tap on the "+" icon, usually located at the bottom right of the screen.
- Select "New Presentation" to start creating your slides.
- Google Slides will offer you a variety of themes to choose from.
- Select one that suits the style and purpose of your presentation.
- Tap on the slide where you want to add content.
- Use the toolbar to insert text, images, shapes, and more.
- You can add new slides by tapping on the "+" icon near the slides preview.
- Your presentation will be automatically saved to your Google Drive.
- You can share it with others by tapping on the "Share" icon and entering their email addresses.

Activity 2.3: Using Word Processing (Question and Answer – 5 minutes)

Word processing software is a powerful tool used for creating, formatting, and editing various types of documents. Whether you're jotting down thoughts, taking meeting notes, drafting emails, or writing standard operating procedures word offer much more than the typewriters of old.

- How comfortable are you with word processing programs?
- How often do you use them?

Activity 2.4: Practice using Word (20 minutes)

Go to this link Basic Function of Word and explore how to create a text document. Then using a Microsoft word prepare a text document based on the guidance on the resource. Align your document with your subject discipline.

NB: As they create their worksheet, don't forget to practice using features like select, copy, paste, and other functions of the Word.

Activity 2.5: Using Google Docs to create a Word document (20 minutes)

Google Docs is an online word processor that lets you create and format documents and work with other people using Google Docs. On your computer or phone open Google Docs. You can access Google Docs through the nine dots on Chrome browser (Please refer accessing Google Apps in unit two).

Activity 2.3. Accessing Image for your instruction (Group Discussion - 10 minutes)

This activity focus on how to find and copy images from the internet to use in your teaching as a resource. This can be a valuable way to enhance your lessons and engage students. In group of four to six, discuss on the following questions:

- Where did we get images for our worksheets? Or when we need images for different instructional purpose?
- How do we copy images?
- Do we need to consider anything as we copied images?

Figure 13;Free Source of Images; Source @Google Image

Facilitator Notes:

Ask if participants have ever downloaded an image from the internet and where they sourced it from, with Google Images likely being a common response. Educate them on various platforms where teachers can access free and legal images, emphasizing the importance of looking for images with a

Creative Commons (CC) license. Mention that search engines like Google Images and Bing Images allow users to filter for CC images.

Highlight that platforms such as Pixabay and Unsplash specialize in providing free images. Additionally, introduce the Noun Project as a valuable resource offering free icons for various purposes, particularly beneficial for educators creating worksheets or presentations.

Guide participants on how to search for legally usable images on search engines like Google by navigating to the Usage Rights menu and selecting Creative Commons Licenses. This filter ensures that only images with the CC license are displayed.

Demonstration (15 minutes)

Do an example with Google Images, Unsplash, Pixabay and Noun Project. Take participants through the steps of copying images and use on a working document.

Group Work (15 minutes)

In group of four to six, ask participants to access images from one of the above sources for a lesson in their specific subject area. Let groups work on different source of image such as Bing AI image, Google Images, Unsplash, Pixabay and Noun Project at a time. Finally, allow them to present their result to the whole class. Ask them also to reflect on their experience.

Session Three: Open Educational Resources

Open Educational Resources (OERs) are teaching, learning and research materials in any medium that can be found in the public domain or have been released under an open license that permits no-cost access, use, adaptation, and redistribution by others with no or limited restrictions. Below are some educational resources for your consideration:

Subject specific open educational resources (OER) are learning materials that are tailored to a particular subject or discipline, such as mathematics, history, or engineering. They can include full courses, course materials, modules, textbooks, videos, tests, softwares, etc. Subject specific OER can help teachers and learners to find relevant and quality resources for their teaching and learning needs.

Some examples of platforms that offer subject specific OER are:

- https://oercommons.org/: A public digital library of OER that allows users to search and browse OER from various sources and subjects. Users can also create and publish their own OER using the Open Author tool.
- https://merlot.org/merlot/.A curated collection of free and open online teaching, learning, and faculty development services contributed and used by an international education community. Users can search for OER by discipline, material type, audience, language, and more.
- https://phet.colorado.edu/: Simulations and animations for STEM subjects.
- https://literacy.concordia.ca/en/: Resources for English Language.

Activity 3.1. How to Use OERs (Presentation/Lecture/ -10 minutes)

When we use resources from OERs, it is very important to ask ourselves the following questions:

- How does the content related to my learning outcomes?
- Who created the content? who is using the content?
- When was last updated?

It is also important to apply the 5R activities: retain, reuse, revise, remix, and redistribute as you plan to use contents from open educational resources.

- Retain a copy of an OER on your device or cloud storage for future use.
- Reuse an OER in its original form for your lesson, such as showing a video or assigning a reading.
- Revise an OER by modifying it to suit your needs, such as adding annotations, comments, questions, or feedback.
- Remix two or more OER by combining them to create a new resource, such as integrating a text with an image or a quiz.
- Redistribute an OER by sharing it with others, such as your students, colleagues, or online.

Group Discussion (20 minutes)

In small groups, review one of the examples of open educational resources provided in previous pages and explain on how to apply the 5R principles as you select content for your lesson.

Activity 3.1. Exploring Ministry of Education e-library Resources

Ministry of Education Ethiopia has established e-library for teachers and students to access relevant educational resources online through cloud technology. The e-library enable teaching and learning resources to be available online through computers and smart phones. Through this platform teachers and students will have access to approved resources for teaching and learning use.

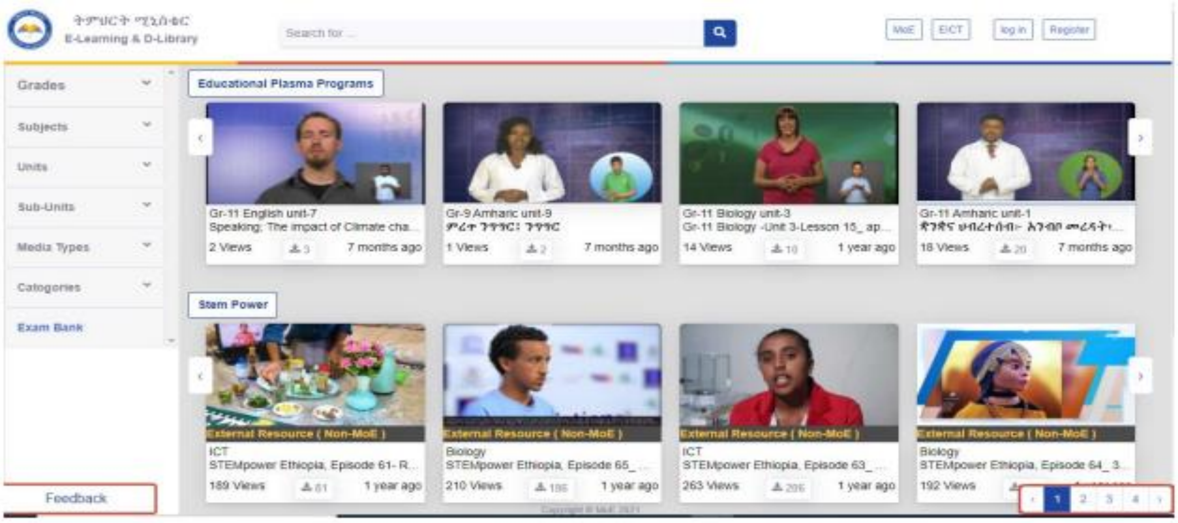


Figure 14. MoE Digital Library

Group Discussion (15 minutes)

In groups of four to six, discuss on the following questions:

- Have you ever utilized digital content from the MoE digital library portal?
- What specific topic or subject was covered in the lesson where you used digital content from the portal?
- Describe how you incorporated the digital content into your teaching.
- Was the content beneficial for enhancing your lesson?
- When selecting content from the portal, what criteria did you consider?

Demonstration (20 minutes)

Use the following what to do Instruction and Demonstrate how to access digital content from MoE Digital Library. Please select contents which are relevant to your subject matter area and describe to your colleagues on how you would use it in your lesson?

What to do:
Step 1: Go to: http://elearn.moe.gov.et.

Step 2: Select content of your choice based on grades, subjects, units, media types, and categories on the left side of the page.

Step 3: Use selected content for the work at hand.

Activity 3.3. MoE Learn English Platform (https://learn-english.moe.gov.et/)

MoE learn English platform is a free of charge or **zero rate** site for learning English language and skills. It offers various resources and activities for different levels of learners, from grade KG to grade 12. You can find videos, podcasts, and quizzes on topics such as grammar, vocabulary, pronunciation, listening, writing, and more. You can also create an account to access the site and track your progress. The site is developed by Ministry of Education Ethiopia in partnership with ethiotelecom. The site is updated regularly with new content and features.

Figure 15. MoE Learn English Website

Group Work – Review MoE Learn English Website (20 minutes)

In group of four to six, review MoE Learn English Website (https://learn-english.moe.gov.et/)

- What are your impressions of the site?
- Does it use zero rating or charge you for data usage?
- Are the contents useful and relevant for your teaching and learning?

Activity 3.4. Review Khan Academy Resources (https://www.khanacademy.org/)

Khan Academy is one of the examples of open educational resources that deliver high-quality educational content across multiple disciplines. This platform provides on its website, or on the Khan Academy's YouTube™ channel, an advanced learning analytics module with useful visualizations. The Khan Academy platform enables online courses in which lessons are produced in the form of videos, interactive activities, and challenges.

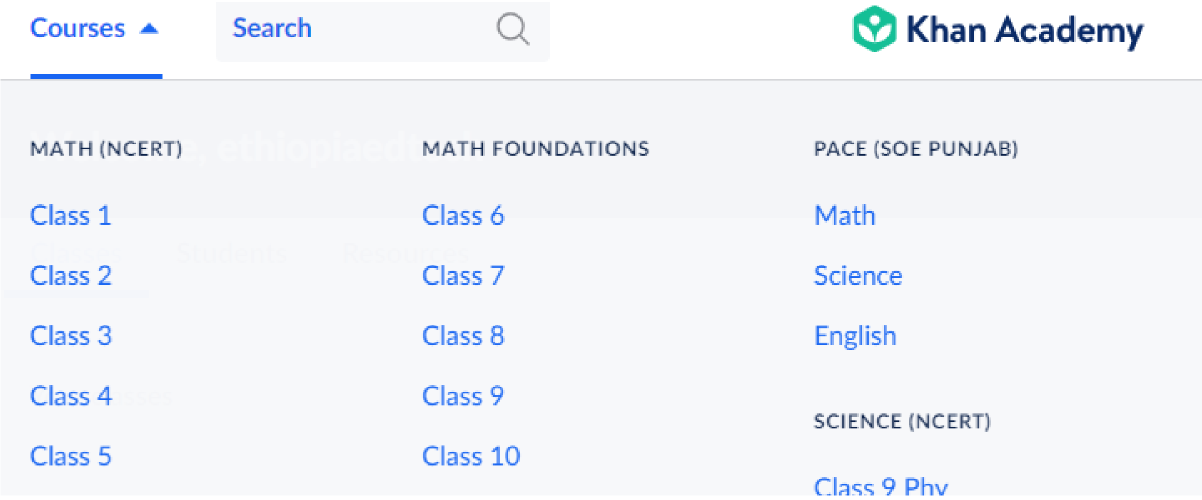


Figure 16. Khan Academy

Students can watch videos and solve supplementary practice exercises to understand various lessons and concepts more easily. Also, teachers can make use of Khan Academy to supplement the teaching process and provide extra content to learners to enhance learning.

Individual Task (15 minutes)

Go to https://www.khanacademy.org/ and identify content related to your subject area. Which content do you identified? How are you going to use the content to enhance learninig outcomes among students? How do you explain the whole experiences of accessing content from Khan Academy?

Activity 3.5. YouTube as Source of Educational Contents

YouTube is not open educational resources, but it can be a powerful tool for teachers to enhance their lessons and cater to different learning styles. Here are some ways teachers can leverage YouTube for educational purposes:

- Finding educational content: YouTube offers a vast library of educational videos on almost any subject imaginable. Teachers can find documentaries, lectures, experiments, simulations, and instructional videos created by educators or educational institutions.

- Visualizing complex concepts: Scientific phenomena, historical events, or abstract ideas can be brought to life through engaging and informative videos. This can be particularly helpful for students who learn better visually.

- Introducing new topics: A captivating and well-made video can spark students' curiosity and introduce a new topic in a stimulating way.

- Flipped classroom approach: Teachers can use YouTube videos for students to watch at home, freeing up classroom time for discussions, activities, and deeper exploration of concepts.

Additional tips for teachers using YouTube for Educational Purpose:

- Carefully curate content: Since not all YouTube content is created equal, teachers need to preview videos and choose those that are accurate, age-appropriate, and meet learning objectives.
- Consider copyright: Copyright laws apply to YouTube videos. Teachers should be familiar with fair use guidelines to ensure they are using content legally.
- Engage students with the video: Simply showing a video isn't enough. Teachers should prepare discussion questions or activities to help students process the information and connect it to the lesson.

Individual Task (15 minutes)

Go to YouTube and identify content in your subject matter for any topic you might think to explore further. Which content do you identified? How are you going to use the content to enhance learning outcomes among students? How do you explain the whole experience of accessing content from YouTube?

Activity 3.6. Exploring Digital Skills Training for Educators (EdTech 101 online course)

The EdTech 101 Course has been thoughtfully prepared as a complement to the face-to-face digital training. Its primary purpose is to allow educators (teachers, principals and supervisors) to continue practising the use of digital tools and platforms once they return to school. In addition to the content covered during in-person sessions, this online course provides additional insights on how to seamlessly integrate digital technologies into teaching and learning practices.

The course is suitable for both new and experienced teachers, offering comprehensive coverage of essential topics. Participants will explore an introduction to educational technology, delve into various digital platforms, discover open educational resources (OER), and gain an understanding of digital citizenship. To fully grasp the material, participants can expect to invest approximately two weeks in completing the course. However, the flexibility of the course allows educators to take it at their own pace, anytime and anywhere that suits them. Based on their choice, teachers can also choose to focus on specific sections that interest them once they joined the course.

Join the training on Canvas with the following steps:

- **Open a Browser and Go to:** https://canvas.instructure.com/enroll/CX4AC8
- **Complete the Request Form**: Fill in the required information:
    - New user details (if applicable).
    - Full name.
    - Email address.
    - Agree to the terms of use.
    - If there's a Captcha form, complete it as well.
    - After submitting the form, you'll be directed to the course dashboard.
    - Here, you'll find information related to the training course.
- **Activate Your Account via Email**:
    - Check your email inbox for an activation email from Canvas.
    - Click the activation link provided in the email.
    - You'll be taken to a page where you can set your password.

- **Access the Course**:
    - Now that your account is activated, you can log in to Canvas using your email and the password you just set.
- **Mobile Access**:

- For convenience, you can also download the Canvas Student App from the App Store or Google Play Store on your phone.
- Use the app to attend the course on the go.

Individual task (45 minutes)

Get registered yourself on the course. Please follow the link provided to register for the course. Explore the course features, check your email, and activate your account using the activation email. Your facilitator will guide you through the registration process.

Key Ideas

Digital Content

Digital content can be a useful tool if teachers use it appropriately in improving learning outcomes among students. Digital tools might be employed in diverse ways to enhance learning experiences. One significant advantage of using digital content is its capacity to explain complex concepts in a more captivating manner. Teachers leverage interactive tools, simulations, and educational games to simplify the topic under discussion. Moreover, digital content facilitates differentiation, catering to students with varying learning styles and paces. Learners can revisit lessons and access supplementary resources online, fostering a self-directed learning environment. Additionally, digital content streamlines tasks for teachers—pre-made materials, online assessments, and grading software save valuable time, allowing personalized feedback to students.

Below are some of the factors we might consider as we select digital resources for our lesson.

- Learning outcomes: What knowledge, skills and attitudes do you want the learners to achieve? In fact, technology should not drive learning but rather the set learning outcomes.
- Age of learners: the technology tools to be used should consider learner development stage and their readiness to use it.
- Access to technology: What technology is available for use in the teaching and learning process.
- Learner centeredness: Does the technology chosen allow the learners to learn collaboratively on their own and can they be able to use it without depending on the teacher.
- Creativity and innovation: does the technology arouse creativity and innovation in the learners? Can the learners suggest other ways in which they can use the technology?
- Safety of learners: This should be a paramount importance especially when learners are expected to use online tools and resources.

- Teacher competence: How the teacher use the technology with confidence as he facilitates learning.
- Inclusiveness: technology instructional design should be accessible to all learners including those with special needs.

Images

Using visuals such as images play a crucial role in enhancing both teaching and learning. They capture students' attention, simplify complex ideas, and act as translators for abstract concepts. Thought-provoking images also stimulate discussions and critical thinking. For younger learners and those acquiring a new language, pictures bridge the gap between words and their meanings, reinforcing vocabulary acquisition. By incorporating a variety of visuals, teachers create an inclusive learning environment that fosters deeper understanding and a lifelong love of learning.

Power Points

Teachers and educators often utilize presentation tools like PowerPoint and Google Slides to create educational content for their students. These platforms allow them to save time and seamlessly incorporate various resources into their materials. Additionally, some educators choose to record their presentations using PowerPoint's recording feature, making it convenient to share with students for future reference.

Ministry of Education e-Library

Ministry of Education e-Library provides a wealth of educational content, most of them verified and approved. Access a variety of engaging formats to suit your learning style, including educational videos, audiobooks, and textbooks. Follow the below steps to access resources from MoE e-Library.

Open Educational Resources (OERs)

Open educational resources (OERs) are transforming classrooms by offering teachers a treasure of free and adaptable learning materials. These resources, which can include digital textbooks, interactive exercises, and multimedia content, empower teachers in several ways. Firstly, OERs tackle the issue of cost. By incorporating them, teachers can reduce the financial burden on students who might otherwise struggle to afford traditional textbooks. Secondly, OERs are incredibly flexible. Many come with open licenses, allowing teachers to modify and tailor them to their specific curriculum and student needs. This fosters a more personalized learning experience. Additionally, OERs can tap into the power of collaboration. Teachers can share and adapt resources developed by colleagues around the world, promoting innovation and the exchange of best practices. Ultimately, OERs empower teachers to create dynamic and engaging lessons that cater to diverse learning styles, all while promoting a more equitable and accessible learning environment for all students.

Implication for teaching

Record your responses to the following questions as your key learning and future considerations on your handouts.

- What did you learn about digital content and how are you planning to use them in the future?
- What is your plan to use images from different sources for your teaching and learning or any other related task in your school?
- What is your plan to use slideshow presentations in your teaching and learning or any other related task in your school?
- What did you learn about MoE e-Libraries and Learn English platforms?
- What are Open Educational Resources and How are going to use them going forward?
- What is your plan to use MoE Digital Library and Learn English Platform for your teaching and learning or any other related task in your school?
- How are you going to encourage your students to access the MoE digital libraries and other OERs?
- What did you learn about Khan Academy and YouTube?
- How are you going to encourage your students to access digital content from YouTube and Khan Academy Sources?

Self-Assessment

1. What is one significant advantage of using digital content in education?

   A. It saves teachers time by automating grading.
   B. It fosters self-directed learning among students.
   C. It replaces traditional textbooks entirely.
   D. It simplifies complex ideas through interactive tools.

2. How do images enhance teaching and learning?

   A. By providing pre-made materials for teachers.
   B. By bridging the gap between words and meanings.

C. By automating assessments.
D. By replacing traditional textbooks.

3. Which presentation tools are commonly used by educators?

   A. Google Sheets and Excel
   B. PowerPoint and Google Slides
   C. Word and Notepad
   D. Prezi and Keynote

4. How can teachers create a PowerPoint presentation using Google Slides on their phones?

   A. By downloading the Google Slides app and signing in with their Google account.
   B. By using a laptop or desktop computer.
   C. By searching for "Google Slides" in the app store.
   D. By selecting a theme from a variety of options.

5. What does the Ministry of Education e-Library provide?

   A. Free laptops for students
   B. Educational videos, audiobooks, and textbooks
   C. Online assessments
   D. Grading software

Reference Materials

Read	Importance of Using PowerPoints and Word as a Teacher
Read	The Basics of Word
Read	The Basics of PowerPoints
Watch	How to use Google Docs and Slides
Watch	Creating Quality Digital Contents
Read	Best Practice for Teaching with Digital Content
Read	How to use image effectively in your lesson
Read	Why Should I use OERs?
Watch	Impactful use of OER
Read/Watch	http://elearn.moe.gov.et.
Watch	https://learn-english.moe.gov.et/
Read	How to join online course on Canvas

UNIT SIX: DIGITAL CITIZENSHIP

Introduction

In this chapter, you will discuss about safe use of technologies such as mobile phone, computers, tablet, and the internet. Specifically, you will discuss on risks in connection with internet use and safety measures.

Learning Objectives

By the end of this chapter, you will be able to:

- Explore safe and responsible behaviour in using internet and communication technologies.
- Explain the risks associated with using the internet and communication technologies.
- Contextualize e-safety rules and guidelines for their schools.

Key Topics

Session One: Internet Risks and e-Safety

Session Two: Computer and Smartphones Safety

Session One: Internet Risks and e-Safety

Activity 1.1: Exploring the concept of e-Safety. Think Pair Share (10 minutes)

What is e-Safety? With what concept or term does e-Safety connected?

e-Safety is often synonymous with online, or internet safety and it is concerned with being safe and appropriate use of technologies without compromising personal security and safety.

Activity 1.2: Unpacking Risks Associated with Internet

Group Discussion (15 minutes)

Students are often unaware of the potential danger in relation to internet and are susceptible to unsafe online behaviour. Now, in group of four to six, discuss on potential e-Safety risks. After you finish your discussion, share with your facilitator on any convenient platform for you.

Activity 1.3: Exploring e-safety risks.

Group Discussion (15 minutes)

In small groups, discuss on the following potential e-safety risks. (Each group might discuss at least on two of the risks mentioned below). Then, prepare online presentation using Google Slides or any convenient platform and present for the whole class.

1. Social Networking Risks
2. Age restrictions
3. Sharing Online profiles/Security risk
4. Publishing content
5. Uploading Photos and Videos
6. Cyberbullying
7. Copyright
8. Exposure to inappropriate online content
9. Excessive time online

Activity 1.4: Fake News

Being online exposes children to number of fake news and unverified information which put them and even others to risks of different kind.

Whole class discussion (5 minutes)

- What is fake news? what is news?
- Give examples of fake news on digital platforms?

Facilitator Notes

- ***News*** *is factual information about a recent event that is new to people and will be of interest to them.*
- ***Fake news*** *is lies and/or propaganda told for a political or commercial purpose and influence millions of people. It's often deploying through digital technology, social media, news networks to go viral and reach people very quickly.*

Activity 1.5: Fact, Opinion and Fake news

Whole class discussion (10 minutes)

- What is the difference between facts and opinion?
- Give some examples of facts, opinion and fake information on the similar topic?

- How can we help students to differentiate between facts, opinions, and fake information?

Example of Fact and Opinion

- **Fact:** Ethiopia is one of the Country in East Africa.
- **Opinion:** Ethiopia will soon become middle income Country.
- **Fact:** Abebech Gobena has provided education opportunity for many Ethiopians through her NGO.
- **Opinion:** Abebech Gobena is a well-remembered person in Ethiopian philanthropy work. Fact: Addis Ababa is the capital of Ethiopia.
- **Opinion:** Pollution is the main problem facing Addis Ababa.

Media Detection questions

Always encourage your students to ask themselves the following questions as they come across media contents.

Figure 17. Media detection questions

Activity 1.6: Adopting e-Safety rules for your school

Group Discussion (15 minutes)

Do you have e-safety rules at your school? In small group discuss on possible e-Safety rules for students and teachers in your school. Then, post your answers with your group name on top of it on one of interactive platforms.

Facilitator Notes: Basic e-safety rules

Social networking poses little risk if students follow basic e-safety 'rules' such as:

- *keeping personal information private*
- *respecting the rights and feelings of others*
- *Stick to the given assignment (importance of providing specific links)*
- *thinking about the long-term consequences of what you post online*
- *reading and adhering to the terms and conditions of use*

Session Two: Computer and Smartphone safety

Activity 2.1. Using Computer and smartphones safely (15 minutes)

Make a group of four to six members and discuss on the following issues.

1. How do you give care and protect your devices from malfunctioning and break?

2. What safety measures due you take to protect and secure your devices from an allowed users, virus and cyber-attacks?

Key Ideas

Internet Risks

The following are common internet risks that we should be aware of and also educate our students.

- ***Social Networking Risks:***
  - Social media platforms can expose users to cyberbullying, inappropriate content, and privacy breaches.
  - Discuss how to manage privacy settings, avoid sharing personal information publicly, and recognize fake profiles.
- ***Age Restrictions***:
  - Many online services have age restrictions to protect children from inappropriate content.
  - Explore the importance of adhering to age limits and the risks associated with underage access.
- ***Sharing Online Profiles/Security Risk***:
  - Sharing personal information online can lead to identity theft, phishing attacks, and stalking.
  - Highlight the need for cautious profile sharing and strong passwords.
- ***Publishing Content***:

- Posting content online (blogs, videos, etc.) can have unintended consequences.
- Discuss responsible content creation, copyright awareness, and avoiding harmful material.

- ***Uploading Photos and Videos***:
  - Sharing images and videos can lead to privacy breaches or misuse.
  - Talk about consent, geotagging, and the impact of sharing visual content.
- ***Cyberbullying***:
  - Online harassment affects mental health and well-being.
  - Address strategies to prevent and respond to cyberbullying.
- ***Copyright***:
  - Using copyrighted material without permission can lead to legal issues.
  - Educate about fair use, Creative Commons licenses, and proper attribution.
- ***Exposure to Inappropriate Online Content***:
  - Children may accidentally encounter harmful or explicit material.
  - Discuss safe browsing habits and parental controls.
- ***Excessive Time Online***
  - Spending too much time online can impact physical health, sleep, and social interactions.
  - Explore healthy screen time practices and digital balance.

Safe Use of Computers and Smartphone

Maintaining clean digital devices is crucial for both the longevity of the devices and our own well-being. Let's explore some reasons why it's essential to keep your electronic equipment clean:

1. **Device Performance and Longevity**:
   - Regular cleaning helps prevent dust buildup and clogged fans, which can lead to overheating and damage to internal components.
   - Clean devices run more smoothly, ensuring optimal performance and extending their lifespan.
2. **Improved Appearance**:
   - A clean device looks better and is more pleasant to use.
   - Considering how much time we spend interacting with our devices, an improved appearance positively impacts our daily experience.
3. **Health Protection**:
   - Think about all the surfaces you touch throughout the day. Now imagine transferring that to your devices—keyboards, screens, and touchpads.
   - If you don't clean your devices, they can harbour bacteria and germs, posing health risks when you touch your face or hands.
   - Safe use of devices helps your eye from being damage due to inappropriate use.
4. **Avoiding Constant Replacements**:
   - Regular cleaning reduces wear and tear, preventing premature device failure.
   - Frequent replacements are inconvenient and costly, so maintaining your devices can save you time and money.

Implication for Teaching

Record your responses to the following questions as your takeaway and future consideration on your handouts.

- What did you learn e-safety?
- What are the potential risks in using digital technologies (internet)?
- What new skills, experience, knowledge have you got?

- How would you like to apply the new skills in your subject teaching learning activities?

Self Assessment

1. **What is the difference between facts and opinions?**

A. Facts are subjective statements, while opinions are objective.
B. Facts are based on evidence and can be verified, while opinions are personal beliefs.
C. Facts and opinions are interchangeable.
D. Opinions are always accurate, while facts can be misleading.

2. **Which of the following statements is an opinion?**

A. Ethiopia is one of the countries in East Africa.
B. Addis Ababa is the capital of Ethiopia.”
C. Abebech Gobena has provided education opportunities for many Ethiopians through her NGO.
D. Ethiopia will soon become a middle-income country.

3. **What risks are associated with social networking platforms?**

A. Exposure to cyberbullying and inappropriate content
B. Increased privacy and security
C. Enhanced communication skills
D. Improved mental health

4. **Why is it important to keep digital devices clean and in good working order?**

A. To prevent identity theft
B. To avoid copyright infringement
C. For the health of the device and the user
D. To enhance internet speed

Reference Materials

Read	Smart Phone Use Safety Tips
Read	Parental Guide to Smartphone Safety
Read	How to secure your devices
Read	e-Safety Tips
Watch	Safe Online
Watch	Digital Footprint

Watch	Four Reasons to care about your digital footprint
Watch	How Fake News Spread
Watch	Fact vs Fake

Well done! You've made it to the end of the Module! We hope you've found it useful, and you'll join us Canvas Online Digital Skills Training.