4.

PLANNING FOR TEACHING-LEARNING OF MATHEMATICS

"|Plans are of little importance, but planning is essential."

INTRODUCTION

The day to day planning of the details and sequences of each day work is a great importance to each individual teacher. The daily lesson plans for a teacher determine what learning activities will go on in the class during that period. A teacher who goes to the class without planning for the lesson runs the risk of wasting time and effort.

Indeed the very act of writing the plan out forces a crystallisation of the plan in the teachers mind. This in itself is an important step towards a successful consumption of what is being planned.

According to "Good" a lesson plan is " outline of the important points of a lesson arranged in the order in which they are to be presented to students by teacher".Davis defined "Lesson plan as an arrangement of learning, planning, organising and controlling by a teacher".

9.1 WHY PLANNING TEACHING-LEARNING?

Teachers who do not produce a lesson plan are often lazy, or feel that they can create a lesson based on what is happening in the room at that moment. This can sometimes work, but to continue to never have a lesson plan proves to be ineffective, besides, your students will become frustrated and feel a sense of negligence or carelessness on the teacher's part as well as not getting their money's worth.

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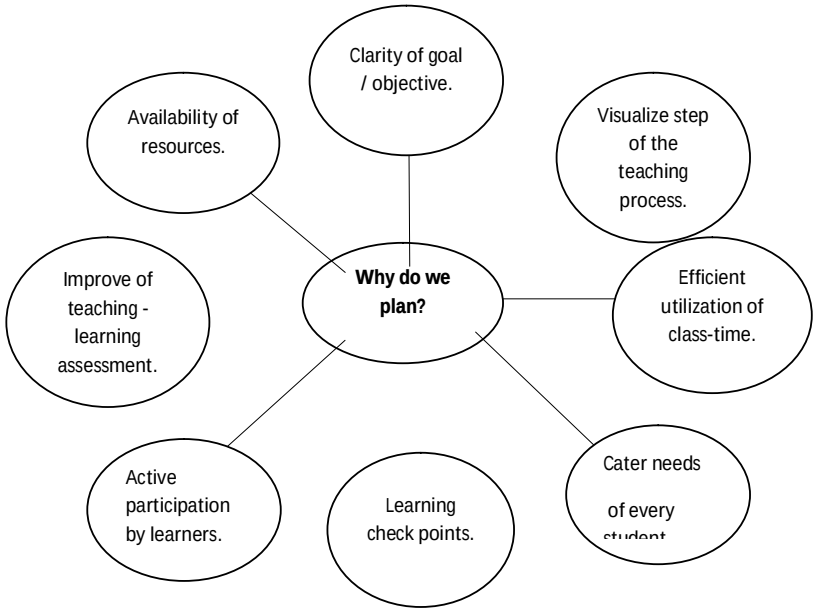

Planning is essential because:

- ❖ It helps the teacher conduct her lesson in an orderly fashion and it allows students to know what they are going to be learning and how it fits into the course syllabus.
- ❖ Students also feel that the lessons are sequenced properly.
- ❖ Having a good lesson plan will also increase confidence in the teacher.
- ❖ In addition, a detailed plan clearly demonstrates that the teacher has taken the time, as well as, put in the thought and effort into making the lesson.
- ❖ Planning detailed lessons will avoid problems in class.
- ❖ This will give the teacher confidence that they have done their best to plan for any eventuality, or at least minimize some problems.

Selection of Appropriate Instructional Strategies:

Learning involves three components, namely,

- · Listening
- · Observing
- · Performing

Knowing the appropriate instructional strategy and the specific content format that aids learning and practice ensures, achieves the learning objectives and doesn't disappoint learners. These are the three phase instructional strategies to keep in mind;

I. Tell Phase:

- Use appropriate attention, grabbing techniques.
- **Reiterate the learning objectives:** to establish relevance and whet interest.
- **Tell learners:** What, why, how, when and if applicable, Where.
- **Refer to prior learning:** to link what you are about to teach to personal experiences.
- **Discovery learning:** help learners discover and become aware of what they already know.
- **Questions**: Ask probing questions to engage the learners and find out about their prior learning.
- **Flowcharts**: Use these diagrams to present a quick overview of the content.
- **Metaphors**: Use these to impart a sense of familiarity with unknown concepts.
- **Stories and Drama**: There are no better hooks.
- **Visuals (Info-graphics, Photos, and Diagrams)**: Pictures do a better job of explaining complex matter than words. Use them to explain the big picture of the subject.

II. Demonstrate (Show) Phase:

- **Explain with examples and analogies:**Provide specific examples and real evidence of the concepts from real-life scenarios that the learners can relate to. In some cases, throwing in a few non-examples along with the examples can better clarify concepts and procedures.
- **Case Studies:** Application- and result-oriented adult corporate learners are usually hooked by this problem-based learning approach.
- **Scenarios:** Create realistic scenarios and make sure the characters ooze authority while being relatable.
- **Simulations:** Simulations mimic the reality of the learner and place the learning in context while keeping the learners engaged.
- **Visual Aids:** Comparison tables and concept maps help learners visualize complex information and show relationships.

- **Step graphics and tables:** A complex procedure should always be broken down into its constituent steps.
- **Guided Animations and Videos for what-happens (processes):**How a procedure is being carried out is not always apparent from textual explanations or even photographs. Video or guided animations clarify better.
- **Examples and non-examples:** Create examples and non-examples that reflect the reality of the learners.
- **Info-graphics:** Comparing two processes, ideas, items, or people Info-graphics area is great tool for this.

III. Apply/Do

- **Drills:** Drills are effective for practicing low-level or foundational skills.
- **Simulations:** These are effective for practicing application-level content.
- **Scenarios and Case Studies:** These compel learners to analyse multiple types of data to arrive at the solution.
- **Role-Play Activities:** Role-playing practice activities let learners apply their newly-learned skills to solve real-life and dynamic problems within the controlled learning environment.
- **Games:** Games engage learners and provide a welcome break, as long as they remain relevant to the content being learned.

9.2 PLANNING - AN EXAMPLE: ANNUAL PLAN, UNIT PLAN, LESSON PLAN, PERIOD PLAN

9.2.1 PLANNING - AN EXAMPLE

A very basic example of a plan: Perhaps you want to go see a movie at a specific time, that is the plan. The procedure to accomplish the plan would define the steps to be taken in order. First, you would look on a Web site for listings of movies in your area, then you would decide which one looks good (if any). Then you would secure transportation thereto, optionally but almost certainly also inviting one or more acquaintances to join you. You may have to adjust your time to when the movie actually starts. A plan defines what you are going to do, this can be done by choosing from what you haven't done yet. A procedure defines how you are going to do it, this can be done by choosing from how it will have been accepted then.

9.2.2. ANNUAL PLAN

Annual planning is done by the teacher at the beginning of the year for the entire course. For example, a teacher who teaches mathematics for a particular class plans the particular co-curricular activities as per the syllabus for the entire academic year.

A. Important Features of anAnnual Plan

1. The number of units to be covered as per the syllabus can be planned efficiently.
2. The number of periods needed to cover each unit, the number of periods needed to allot per week can be planned.
3. It keeps the teacher on the right track.
4. It enables the teacher to cover the syllabus within the allotted time as planning saves waste of time and energy.
5. It provides teacher systematic planning and teaching
6. It gives self-confidence to the teacher as she is sure what is expected of her during each period/week/month/term etc.
7. The year planning helps the teacher in making decision regarding when to teachwhat, how much time can be assigned for each unit/ topic, how many hours of project or laboratory work can be assigned to the students.
8. It helps the teacher to plan co-curricular activities in without haste and anxiety.
9. the teacher can plan revision, formative test and other summative exams easily

B. Format of an Annual Plan:

1. Class :

2. Subject :

3. No.of periods:

4. Competencies & Academic standards:

- **Problem solving**
- **Reasoning and Proof**
- **Communication**
- **Connections**
- **Representation**

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C. Month wise division:

S.No	Month	Name of Chapter	No of periods	Resources	Proposed activities
1		Real Numbers			
2		Polynomials and Factorisation			
3		Linear Equations in two variables			
4		The elements of Geometry			
5		Lines and Angles			
6		Co-ordinate Geometry			
7		Triangles			
8		Quadrilaterals			
9		Areas			
10		Circles			
11		Geometrical Constructions			
12		Surface Areas and Volumes			
13		Statistics			
14		Probability			
15		Proofs in Mathematics			

5. Teacher's reflections on implementation of year plan :

……

6. Head master's reflection and suggestions on implementation of year plan :

……

9.2.3 UNIT PLAN

Unit planning advocates the division of subject matter or content into small but meaningful units. Unit plan may have several lessons

according to the content. A unit is a block of several topics related to the subject matter overviewed by the learner.

According to Bossing "A unit consists of comprehensive series of related and meaningful activities series so as to achieve pupils purpose provide significant education experience and results in appropriate behavioural changes".

A. Steps involved in developing a unit plan

i. Preparation or motivation:

The motivation should not be forced from outside by the teacher but should be natural or self-directed. They should also overview the unit and find out the scope of the material. Motivation is not only required in the begin9ng but throughout the lesson.

ii. Knowing the previous experiences:

"Start with the pupils where they are" is the modern slogan in education. It is essential to know about the previous knowledge of the pupil so that neither there is duplication of what they already have nor any danger having anything in the unit which is above the comprehension of the students. The previous knowledge can be found out by questioning or by preparing inventory.

iii. Presentation:

In this step some new experiences are given to the pupils. Care should be taken that only that much amount of new experience is given to the students as they easily digest and assimilate.

iv. Organisation of learning:

The pupils should get opportunities to bring their learning together so that they may establish relationship between the new experiences and assimilate them. This organisation may be written or verbal.

v. Summarization :

This is usually required at the closing of the teaching unit, to bring together all the learning. This may also be done in intervals during the progress of the unit. Organisation and summarization goes together.

vi. Review and drill:

During the progress of the teaching unit there is every likelihood that some part of it is forgotten and some has not been completely comprehend. For this review or re-teaching or just revision of the new experience taught during presentation is required.

vii. Evaluation:

This required knowing what the pupils have achieved and what they have failed to achieve. Evaluation should be mainly self-evaluation. This

may be in the form of oral or written tests after short intervals, say, after a week or fortnight or may be in the form of performance tests interviews, self-check, puzzles etc. The final test is conducted to give grades to the pupils and also to evaluate the effectiveness of teaching.

B. Format of a Unit Plan:

Class : 9th

Subject : Mathematics

Chapter : 10. Surface Area and Volume

No.of Periods : Instructional periods (8) + exercise (4) = 12

Academic standards to be achieved

Problem Solving :

1. Students can solve the problem regarding lateral surface areas of three dimensional objects like cuboids, cube, regular prism, regular cylinder, cone, sphere and hemisphere.
2. Can solve the problems regarding volumes of three dimensional objects like cuboids, cube, regular prism, regular cylinder, cone, sphere and hemisphere.

Reasoning Proof :

1. Can compare and contrast the lateral and total surface areas of these different 3D objects, gives reasons and proofs.

2. Can compare and contrast the volumes of these different 3D objects gives reasons and proofs.

Communication:

1. Explain the realtions between the lateral and total surface areas of these different 3D objects and give their formulae in mathematical language.
2. Explain the relations between the volumes of these different 3D objects and give their formulae in mathematical language.
3. Can create similar sums on his own.

Representation:

Can represent the shape of 3D objects as 2D diagrams and net shapes.

Connections:

Can use the knowledge of calculating surface areas and volumes of 3D shapes in daily life.

C. Format of Unit Plan with Period wise distribution of the chapter

No. of period	Teaching items/Concepts	Teaching strategy	Resource for Teaching /aids/TLM	Students' understanding/reflections
1	Lateral and total surface areas of cuboid and cube	Whole class activity / group activity / individual activity	Cartoon boxes of cuboid and cube shapes	
2	Volumes of cuboid and cube	Whole class activity / group activity / individual activity	Cartoon boxes of cuboid and cube shapes	
3	Understanding the volume of regular prism and pyramid	Whole class activity / group activity / individual activity	Solid prisms and pyramids of different number of sides	
4	Discussion on Exercise 10.1	Whole class activity / individual activity	Text book	
5	Lateral and total surface areas and volume of right circular cylinder	Whole class activity / group activity / individual activity	Cylindrical tin	
6	Discussion on Exercise 10.2	Whole class activity / individual activity	Text book	
7	Slant height and its relation with other dimensions of right circular cone	Whole class activity / group activity / individual activity	Ice cream cone, funnel ...	
8	Lateral and total surface	Whole class activity /	Card board model of right	

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	and volume of right circular cone	group activity / individual activity	circular cone, A model to find volume	
9	Discussion on Exercise 10.3	Whole class activity / individual activity	Text book	
10	Surface area of sphere and hemisphere	Whole class activity / group activity / individual activity	Ball, Spoon, a cut ball	
11	Volume of sphere and hemisphere	Whole class activity / group activity / individual activity	Solid sphere, hemisphere	
12	Discussion on Exercise 10.4	Whole class activity / individual activity	Text book	

Additional information gathered by the teacher (Teacher's Notes): . . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

Reflections of the teacher after transaction of the chapter: . . . . . .
. . . . . .
. . . . . .
. . . . . .

9.2.4 LESSON PLAN

Careful lesson planning is the key to successful teaching. Lack of planning encourages fumbling and indicium with accompanying disciplinary problems.

According to international dictionary of education "lesson plan is the outline of the important points of a lesson arranged in order in while they are to be presented to students by the teacher".

Teaching is the task of the teacher which is performed for the development of a child. Lesson planning is the heart of an effective teaching programme in schools. It is shaped and systemised to fulfil our aims of the lesson in order to do full justice to a topics or lesson it is highly desirable to give every lesson a logical shape.

A. Important Features of a Good Lesson Plan

A good lesson plan should have following important characteristics,

1. All the objectives of the lesson, both general and specific should be stated clearly proposes to take in the class.
2. A good lesson plan should outline in detail the various steps that the teacher proposes to take in the class.
3. A good lesson plan should it remain at the oral or mental stage, it should be preferably written.
4. A good lesson plan should have its basis on the previous knowledge and experience of the learner and the present knowledge should be well integrated with the previous knowledge.
5. Ample provisions should be made in the lesson plan for arousing the curiosity and sustaining the interest of the students.
6. The subject matter presented, the materials used, and the teaching aids selected should cater to the individual needs and abilities of the students.
7. The lesson plan should reveal the development of the topic.
8. The lesson planning requires that the lesson unit must be finished within the time allocated.
9. A good lesson plan should contain the questions to be asked, illustrations to be used the assignments to be done and the activities to be carried out.
10. The teaching techniques to be used by the teacher should be clearly explained in the lesson plan.

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11. A good lesson plan should indicate the list of A.V aid to be used and should specify when and how to use them.
12. Application stage for applying the learned rules and formulae should find a place in the lesson plan.
13. A good lesson plan should stimulate reflective thinking, independent thinking and originality of expression on the part of the students.
14. A good lesson plan should be flexible and not rigid. It should make the presentation more effective.
15. A lesson plan should provide for consolidation and recapitulation of ideas.
16. References should be clearly given.
17. It should suggest activities to meet individual differences.
18. It should provide intrinsic and extrinsic motivation.
19. A good lesson plan should provide the basic for further learning.
20. A good lesson plan should indicate where the knowledge will be applied in practical situation life.
21. A good lesson plan should indicate the time period required to complete the lesson and it should also indicate the approximate time required for each step.
22. A good lesson plan prepares a brief summary at the end.

B. Format of a Lesson Plan

S.No	Steps	Teaching Points	Teaching-Learning activities		Black-Board Activity/ Teaching Aids
			Teacher's	Students	
I.	Introductory Activities a. Testing Previous Knowledge b. Motivation c. Topic Declaration				
II.	Developmental Activities a. Presentation b. Association c. Generalization d. application				
III.	Culminatory Activities a. Summary b. Recapitulation c. Assignment d. Home Work				

9.2.5 PERIOD PLAN

It is a plan that is executed each day using specific strategies and approaches for in teaching-learning.

A. Steps in Period Plan

1. Introduction

- ❖ Greetings
- ❖ Testing / re-teaching previous knowledge (Game / situation / probing questions)
- ❖ Introduction to concept through daily life situation
- ❖ Announcement of the topic
- ❖ Scope of the topic

1. Presentation and Discussion

- ❖ Reading the text book
- ❖ Discussion on key terminologies and key concepts
- ❖ Activities (Whole class / group / individual) to comprehend the concepts
- ❖ Summing up the teacher

2. Problem Solving

- ❖ Solving by the teacher with discussion and help students
- ❖ Solving problems by the students in groups / individual
- ❖ Discussion on mistakes done by the students and doubt clarification

3. Recapitulation

- ❖ Revision / summing up of concepts taught in the period

4. Home Work

- ❖ Suggesting Problems in exercises or problems assigned by teachers

B. Example:

CONGRUENCY OF TRIANGLES

I. Chapter – Analysis:

This chapter consists of 19 pages

- ❖ One activity,
- ❖ Two Do this exercises,
- ❖ Five Try this exercises,
- ❖ 7 Examples,
- ❖ Four Exercises
- ❖ (19 Problems) are there.

So more periods should be given for students practice. All problems in the exercises have to explain in 'Discussion Method' and encourage them to do the problems on their own. Do this (Individual), Try this (Group Activities) should be done in the class room.

II. Concept Mapping:

III. Notions:

(i) To able understand congruency.

(ii) It is good that if they have knowledge in previous concepts like point, line, line segment, ray, Angle, vertex, Triangles, corresponding sides, corresponding sides etc.,

IV. Focusing Points:

- ❖ Children should know about S.S.S., S.A.S., A.S.A, and R.H.S. Congruency Rules.

CONGRUENCY OF TRIANGLES

I. Chapter – Analysis:

This chapter consist of 19 pages 1) One activity, 2) Two Do this exercises, 3) Five Try this exercises, 4) 7 Examples, 5) Four Exercises 6) (19 Problems) are there. So more periods should be given for students practice. All problems in the exercises have to explain in 'Discussion Method' and encourage them to do the problems on their own. Do this (Individual), Try this (Group Activities) should be done in the class room.

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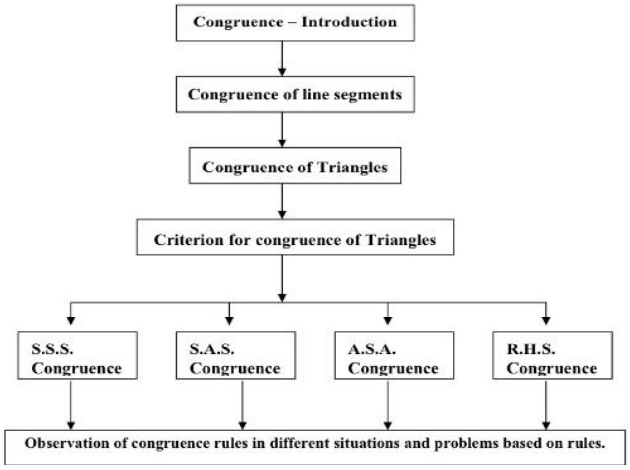

UNIT PLAN

I. **Class :** VII

II. **Chapter :** congruency of Triangles

III. **No.of periods required :** T.P. [8] + P.P. [5] = 13 Periods

IV. **Expected Learning out come / Academic Standards:**

1. **Problem Solving:**
   - Using congruency rules identifies the congruent triangles.
   - Solves the problems related to congruency.
2. **Reasoning Proof:**
   - Give reasons and proofs for triangles which are congruent using the congruency rules
   - Classify and compare the triangles, which are congruent with other triangles.
3. **Communication:**
   - Appreciates the congruency in 2-D figures
   - Uses the ≅ symbol.
   - Explains the congruency rules.
4. **Connections:**
   - Observes the congruency shapes/ things in surroundings
   - Uses the congruency concept and congruency rules in his daily life.
5. **Representation:**
   - Represent the congruent triangles using symbols, notation.

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PERIOD WISE PLAN

Period Number	Topic	Teaching Learning Strategy	Teaching Learning Material [TLM]
1.	Introduction	**Whole class Activity** Using coins, Rupee Notes text book pages to make children understand the 'Congruency' **Individual Activity** 1] Make children to do "Do this exercise in page No.164 2] Children has to show congruent shapes in the class room **Discussion Method:** Discussion on Primary geometrical concepts	Coins, Notes, Papers, Note books, Text books etc., Chart showing geometrical figures
2	Congruence of Line segments, congruence of Triangles	Group work : Prepair some line segments and some triangles with paper then ask the children coincide the line segments and triangles **Discussion:** Make the children to express their openions about congruency **Individual Activity:** 'Do this' Exercise in page No.166.	Tracing paper scissor chart Flash cared with ≅ symbol.
3	S.S.S. Congruence	**Group work:** Read Page No.167 Draw the different triangles with given one side, given two sides, and given three sides. Make them to observe the difference. Using their understanding, introduce S.S.S. rule.	S.S.S. Congruency triangles shapes.
4.	Try this example Exercise about S.S.S.	**Group Activity :** Try this 168 page **whole class activity:** explanation of example in discussion method. **Whole class activity:** All the four problems should discuss with children in friendly way. After clarifying doubts problems must be done by every child individually.	

5.	S.A.S. Congruency	**Group Activity :** Reading page No.169 and 170 construction of triangles with 1] One side and one angle 2] Two sides and angle between two sides 3] changing both sides mutually and included angle. And make them to observe all the above three cases **Demonstration :** Checking the congruency of triangle with coincidence	S.A.S. Congruency triangles shapes S.A.S. Chart.
6	Try this examples Exercise –2 S.A.S.	**Group Activity :** 170 page try this activity **Whole class activity** : Explanation of example 2 and example 3. **Individual Activity:** Exercise –2 problems explanation in discussion method.	
7	A.S.A. Congruence	**Group activity :** Read page No.173 Try to draw a triangle with given three angels construct triangles with two given angles and a side. What is your observation ASA congruency explanation.	A.S.A. Congruence rule Flash card.
8	Try this examples A.S.A.	**Group Work:** Try this page No:173, **Whole class activity :** Explanation of examples 4 and 5 Group work: Try this page No.174 **Whole class activity :** 3rd exercise problems discussion with children. Group discussion. Doubts clarification. Encourage them to do exercise in home as individual activity	
9	R.H.S. Congruency	Group work: Read page No.175 and 176 Draw the figues using activities [I] to [VI] in page 175 what is the specially of [VI] explanation of R.H.S. **Whole class activity :** explanation of example 6 and 7	R.H.S. Rule Flash card

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10.	Try this exercise R.H.S.	**Group Work:** Make the children to complete try this exercise in page 177 and 178 in groups and ask them to explain about R.H.S. Applications **Whole class activity :** 4th exercise 1st and 2nd problems explanation in participatory, discussion method.	
11	Exercise –4	**Whole class Activity :** 4th exercise 3-6 problems understanding and doubts clarification about how to solve.	
12	Exercise – 4	**Whole class Activity :** 4th Exercise 7-9 problems explanation in participation method .	
13.	Review S.S.S., S.A.S, A.S.A, R.H.S.	**Whole class Activity :** Review all the concepts in participatory and discussion method and quiz.	

6. Teacher Notes:

Reference books — VI Class text book (State) Ganitha Chandrika

VII (CBSE / ICSE Books) Mathematics Studio Magazine

Reference web sites

1. www.maths is fun.com
2. www.shyamsunder Gupta.com
3. www.be iitans.com
4. www.google.com
5. www.apmaths forum.com
6. www.wikipedia.congruency of triangles

Additional information :- Down load one page.

Note: Here leave 10 –15 pages to collect additional information every year visiting officers proficiency. So every year we have to add some information.

7. Teachers Reflections :

PERIOD - PLAN

Class: VII, **Sub: Mathematics**

I. Introduction: Congruency of Triangles period 1

i		How are you children who did not come to school yesterday? Why? Do you know children, If you come to school regularly you can learn the mathematics. [Try to mingle with the children by talking with them and asking about them].
ii	Observation of Pre concepts	Show them to various coins and currency. How are they? Keep one above the one. Which coins have same shape & what do call these type of things? What does triangle mean? What are the corresponding sides and corresponding angels. [If it needs, make children to know about the congruency with the situations discussions]
iii	Concept Introduction	What are the congruency things in the above topic? What do you know about the congruency? Do we have congruent things in our class? [Show them same text books & Note books etc.]
iv	Announcement of the Topic	Today, we are going to know about the congruency
v	Importance of the lesson:	He solves the problems in his daily life which he gets with the congruent things. He praises the advantages of congruent things such as books, Tiles, Stickers and Rocks.
	Aims:	He understands the congruency He can identify the congruent things
	TLM:	Various currency papers coins, text books shapes

II. Demonstration & Discussion:

1	Reading	Observe the pictures in 161-162 and read. Ask them to identify the difficult words and write on the board [1] Congruent [2] Trace [3] super impose – etc.
2	Discussion on Key words	Discuss on the important words and make them understand the words.
	Congruent :	Things which are same size and shape
	Trace:	Xerox and one more thing which is the same
	Super impose :	If we keep things one on the above they will be seen one. [Make them understand with the Examples Discussions
3	Activities / Discussions to understand the concept:	1. How are the Rs.10/- and Rs.5/- notes in the 163 page. 2. Make them to do exercises 'Do this' individually in page No.164. 3. Ask them which are the congruent and which are not congruent and say difference between shape and size. 4. Teach them, congruent means which have the same size and same shape.

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III. Problem solving :

1	Problem solving by the teacher on the Black board:	A] Draw the different shapes of figures on the blackboard and explain them which are congruent and why? B] Make them to get complete awareness on congruency by the super impose activity with Triangle, Rectangles and Squares.
2	Solving examples with the children	i. Like above ask them to cut various shapes and figures? ii. Cut the figures and super impose them and discuss about them iii. Make them to explain what congruent
3	Discussion on mistakes done by the children – doubts clarification:	i. Make them to sit in groups and discuss on the problem. ii. Ask them to clarify doubts with each other iii. Discuss on the mistakes by the children, which are observed by the teacher.

IV. Recapitulation

4	Recapitulation	Revise the topic what they have learnt that day Same size and different shapes of figures various shapes and same size of figures Same size and shape of figures Congruent maps and their properties

V. Home work

	Home work	i. Tell them to bring the congruent figures which is given by the teacher ii. Tell them recognize congruent things in their home? iii. Tell them recognize the congruent things in the nature and bring them to school.

9.3. INQUIRING FOR PLANNING LESSON DESIGN (TRANSACTION OF LESSON SCERT MODEL)

Memorizing facts and information is not the most important skill in today's world. Facts change, and information is readily available .What's needed is an understanding of how to get and make sense of the Learning content. Educators must understand that schools need to go beyond information accumulation and move toward the generation of useful and applicable knowledge.

Inquiry based curriculum has been shown to develop independent critical thinking skills,

positive attitudes, curiosity toward science and Increased achievement in content.Inquiry is not so much seeking the right answer,but rather seeking appropriate resolutions to questions and issues.

9.3.1 FEATURES OF INQUIRY BASED LEARNING

- The inquiry approach is more focused on using and learning content as a means to develop information-processing and problem-solving skills.
- The system is more studentscantered.
- The teacher act as a facilitator of learning.
- More emphasis is given on "how students will come to know" and less on "what they know."?
- Inquiry strategies enhance learning based on increased student involvement in the process.
- Students are more involved in the construction of knowledge through active involvement.
- Students choose learning based on a topic (usually within a set range) that is of interest to them.
- Students are engaged by project learning
- It leads to active construction of meaningful knowledge rather than passive learning of facts.
- Provides opportunity for the construct in-depth knowledge of it.
- Learning becomes almost effortless.
- It fascinates students and reflects their interests and goals.
- Inquiry learning allows students to make some choices based on learning styles and multiple intelligences.

9.3.2 BENEFITS OF INQUIRY BASED LEARNING

- Students will learn collaboration skills, (needed in the 21 century) between students and also between students and teachers.
- Have the opportunity to use multiple learning styles and intelligences
- Use a constructivism approach where they are active participants in learning process rather than passively accepting information from the teacher become problem solvers rather than direction followers
- learning is process orientated rather than product orientated
- connect with real world problems and situations
- apply skills of different disciplines – math, language arts, social studies
- propose questions, explanations and predictions
- use tools to gather, analyze and interpret data gain useful knowledge about the natural and human-designed worlds.

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9.3.3 HOW DO YOU USE INQUIRY IN TEACHING?

Almost any topic can become the foundation for an inquiry-based project.

Following steps can be used in inquiry based teaching:

- Modifying an existing lesson plan to an Inquiry approach;

  E.g.:(Suppose you've decided triangles as a topic ask the students,what they would like to know abouttriangles and generate questions based on student interest.
- Have students help prioritize the questions to limit the scope of the inquiry.

  For integration, consider the questions identified and map the questions to other areas of study.

  E.g.: Properties of triangles,Sum of the angles in a triangle etc.

9.3.4 STEPS IN INQUIRY BASED LEARNING

2. Explore and make an observation:

- I am curious about
- It surprised me that
- I wonder how this concept affects another part of the concept …

3. Question:

- Meaningful questions are inspired by genuine curiosity.
- List questions that will help in investigation.

3. Investigate:

- Follow that curious impulse and start the investigation process.
- Come up with a plan to collect information that will help answer your question
- (What information is needed?
- How will information be collected? (Record sheet, drawings, photos, and video)
- How will information be organized to answer your question?)

4. Answer your questions.

5. Analyse:

- What does the information tell you?
- Can you answer your question with this information?
- What conclusions can you make?

6. **Reflect**: Take the time to look back at your question, the research you did, and the conclusions you made. Ask yourself the following questions,

- ❖ Did you learn what you thought you would?
- ❖ What surprising things did you learn?
- ❖ What new questions do you now have?
- ❖ What new information might you collect?

7. **Discuss and share:**

- ❖ How you will share what you learned with the rest of your class?
- ❖ What do they need to know to share in your experience?
- ❖ How will you present the information? (oral, video, or poster presentation, or a write-up)
- ❖ Is there a way that you can get feedback on your process?

9.3.5 TIPS FOR THE TEACHERS

1. **Demonstrate:**Start with an open-ended question or demonstration, as opposed to beginning a lesson with definitions and explanations.
2. **Conduct Experiment:**Gather responses and questions from students with little comment or direction, require students to collaborate on designing experiments or methods of inquiry. Have student teams conduct experiments or gather data.
3. **Re-evaluate:**Re-evaluate question based on new data and re-experiment or collect new data based on revised question, share learning's
4. **Pre-plan:**

- ❖ Before going to the student, determine any preliminary factors or characteristics that must be true in order to achieve your larger goals or plans.
- ❖ Consider factors such as scope, the amount of time you'll spend over how many sessions, relationships to other projects, topical focus, age appropriateness, and skills you want to use, resources, media and collaboration techniques.
- ❖ Make any decisions up front that you have to, but let your students decide as much as possible.

5. **Identify skills:**Identify skillsyou want your students to learn. Some basic skills used in inquiry learning include:

- ❖ collaborating,
- ❖ observing,
- ❖ classifying and sequencing,
- ❖ stating problems or questions,
- ❖ problem solving,
- ❖ designing experiments or investigations,
- ❖ data collection,
- ❖ analysis and interpretation of data,
- ❖ defining terms,
- ❖ creating a hypothesis,
- ❖ predicting,
- ❖ Inferring, and communicating.

6. **Brainstorm:**

- ❖ Assuming the widest range of possibilities, start a discussion in class to find out what the students are interested in.
- ❖ Ask some broad questions about their interests.
- ❖ Try some simple mapping activities to record the ideas they suggest
- ❖ begin winnowing them down to one or a few.
- ❖ Guide them toward achieving learning objectives and mastery of skills that they need.
- ❖ In most cases, you'll be better off having the whole class work on a single concept
- ❖ Break up into teams to work on particular questions, aspects or executions of that theme or idea.
- ❖ Just make sure that they feel ownership of the topic and truly care about it.

7. **Work in teams:**Avoid letting individuals work alone on totally unconnected projects. It's not that there's anything wrong with that, but the kids won't get the advantage of developing collaboration skills and you'll be spread awfully thin trying to help them all on such disjointed topics.
8. **Assessment:**Assess the student performance, focused on determining the progress of skills development in addition to content understanding.

Hence, Inquiry learning is concerned with in-school success, but it is equally concerned with preparation for life-long learning.

9.4 IDENTIFICATION AND ORGANIZATION OF CONCEPTS FOR TEACHING -LEARNING OF MATHEMATICS (ALGEBRA, GEOMETRY, TRIGONOMETRY, COORDINATE GEOMETRY, STATISTICS AND PROBABILITY)

9.4.1 NEEDS OF IDENTIFICATION AND ORGANIZATION OF CONCEPTS FOR TEACHING-LEARNING OF MATHEMATICS:

Identification and organization of concepts for teaching-learning of mathematics can be broadly divided into the following categories;

I. Conceptual Understanding
II. Procedural Knowledge
III. Problem Solving Skills and Strategies
IV. Problem Solving Skills and Strategies
V. Communication

I. Conceptual Understanding: Conceptual Understanding includes the ability to, interpret the problem;

- ❖ select appropriate information,
- ❖ apply a strategy for solution,
- ❖ making connections between the problem situation,
- ❖ relevant information,
- ❖ appropriate mathematical concepts and logical/reasonable responses.

Full Conceptual Understanding:

- ❖ The student uses all relevant information to solve the problem.
- ❖ The student's answer is consistent with the question/problem.
- ❖ The student is able to translate the problem into appropriate mathematical language.

Partial Conceptual Understanding:

- ❖ The student extracts the "essence" of the problem, but is unable to use this information to solve the problem.
- ❖ The student is only partially able to make connections between/among the concepts.
- ❖ The student's solution is not fully related to the question.

- ❖ The student understands one portion of the task, but not the complete task.

Lack of Conceptual Understanding:

- ❖ The student's solution is inconsistent or unrelated to the question.
- ❖ The student translates the problem into inappropriate mathematical concepts.
- ❖ The student uses incorrect procedures without understanding the concepts related to the task.

II. Procedural Knowledge

Procedural Knowledge deals with the student's ability to demonstrate appropriate use of concepts. Evidence includes the verifying and justifying of a procedure using concrete models, or the modifying of procedures to deal with factors inherent in the problem.

Full Use of Appropriate Procedures:

- ❖ The student uses principles efficiently while justifying the solution.
- ❖ The student uses appropriate mathematical terms and strategies.
- ❖ The student solves and verifies the problem.
- ❖ The student uses mathematical principles and language precisely.

Partial Use of Appropriate Procedures:

- ❖ The student is not precise in using mathematical terms, principles, or procedures.
- ❖ The student is unable to carry out a procedure completely.
- ❖ The process the student uses to verify the solution is incorrect.

Lack of Use of Appropriate Procedures:

- ❖ The student uses unsuitable methods or simple manipulation of data in his/her attempted solution;
- ❖ The student fails to eliminate unsuitable methods or solutions;
- ❖ The student misuses principles or translates the problem into inappropriate procedures;
- ❖ The student fails to verify the solution.

III. Problem Solving Skills and Strategies

- ❖ Problem Solving requires the use of many skills, often in certain combinations, before the problem is solved.
- ❖ Students demonstrate problem solving strategies with clearly focused, good reasoning that leads to a successful resolution of the problem.

Evidence of Thorough/Insightful Use of Skills/Strategies:

- The skills and strategies show some evidence of insightful thinking to explore the problem.
- The student's work is clear and focused.
- The skills/strategies are appropriate and demonstrate some insightful thinking.
- The student gives possible extensions or generalizations to the solution or the problem.

Evidence of Routine or Partial Use of Skills/Strategies:

- The skills and strategies have some focus, but clarity is limited.
- The student applies a strategy which is only partially useful.
- The student's strategy is not fully executed.
- The student starts the problem appropriately, but changes to an incorrect focus.
- The student recognizes the pattern or relationship, but expands it incorrectly.

Limited Evidence of Skills/Strategies:

- The skills and strategies lack a central focus and the details are sketchy or not present.
- The procedures are not recorded (i.e., only the solution is present).
- Strategies are random.
- The student does not fully explore the problem, looking for concepts, patterns or relationships.
- The student fails to see alternative solutions that the problem requires.

IV. Communication

In assessing the student's ability to communicate, particular attention should be paid to both the meanings he/she attaches to the concepts and procedures and also to his/her fluency in explaining, understanding, and evaluating the ideas expressed.

Complete Communication:

- The student gives a complete response with clear, coherent, unambiguous, and elegant explanations.
- The student communicates his/her thinking effectively to the audience.
- The details fit and make sense.
- One step flows to the next and shows organization.
- The student presents strong supporting arguments.

Partial or Incomplete Communication:

- The student's explanation is unclear, inconsistent or not complete.
- The student uses terminology incorrectly or inconsistently.
- The student's visual aids (graphs, tables, diagrams, etc.) are inappropriate or not directly related.
- The student's explanation centres on his/her solution, not on his/her thinking.

Limited or Lack of Communication:

- The student's explanation is not understandable or not present.
- The student either does not use or misuses appropriate mathematical terminology.
- The student does not use essential visual aids to enhance or clarify the explanation.
- The student's explanation lacks focus.

ALGEBRA

Algebra is a branch of mathematics dealing with symbols and the rules for manipulating those symbols. In elementary algebra, those symbols (today written as Latin and Greek letters) represent quantities without fixed values, known as variables. Just as sentences describe relationships between specific words, in algebra, equations describe relationships between variables. Take the following example:

I have two fields that total 1,800 square yards. Yields for each field are T! gallon of grain per square yard and ½ gallon per square yard. The first field gave 500 more gallons than the second. What are the areas of each field?

We can write this problem as;

$$x + y = 1{,}800 \quad \text{—— (1)}$$

$$\tfrac{2}{3}.x - \tfrac{1}{2}.y = 500 \quad \text{—— (2)}$$

The letters x and y represent the areas of the fields.

The first equation is understood simply as "adding the two areas gives a total area of 1,800 square yards." The second equation is more subtle.

Since x is the area of the first field, and the first field had a yield of two-thirds of a gallon per square yard, "$\tfrac{2}{3}.x$" — meaning "two-thirds times x" — represents the total amount of grain produced by the first

field. Similarly "½'"y" represents the total amount of grain produced by the second field. Since the first field gave 500 more gallons of grain than the second, the difference (hence, subtraction) between the first field's grain (T!'"x) and the second field's grain (½'"y) is (=) 500 gallons.

GEOMETRY

Geometry is a subject in mathematics that focuses on the study of shapes, sizes, relative configurations, and spatial properties. Derived from the Greek word meaning "earth measurement," geometry is one of the oldest sciences. It was first formally organized by the Greek mathematician Euclid around 300 BC when he arranged 465 geometric propositions into 13 books, titled 'Elements'. This, however, was not the first time geometry had been utilized. As a matter of fact, there exists evidence to believe that geometry dates all the way back to 3,000 BC in ancient Mesopotamia, Egypt!

Geometry has been the subject of countless developments. As a result, many types of geometry exist, including Euclidean geometry, non-Euclidean geometry, Riemannian geometry, algebraic geometry, and simplistic geometry.

This discussion primarily focuses on the properties of lines, points, and angles. We will also place emphasis on geometric measurements including lengths, areas, and volumes of various shapes. By the end of this section it won't be hard to see that geometry is all around us!

The History of Geometry

Geometry's origins go back to approximately 3,000 BC in ancient Egypt. Ancient Egyptians used an early stage of geometry in several ways, including the surveying of land, construction of pyramids, and astronomy. Around 2,900 BC, ancient Egyptians began using their knowledge to construct pyramids with four triangular faces and a square base.

Euclid's Elements

The next great advancement in geometry came from Euclid in 300 BC when he wrote a text titled 'Elements.' In this text, Euclid presented an ideal axiomatic form (now known as Euclidean geometry) in which propositions could be proven through a small set of statements that are accepted as true. In fact, Euclid was able to derive a great portion of planar geometry from just the first five postulates in 'Elements.' These postulates are listed below:

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(1) A straight line segment can be drawn joining any two points.

(2) A straight line segment can be drawn joining any two points.

(3) Given any straight line segment, a circle can be drawn having the segment as radius and one endpoint as center.

(4) All right angles are congruent.

(5) If two lines are drawn which intersect a third line in such a way that the sum of the inner angles on one side is less than two right angles, then the two lines inevitably must intersect each other on that side if extended infinitely.

Euclid's fifth postulate is also known as the parallel postulate.

René Descartes' Coordinate Geometry

The next tremendous advancement in the field of geometry occurred in the 17th century when René Descartes discovered coordinate geometry. Coordinates and equations could be used in this type of geometry in order to illustrate proofs. The creation of coordinate geometry opened the doors to the development of calculus and physics.

The Development of Non-Euclidean Geometry:

In the 19th century, Carl Friedrich Gauss, Nikolai Lobachevsky, and János Bolyai formally discovered non-Euclidean geometry. In this kind of geometry, four of Euclid's first five postulates remained consistent, but the idea that parallel lines do not meet did not stay true. This idea is a driving force behind elliptical geometry and hyperbolic geometry.

TRIGONOMETRY

Trigonometry is a branch of mathematics that studies relationships between the sides and angles of triangles. Trigonometry is found all throughout geometry, as every straight-sided shape may be broken into as a collection of triangles. Further still, trigonometry has astoundingly intricate relationships to other branches of mathematics, in particular complex numbers, infinite series, logarithms and calculus.

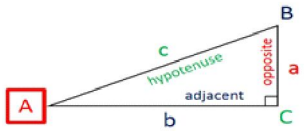
The word trigonometry is a 16th-century Latin derivative from the Greek words for triangle (*trigônon*) and measure (*metron*). Though the field emerged in Greece during the third century B.C., some of the most important contributions (such as the sine function) came from India in the fifth century A.D. Because early trigonometric works of Ancient Greece have been lost, it is not known whether Indian scholars developed trigonometry independently or after Greek influence.

An example: Height of a sailboat mast

Suppose you need to know the height of a sailboat mast, but are unable to climb it to measure. If the mast is perpendicular to the deck and top of the mast is rigged to the deck, then the mast, deck and rigging rope form a right triangle. If we know how far the rope is rigged from the mast, and the slant at which the rope meets the deck, then all we need to determine the mast's height is trigonometry.

Depending on what is known about various side lengths and angles of a right triangle, there are two other trigonometric functions that may be more useful: the "**sine** function" written as sin(x), and the "**cosine** function" written as cos(x). Before we explain those functions, some additional terminology is needed. Sides and angles that touch are described as **adjacent**. Every side has two adjacent angles. Sides and angles that don't touch are described as **opposite**. For a right triangle, the side opposite to the right angle is called the **hypotenuse** (from Greek for "stretching under"). The two remaining sides are called **legs**.

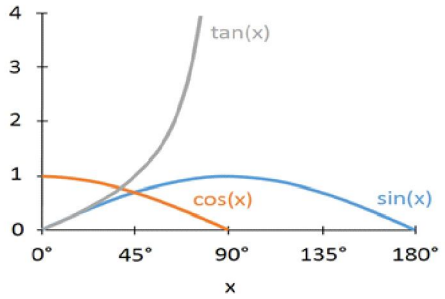
From our ship-mast example before, the relationship between an angle and its tangent can be determined from its graph, shown below. The graphs of sine and cosine are included as well.



$$\sin(A) = \frac{\text{opposite}}{\text{hypotenuse}} = \frac{a}{c}$$

$$\cos(A) = \frac{\text{adjacent}}{\text{hypotenuse}} = \frac{b}{c}$$

$$\tan(A) = \frac{\text{opposite}}{\text{adjacent}} = \frac{a}{b}$$



COORDINATE GEOMETRY

Coordinate geometry is one of the most important and exciting ideas of mathematics. In particular it is central to the mathematics students meet at school. It provides a connection between algebra and geometry through graphs of lines and curves. This enables geometric problems to be solved algebraically and provides geometric insights into algebra.

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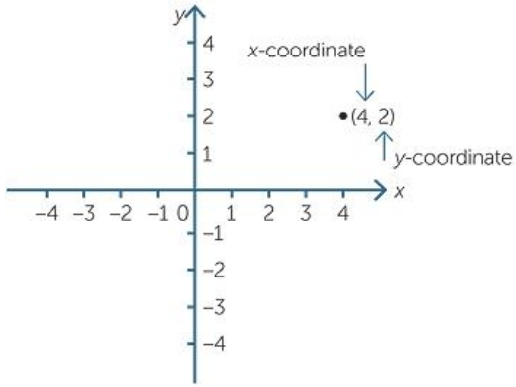
The invention of calculus was an extremely important development in mathematics that enabled mathematicians and physicists to model the real world in ways that was previously impossible. It brought together nearly all of algebra and geometry using the coordinate plane. The invention of calculus depended on the development of coordinate geometry.



STATISTICS

Statistics is a mathematical body of science that pertains to the collection, analysis, interpretation or explanation, and presentation of data, or as a branch of mathematics. Some consider statistics to be a distinct mathematical science rather than a branch of mathematics. While many scientific investigations make use of data, statistics is concerned with the use of data in the context of uncertainty and decision making in the face of uncertainty.

ven though you may not have realized it, you probably have made some statistical statements in your everyday conversation or thinking. Statements like "I sleep for about eight hours per night on average" and "You are more likely to pass the exam if you start preparing earlier" are actually statistical in nature.

Statistics is a discipline which is concerned with:

- designing experiments and other data collection,
- summarizing information to aid understanding,
- drawing conclusions from data, and
- estimating the present or predicting the future.

The two statements at the beginning illustrate some of these points.

In making predictions, Statistics uses the companion subject of Probability, which models chance mathematically and enables calculations of chance in complicated cases.

Today, statistics has become an important tool in the work of many academic disciplines such as medicine, psychology, education, sociology, engineering and physics, just to name a few. Statistics is also important in many aspects of society such as business, industry and government. Because of the increasing use of statistics in so many areas of our lives, it has become very desirable to understand and practice statistical thinking. This is important even if you do not use statistical methods directly.

PROBABILITY

Probability is a branch of mathematics that deals with calculating the likelihood of a given event's occurrence, which is expressed as a number between 1 and 0. An event with a probability of 1 can be considered a certainty: for example, the probability of a coin toss resulting in either "heads" or "tails" is 1, because there are no other options, assuming the coin lands flat. An event with a probability of .5 can be considered to have equal odds of occurring or not occurring: for example, the probability of a coin toss resulting in "heads" is .5, because the toss is equally as likely to result in "tails." An event with a probability of 0 can be considered impossibility: for example, the probability that the coin will land (flat) without either side facing up is 0, because either "heads" or "tails" must be facing up. A little paradoxical, probability theory applies precise calculations to quantify uncertain measures of random events.

In its simplest form, probability can be expressed mathematically as: the number of occurrences of a targeted event divided by the number of occurrences *plus* the number of failures of occurrences (this adds up to the total of possible outcomes):

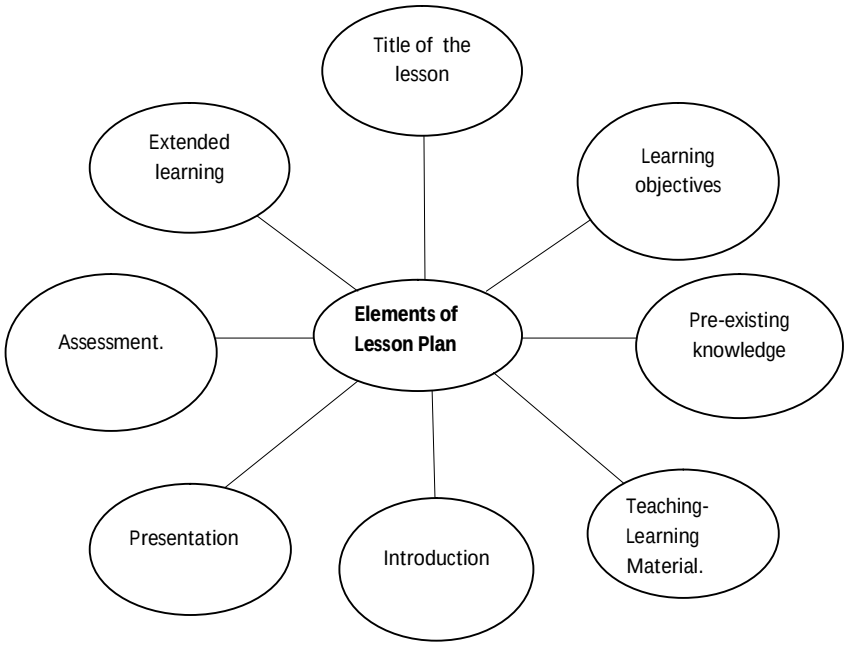
$$p(a) = p(a)/[p(a) + p(b)]$$

Calculating probabilities in a situation like a coin toss is straightforward, because the outcomes are mutually exclusive: either one event or the other must occur. Each coin toss is an *independent* event; the outcome of one trial has no effect on subsequent ones. No matter how many consecutive times one side lands facing up, the probability that it will do so at the next toss is always .5 (50-50). The mistaken idea that a number of consecutive results (six "heads" for example) makes it more likely that the next toss will result in a "tails" is known as the *gambler's fallacy* , one that has led to the downfall of many a bettor. Probability theory had its start in the 17th century, when two French mathematicians, Blaise Pascal and Pierre de Fermat carried on a

correspondence discussing mathematical problems dealing with games of chance. Contemporary applications of probability theory run the gamut of human inquiry, and include aspects of computer programming, astrophysics, music, weather prediction, and medicine.

9.5. ELEMENTS OF A MATHEMATICS LESSON

There are certain basic elements of lesson plan which can help in planning.



9.5.1. LEARNING OBJECTIVES AND KEY CONCEPTS

Letting clear objectives that enhance students' learning:

A clear and learning objective (or a set of objectives) is essential for effective mathematics teaching. By definition, learning means change in students' understanding.

Learning objectives must focused on the following:

- ❖ It should be based on what students will understand that they did not understand before the lesson.

- It should be about specific mathematics, stated small enough to be achieved within a single lesson.
- It should be focused on students understanding.
- It should provide direction to the teacher to choose the instructional resources.
- It should be connected to student's prior-knowledge.

For example, let us consider the following objective statement:

- "Students will be able to find the area of an L-shape using their prior knowledge of how to calculate the area of rectangles and squares."

This statement is about a specific mathematics topic, the area of compound figures.

The statement also makes connections to students' prior learning. What is not clear in this statement is what students will understand when they can calculate the area of L-shape using their prior knowledge.

Something like the following would be more complete:

- "Students will understand that they can find the area of an unfamiliar shape by changing the shape into familiar ones."

One might want to include also some specific, but generalizable strategies:

- "Students will understand that the area of a compound shape may be calculated by (1) sub-dividing the given shape into a collection of familiar shapes, or (2) cutting and re-arranging the given shape to change it into a familiar shape."

A clear learning objective sets the tone of lesson planning and implementation. The learning objective will guide your selection of the learning task and how you will assess students understanding throughout the lesson. It will also guide you as you consider other ideas that are discussed.

List of the General objectives of Mathematics Lesson Plan Objective:

- An objective is focussed on what we want students to learn;
- It should tell us what students should know or be able to do at the end of the lesson that they couldn't do before.
- It is not the name of a chapter or topic
- An objective should be:
- Observable

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- Measurable
- Student Focused

Verbs for framing objectives

SWBAT + Verb + Outcome

Goal	Knowledge	Understand	Apply	Analyse	Create	Evaluate
Verbs	Arrange Define Describe Identify Label List Match Name Order Outline Recognise Recall Repeat State	Categorize Classify Compare Describe Distinguish Discuss Explain Express Identify Infer Locate Match Paraphrase Predict Summarize Select	Apply Change Choose Demonstrate Dramatize Illustrate Interpret Modify Practice Predict Show Solve Write	Analyse Calculate Compare Contrast Differentiate Distinguish Identify Illustrate Infer Model Outline	Distinguish Select Arrange Categorize Compose Create Design Develop Prepare Plan Rearrange Revise Summarize Tell Write	Compare Conclude Contrast Describe Evaluate Estimate Explain Predict Select Summarize

9.5.2. PRE-EXISTING KNOWLEDGE

Mathematics is a body of well-connected ideas. The specific mathematics you are teaching, therefore, is connected to many different ideas. Each new mathematical idea must be built upon prior knowledge and will in turn lead to other mathematical ideas. Linking the lesson content to the curriculum, the unit, prior lessons, and future lessons is essential when planning to teach a new topic.

When planning to teach a new topic, you need to, examine the broader mathematical story line;

- identify the particular role this specific topic plays in the story.
- Questions to ask are,
- "What have my students studied previously that is related to this topic?"
- "What will my students study in the future that will build upon this topic?"
- understand why a particular topic may be positioned at this particular point in the curriculum.

For example, let us consider the topic of finding the area of compound figures. This topic is often included after students have learned how to calculate the area of rectangles and squares, but before they explore the

area of parallelograms, triangles, and other shapes. So, is this topic simply "applications" where students can use their newly learned knowledge of calculating the area of rectangles and squares.

There are multiple ways to find the area of compound figures. One can sub-divide the given shape into,

- A collection of shapes for which one already knows how to calculate the area
- One can dissect the given figure and re-arrange the pieces to create a familiar shape.
- The first method draws on the idea that the area of a figure is equal to the sum of the areas of its parts.
- The second method draws on the related idea that cutting and rearranging pieces of a figure does not change the area. These same ideas can and should be the foundation for approaching the area of parallelograms, triangles, and other shapes.
- By making sure students understand these ideas, the topic of area of compound figures can serve as a bridge to the future topics of areas of other shapes.

In general, then, planning a lesson necessarily involves consideration of how the ideas in it connect to previous and future ideas.

9.5.3 TEACHING-LEARNING MATERIALS AND INVOLVING LEARNERS IN ARRANGING THEM

Using learning aids for all the students to access the tasks. Access to necessary materials and technologyhelps the teacher to facilitate student's problem solving activities, various learning aids may be useful. These aids include, are certainly not limited to, manipulative, measuring instruments, graph paper, calculators, and computers. In deciding which aids to provide, it is important to consider how they would influence student thinking, against the goals of the lesson.

Some may only understand when showing the picture or displays or tables related content, those learners are called visual learner, and some may understand only when they perform, those learners are called kinaesthetic learners. A teacher need to attract and create interest among the students, prepare the teaching learning material in such way that to attract all the organs of the body, because the sense organs are the gateways of knowledge.

Hence, for effective teaching-learning, a teacher needs to prepare an appropriate teaching-learning aid which caters the need of learners relating to the content.

9.5.4 INTRODUCTION

The main purpose of introduction is to motivate and prepare the students to learn the topic by relating their existing knowledge with the new knowledge. Besides motivation, other purposes of introduction may be to:

- Test previous knowledge
- Establish continuity of lesson
- Present brief outline of the lesson
- Highlight the importance of the lesson
- Clarify the objectives of the lesson
- Raise curiosity among the students and
- Create interest among the students.

9.5.5 PRESENTATION/DEVELOPMENT

a. Providing meaningful tasks or problems

- The problem or task you will provide in the lesson must help students develop the goal understanding;
- It should also capture students' attention;
- setting up the problem/task in the context that is meaningful to students is very important;
- capture students attention so that they generate their own questions;
- teachers must select problems/tasks carefully so that students' own questions are indeed productive ones for moving them closer to the learning goals;
- Paying attention to students' sense of curiosity and surprise may be helpful.

b. Anticipating and planning for students' difficulties

When students are learning mathematics, they encounter many challenges. Identifying possible challenges is an important part of good lesson planning. Research has identified many common errors and misconceptions students make. Besides those common errors and misconceptions, some students may have difficulty understanding a particular problem/task.

c. Anticipating students' responses that include misunderstandings/ misconceptions.

Anticipating how your students will solve the given problem/task is important not only for ensuring that the problem/task is accessible to all students, but also to help teachers develop a plan (or a set of multiple plans) to orchestrate the classroom discourse to guide the class discussion for level-raising.

Japanese teachers call this process *neriage* (need a link to the glossary). By carefully sequencing how students' ideas are shared and discussed, teachers can orchestrate the classroom discourse to guide students to the goal understanding.

- ❖ Although the problem/task selected for the lesson leads students to new understanding, it must be also accessible to all students with their current understanding.
- ❖ The problem/task should have multiple entry points and multiple solution paths.
- ❖ It is essential that teachers actually solve the problem/task they are considering for the lesson themselves - perhaps trying to solve it in as many different ways as possible, using only what students currently understand.

9.5.5. ASSESSMENT: ACCEPTABLE EVIDENCES THAT SHOW LEARNERS UNDERSTAND

Determining learning evidences-Measuring students learning

As assessment becomes an integral part of instruction, teachers must think about how to assess their students understanding throughout the lesson. So, as teachers carefully consider what the learning objective of a lesson is going to be, they also consider how they would know if students have developed the target understanding.Clearly, the results of an assessment question (or a set of assessment questions) toward the end of the lesson will influence not only the planning for the next lesson but also how the lesson will be analysed and revised. Following check list may help the teacher to know the learning evidence of the learners,

- ❖ Evidence of doing purposeful mathematics, including where appropriate, investigating, experimenting, modelling, designing, interpreting, analysing, or solving.

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- ❖ Evidence of mathematical thinking that includes, where appropriate, making comparisons, conjectures, interpretations, predictions, or generalizations.
- ❖ Good understanding of the mathematical concepts and processes.
- ❖ Identification of most, if not all, of the important elements of the concept.
- ❖ Clear, successful communications with an identified audience.
- ❖ One solution and interpretation of those results.
- ❖ Use of variety of tools and techniques appropriate to the form of the concept and the requirements of the task

Teachers may want to carefully articulate what it means to have the goal understanding.

How will the students problem solving be different if they do or do not yet have the goal understanding? Teachers may also think about when to ask those questions to monitor and advance students thinking processes. The results from an assessment question may play a role in how students may be organized during the lesson. The following two questions may provide a useful framework to think about the assessment questions:

- ❖ What specific mathematics does this question involve?
- ❖ How does the question get at students understanding of the specific mathematics?
- ❖ How will the response by those with the desired understanding be different from those who have yet to develop the goal understanding?

Planning of the acceptable evidences of learning for assessment; Extended learning/assignment

Quality lessons intertwine assessment and instruction

As we plan, implement, analyze, and revise mathematics lessons focusing on student'smathematical proficiency, assessment plays a critical role before, during, and after each lesson. National Council of Teachers of Mathematics recommends that assessment should be more than merely a test at the end of instruction to see how students perform under special conditions; rather, it should be an integral part of instruction that informs and guides teachers as they make instructional decisions. Assessment should not merely be done to students; rather, it should also be done for students, to guide and enhance their learning. (NCTM, 2000)

As teachers plan a lesson, they must use their assessment of their students' current understanding. When a learning task is posed in a lesson,

teachers must assess how well students understand the task. As students engage in the learning task, teachers must assess how students are approaching the task, perhaps comparing to anticipated solutions. As the whole class discusses various ideas proposed by students, teachers must constantly assess how well students are understanding and what questions might provide the necessary scaffolding for students to raise the level of their understanding.

As the lesson concludes, teachers must devise a way to assess student's understanding, which, in turn, will inform what needs to take place in the next day's lesson. As teachers analyze a lesson, they must consider carefully what students come to understand in the lesson and what factors may have contributed to students' learning (or lack thereof). Lessons can only be revised effectively based on the analysis of assessment results. As you can see, when assessment becomes an integral part of instruction, planning, implementing, analyzing, and revising mathematics lessons cannot be separated from planning, implementing, analyzing and revising assessment.

9.6 MAKING GROUPS

9.6.1. WHY GROUP LEARNING?

Group work can be an effective method to motivate students, encourage active learning, and develop key critical-thinking, communication, and decision-making skills. But without careful planning and facilitation, group work can frustrate students and instructors and feel like waste of time. Use the class suggestions to help implement your classroom.

9.6.2. FACILITATING FORMATION OF GROUPS

A. Preparing for small group work

1. Think carefully about how students will be physically arranged in groups based on following questions –

❖ Will it be easy for groups to form and for all students to be comfortable?

❖ How the layout of your classroom will impact?

❖ Will students really be able to hear one another clearly?

❖ How can you moderate the activity to control volume?

2. Insist on professional, civil conduct between and among students to respect people's differences and create an inclusive environment.
3. Talk to students about their past experiences with group work.
4. Allow them to establish some ground rules for successful collaboration.

   This discussion can be successfully done anonymously through the use of note cards.

B. Designing the small group activity

1. Identify the instructional objectives:

❖ Determine what you want to achieve through the small group activities, both academically (e.g., knowledge of a topic) and socially (e.g., listening skills).

❖ The activity should relate closely to the course objectives and class content and must be designed to help students learn, not simply to occupy their time.

❖ When deciding whether or not to use group work for a specific task, consider these questions:

❖ What is the objective of the activity?

❖ How will that objective be furthered by asking students to work in groups?

❖ Is the activity challenging or complex enough that it requires group work?

❖ Will the project require true collaboration?

❖ Is there any reason why the assignment should not be collaborative?

2. Make the task challenging:

❖ Consider giving a relatively easy task early in the term to arouse students' interest in group work and encourage their progress.

❖ Assign group tasks that encourage involvement, interdependence, and a fair division of labour.

❖ All group members should feel a sense of personal responsibility for the success of their team mates and realize that their individual success depends on the group's success.

3. Allocate essential resources across the group:

❖ Group members are required to share information (e.g., "Jigsaw" method) or to come up with a consensus;

❖ Randomly select one person to speak for the group;

- ❖ assign different roles to the group members so that they are all involved in the process (e.g., recorder, spokesperson, summarizer, checker, skeptic, organizer, observer, timekeeper, conflict resolver, liaison to other groups);
- ❖ strategy for promoting interdependence is specifying common rewards for the group, such as a group mark.

4. Decide on group size:

- ❖ the size you choose will depend on the number of students, the size of the classroom, the variety of voices needed within a group, and the task assigned.
- ❖ Groups of 4-5 tend to balance well the needs for diversity, productivity, active participation, and cohesion.
- ❖ The less skillful the group members, the smaller the groups should be.

5. Decide how you will divide students into groups:

- ❖ Division based on proximity or student's choice is quickest, especially for large and cramped classes;
- ❖ To vary group composition and increase diversity within groups, randomly assign students to groups by counting off and grouping them according to number; or have them line up according to birthday, height,roll no. etc., before dividing them.
- ❖ Collect a data card from each student on the first day of class to glean important information about their backgrounds, knowledge, and interests.
- ❖ ask students to express a preference (e.g., list three students with whom they would most like to work or two topics they would most like to study), and keep their preferences in mind as you assign groups.

6. Allow sufficient time for group work:

- ❖ Recognize that you will not be able to cover as much material as you could if you lectured for the whole class period;
- ❖ Cut back on the content you wish to present in order to give groups time to work. Estimate the amount of time that subgroups need to complete the activity;
- ❖ Plan for a plenary session in which group's results can be presented or general issues and questions can be discussed.

7. Try to predict student's answers:

- ❖ Expect the unexpected—be better prepared to answer their questions
- ❖ tie together the group work during the plenary session.

8. Design collaborative work in multiple constellations and forms:

- ❖ Pairs, small groups, large groups, online synchronously, online asynchronously, etc. Some students might be better at contributing after they have had time to digest material, while others might be better at thinking on the spot;
- ❖ Students will defer to others in large groups but actively contribute in pairs;
- ❖ All roles should be valued and included.

c. Introducing the group activity

1. Demonstrate you are prepared for the group session:

Arrive punctually, have a handout prepared that relates specifically to the task, and carry through on tasks that you promised to do when you last used group work in the classroom.

2. Share your rationale for using group work:

- ❖ Students must understand the benefits of collaborative learning.
- ❖ Don't assume that students know what the pedagogical purpose.
- ❖ Explicitly connect these activities to larger class themes and learning outcomes whenever possible.

If they do not see the value of the group activity, they might conclude that you are using group work merely to get out of course preparation or lecturing.

3. Have students form groups before you give them instructions:

If you try to give instructions first, students may be too preoccupied with deciding on group membership to listen to you. Or, by the time they have determined their groups, they may have forgotten what they are supposed to do.

4. Facilitate some form of group cohesion:

- ❖ Students work best together if they know or trust each other, at least to some extent.
- ❖ Even for brief group activities, have students introduce themselves to their group members before attending to their task.
- ❖ For longer periods of group work, consider introducing an ice breaker or an activity designed specifically to build a sense of teamwork.

5. Explain the task clearly:

- ❖ This means both telling students exactly what they have to do and describing what the final product of their group work will look like.

- ❖ Explaining the big picture or final goal is important, especially when the group work will take place in steps (such as in snowballing or jigsaw).
- ❖ Using visual structures like charts and sequential diagrams is often helpful, as is the use of sentence starters and specific questions.
- ❖ Remember to include time estimations for the activities. Estimate on the low side; students will work most efficiently as the deadline approaches.
- ❖ If necessary, you can increase the time available.

6. Prepare written instructions for the students:

Either post the instructions on an overhead or PowerPoint slide or, if some of the groups will leave the room, distribute a handout.

7. Set ground rules for group interaction:

Especially for extended periods of group work, establish how group members should interact with one another, mentioning principles such as respect, active listening, and methods for decision making.

8. Let students ask questions:

- ❖ Even if you believe your instructions are crystal-clear, students may very well have legitimate questions about the activity.
- ❖ Give them time to ask questions before they get to work.

D. Monitoring the group task

1. Monitor the groups but do not hover:

- ❖ As students do their work, circulate among the groups and answer any questions raised. Also listen for trends that are emerging from the discussions, so that you can refer to them during the subsequent plenary discussion.
- ❖ be unobtrusive and avoid interfering with group functioning;
- ❖ allow time for students to solve their own problems before getting involved.
- ❖ Even consider leaving the room for a short period of time, because your absence can increase students' willingness to share uncertainties and disagreements.

2. Expect a lot of your students:

- ❖ Assume that they do know, and can do, a great deal.
- ❖ Express your confidence in them as you circulate the room.

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3. Be slow to share what you know:

- ❖ If you come upon a group that is experiencing uncertainty or disagreement, avoid the natural tendency to give the answers or resolve the disagreement.
- ❖ The learning that is accomplished through group work might be slower, but it is generally harder won and thus better.
- ❖ If necessary, clarify your instructions, but let students struggle—within reason—to accomplish the task.

4. Clarify your role as facilitator:

If students criticize you for not contributing enough to their work, consider whether you have communicated clearly enough your role as facilitator.

E. Ending the group task

1. Provide closure to the group activities:

Group work can succeed or fail based on how you incorporate it into the rest of the class and the course. Students need to see how their work in small groups was useful to them and/or contributed to the development of the topic. Thus, end with a plenary session in which students do group reporting:

How group reporting is done "can make the difference between students' feeling that they are just going through their paces and the sense that they are engaged in a powerful exchange of ideas".

Oral reports:

- ❖ Have each group give one idea and rotate through the groups until no new ideas arise.
- ❖ have each group give their most surprising or illuminating insights or their most challenging question.
- ❖ record the ideas raised to validate their value, but limit yourself to key words.

Written reports:

- ❖ Have each group record their ideas on a transparency and either present them yourself or have a group member do so;
- ❖ have groups record their conclusions on a section of the blackboard or on newsprint that is then posted on the wall;
- ❖ Let students circulate around the room and read each other's answers;

- ❖ ask students to move around the room in small groups, rotating from one set of comments to another. As they rotate, they keep up a discussion, treating the comments written on the newsprint or blackboard as a new voice in their discussion;
- ❖ Students can add their own comments in response. have students write brief comments on Post-it notes or index cards;
- ❖ Collect them, take a few minutes to process them or put them in sequence, then summarize their contents.

2. Model how you want students to participate:

- ❖ When responding to students' answers, model the respect and sensitivity that you want the students to display towards their classmates;
- ❖ Readily acknowledge and value opinions different from your own;
- ❖ Don't favour clones! Be willing to share own stories, critique work, and summarize what has been said.

3. Connect the ideas raised to course content and objectives:

- ❖ Recognize that groups might not come up with the ideas you intended them to, so be willing to make your lecture plans flexible.
- ❖ Wherever possible, look for a connection between group conclusions and the course topic.
- ❖ Be aware that misconceptions or inaccurate responses need to be clarified and corrected either by you or by other students.

4. Avoid impromptu lectures:

They interrupt the flow of the conversation during the plenary session and, because they are not prepared, tend to be relatively poor lectures.

5. Don't provide too much closure:

Although the plenary session should wrap up the group work, feel free to leave some questions unanswered for further research or for the next class period. This openness reflects the nature of knowledge.

6. Ask students to reflect on the group work process:

They may do so either orally or in writing. This reflection helps them discover what they learned and how they functioned in the group. It also gives you a sense of their response to group work.

7. A final thought:

- ❖ Successful group work requires not only careful preparation and facilitation but also regular reflection and reassessment afterward.

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- ❖ After a class of small group activities, reflect on the group work process and refer back to the notes you made before class.
- ❖ Add comments about what worked especially well and what you would change in the future to make the exercise run more smoothly.
- ❖ Discuss your use of group work with other instructors, and ask for their suggestions.
- ❖ If you feel that your facilitation skills are weak, work to strengthen them.

9.7. PLANNING AND ORGANIZING ACTIVITIES IN MATHEMATICS

1. Plan and provide a balanced experience that incorporates the exploration, acquisition, consolidation and application of knowledge and skills, with opportunities to use, extend and test ideas, thinking and reasoning.
2. Share the excitement of learning mathematics and capture children's imagination by showing them the unusual or unexpected; give children examples of numbers or shapes that have special or surprising properties; show children how mathematics can be used creatively to represent, measure, predict and extrapolate to other situations.
3. Model for children how to explore mathematics and look for patterns, rules and properties; direct and steer children's learning by providing examples that enable them to observe and identify the rules and laws and deduce for themselves when they apply; help children to describe, replicate and use patterns and properties; ensure that they meet both general applications of rules and regulations.
4. Give children opportunity to consolidate their learning; introduce frequent and regular periods of practice that are short, sharp and focused on children securing, with the necessary accuracy and precision, the mathematical knowledge, understanding and skills they have learned; ensure that they recognise how their learning builds on previous learning and help them to see connections; ensure that they feel appropriately supported and challenged by the work they are set.
5. Demonstrate and promote the correct use of mathematical vocabulary and the interpretation and use of symbols, images, diagrams and models as tools to support thinking, problem solving, reasoning and communication.

6. Teach children how to evaluate solutions and analyse methods, deciding if they are appropriate and successful; help children to understand why some methods are more efficient than others; provide opportunities to compare and measure objects and identify the extent to which shapes and calculations are similar or different; develop children's understanding and language of equivalence and deduction to support reasoning and explanation.
7. Teach children how to evaluate solutions and analyse methods, deciding if they are appropriate and successful; help children to understand why some methods are more efficient than others; provide opportunities to compare and measure objects and identify the extent to which shapes and calculations are similar or different; develop children's understanding and language of equivalence and deduction to support reasoning and explanation.
8. Provide children with the well-directed opportunity to use and apply what they have learned to solve routine and non-routine problems; highlight any properties or patterns they identify or create and make connections to other work they have done; draw on their ideas and model approaches and strategies children can use to support a line of enquiry or to interpret or explain their results and methods, using their own approaches and strategies.
9. Periodically identify the knowledge, skills and understanding children acquire; pause and take stock to review children's learning with them; highlight the strategies and processes upon which they are able to draw; provide opportunities that allow children to make connections and show how ideas in mathematics relate, and how their learning can be applied to new aspects of mathematics.
10. Model with children how they identify, manage and review their own learning; highlight the learning skills they have acquired and used and draw out how these might be applied across the curriculum.

9.8. PLANNING LABORATORY WORK

What is a Mathematics Laboratory?

Mathematics Laboratory is a place where students can learn and explore mathematical concepts and verify mathematical facts and theorems through a variety of activities using different materials. These activities may be carried out by the teacher or the students to explore, to learn, to stimulate interest and develop favourable attitude towards mathematics.

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9.8.1NEED AND PURPOSE OF MATHEMATICS LABORATORY

Some of the ways in which a Mathematics Laboratory can contribute to the learning of the subject are:

- ❖ It provides an opportunity to students to understand and internalize the basic mathematical concepts through concrete objects and situations.
- ❖ It enables the students to verify or discover several geometrical properties and facts using models or by paper cutting and folding techniques.
- ❖ It helps the students to build interest and confidence in learning the subject.
- ❖ The laboratory provides opportunity to exhibit the relatedness of mathematical concepts with everyday life.
- ❖ It provides greater scope for individual participation in the process of learning and becoming autonomous learners.
- ❖ It provides scope for greater involvement of both the mind and the hand which facilities cognition.
- ❖ The laboratory allows and encourages the students to think, discuss with each other and the teacher and assimilate the concepts in a more effective manner.
- ❖ It enables the teacher to demonstrate, explain and reinforce abstract mathematical ideas by using concrete objects, models, charts, graphs, pictures, posters, etc.

1. Design and general layout

A suggested design and general layout of laboratory which can accommodate about 32 students at a time is given here. The design is only a suggestion. The schools may change the design and general layout to suit their own requirements.

2. Physical infrastructure and materials

It is envisaged that every school will have a Mathematics Laboratory with a general design and layout as indicated with suitable change, if desired, to meet its own requirements. The minimum materials required to be kept in the laboratory may include furniture, all essential equipment, raw materials and other necessary things to carry out the activities included in the document effectively. The quantity of different materials may vary from one school to another depending upon the size of the group.

3. Human Resources

It is desirable that a person with minimum qualification of graduation (with mathematics as one of the subjects) and professional qualification of Bachelor in Education be made incharge of the Mathematics Laboratory. He/she is expected to have special skills and interest to carry out practical work in the subject. The concerned mathematics teacher will accompany the class to the laboratory and the two will jointly conduct the desired activities. A laboratory 5 attendant or laboratory assistant with suitable qualification and desired knowledge in the subject can be an added advantage.

4. Time Allocation for activities

It is desirable that about 15% - 20% of the total available time for mathematics be devoted to activities. Proper allocation of periods for laboratory activities may be made in the time table. The total available time may be divided judiciously between theory classes and practical work.

9.8.2 STATE COMMITMENTS IN ORGANIZING LABORATORY WORK

Taking into consideration the national aspirations and expectations reflected in the recommendations of the National Curriculum Framework developed by NCERT, the Central Board of Secondary Education had initiated a number of steps to make teaching and learning of mathematics at school stage activity-based and experimentation oriented. In addition to issuing directions to its affiliated schools to take necessary action in this regard, a document on 'Mathematics Laboratory in Schools – towards joyful learning' was brought out by the Board and made available to all the schools. The document primarily aimed at sensitizing the schools and teachers to the concept of Mathematics Laboratory and creating awareness among schools as to how the introduction of Mathematics Laboratory will help in enhancing teaching – learning process in the subject from the very beginning of school education. The document also included a number of suggested hands-on activities.

With the objective of strengthening the concept further, the Board brought out another document 'Guidelines for Mathematics Laboratory in Schools – Class IX' in the year 2005. The document aimed at providing detailed guidelines to schools with regard to the general layout, physical infrastructure, material and human resources, etc. for a Mathematics

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Laboratory. Besides, the document included a list of hands-on activities and projects, detailed procedure to be followed for carrying out these activities and the scheme of evaluation. In the meantime, the Board had issued two circulars to all its schools with regard to establishing Mathematics Laboratory and introduction of the scheme of internal assessment in the subject. Circular number 10 dated March 2, 2005 clarified that the internal assessment of 20% is to be given on the basis of performance of an individual in activity work, project work and continuous assessment. The schools were also informed through the same circular that the scheme would be effective for Class IX from the academic session 2005-2006 and for Class X from the academic session starting April 2006 i.e. from March, 2007 Examination.

9.8.3. TEXTBOOK ORIENTATION

A topic discussed in the classroom to plan what kind of laboratory work can be carried out for its transaction. Students should be involved in the work of identifying, selecting and arranging for the materials required for performing various kinds of laboratory work. Textbook orientation is nothing but, a practical form of the theoretical concept of the textbook discussed in the classroom.

The learning experiences in the laboratory should provide some challenge to the students to learn. They get interested if they understand the purpose of the experiment and are made to realise the application of it to their everyday life.

Students can be involved in planning and organising various works of laboratory. Following guidelines for planning and organising experiments in mathematics may be considered.

- ❖ It should be ensured that students have a sound theoretical knowledge required for handling the apparatus and performing the experimental work. For this, theory and practical teaching learning situations should be properly integrated and coordinated.
- ❖ Students should come prepared for the laboratory work. They should be encouraged to refer laboratory manual and other supplementary materials. They should be facilitated to find answers to their own questions.
- ❖ Enough apparatus should be set up to provide opportunity to all learners on hands-on-activities. It should be checked that the apparatus are in proper working conditions.

- A notice board to display safety rules of the laboratory, time-table, list of experiments, group patterns, etc. can be maintained and kept up to date.
- Good discipline is necessary for smooth functioning of the laboratory work.
- Maintaining all possible standards of safety in the laboratory.
- Inculcating safety conscious attitude in students is important.
- First-aid box must be kept ready and timely replenishment of medicines must be ensured.
- Remember that safety of the students and teachers is more important than the safety of the apparatus.
- During the laboratory work, extensive and critical discussion on the theoretical aspects of the experiments with the students and continuous assessment of their performance are of utmost importance. This helps the teacher to know their misconceptions and naïve concepts which teachers can facilitate them in construction and re-construction of their knowledge.

9.9. PLANNING ICT APPLICATIONS IN TEACHING LEARNING OF MATHEMATICS

Though teachers know the general advantages of ICT use, many mathematics teachers are unaware of the potential of specific software and tools. It is observed that very little use of appropriate ICT tools is made in mathematics teaching in our schools. ***Reasons for this may include:***

- lack of support and/or training,
- lack of funding to mathematics departments,
- skepticism about benefits of using ICT and
- lack of knowledge of appropriate resources available. Good teaching using ICT begins with clarity of purpose in its use. Most often this comes with experience, and through thoughtful planning and collaboration between teachers integrating ICT into a scheme of work. Less successful use of ICT in core subject teaching typically stems from weak links between the computer task and the lesson objectives

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9.9.1 USE OF ICT IN TEACHING LEARNING PROCESS

A. ICT has the potential to make a significant contribution to pupil's learning in mathematics by helping them to:

a. Practice and consolidate learning skills by using software to revise and give rapid assessment feedback.

b. develop skills of mathematical modelling through exploration, interpretation and explanation of data, by choosing appropriate graphical representations for displaying information from a data-set; by experimenting with forms of equations in trying to produce graphs which are good fits for data-plots; by using a motion sensor to produce distance time graphs corresponding to pupils own movements.

c. experiment with, make hypothesis from, and discuss or explain relationships and behavior in shape and space, and their links with algebra, by using software to

· automate geometric construction

· carry out specified geometric transformations

· perform operations on coordinates or draw loci.

d. develop logical thinking and modify strategies and assumptions through immediate feedback by planning a procedure as a sequence of instructions in a programming language or a sequence of geometrical constructions in November 2012 geometry software or a set of manipulations in a spreadsheet.

e. Make connections within and across the areas of mathematics, for example, to relate a symbolic function, a set of values computed from it, and a graph generated by it to a mathematical or physical situation, such as the pressure and volume of a gas, which it models.

f. Work with realistic and large sets of data.
For example, carrying out experiments using large random samples generated through simulations. explore, describe and explain patterns and relationships in sequences and tables of numbers, by entering a formula in algebraic notation to generate values in an attempt to match a given set of numbers.

g. learn and memorize by manipulating graphic images.
For example, the way the graph of a function such as $y= x^2$ is transformed by the addition or multiplication by a constant.

B. ICT also has the potential to offer valuable support to the mathematics teachers by:

a. Helping them to prepare teaching materials. For example, downloading materials for classroom use from the Internet, such as mathematics problems for pupils to solve with accompanying teachers' notes, software for computers and reviews of published resources.

b. Providing a flexible and time-saving resource that can be used in different ways and at different times without repetition of the teachers' input by enlarging fonts, adding diagrams or illustrations, adapting parameters used in problems.

c. providing a means by which subject and pedagogic knowledge can be improved and kept up-to-date by accessing the virtual teacher center to obtain practical advice, to exchange ideas with peers and 'experts' outside school.

d. Aiding record-keeping and reporting by storing and regularly updating formative records which can form the basis of a subsequent report.

9.9.2ICT TOOLS IN MATHEMATICS TEACHING-LEARNING

In India development in ICT has been very rapid, and in general, the costs have fallen considerably. As a result it is now the case that many homes contain more powerful ICT resources than are currently available to many teachers of mathematics in schools and colleges. Many common ICT tools have been developed for personal use, and their deployment in a teaching environment requires careful consideration. Observations consistently show stray instances of use of appropriate ICT tools in mathematics teaching at various levels.

Reasons for this may include:

- ❖ lack of ICT capability
- ❖ lack of support and/or training,
- ❖ lack of funding devolved to mathematics departments,
- ❖ skepticism about benefits of using ICT and
- ❖ lack of knowledge of what is available.

ICT capability-It involves technical and cognitive proficiency to access, use, develop, create and communicate information appropriately. ICT capability is much broader than acquiring a set of technical competencies in software applications, although these are very important.

ICT capability involves the appropriate selection, use and evaluation of ICT. In essence, teachers need to know **what** ICT tools are available**, when** to use it and **why** it is appropriate for the task. Teachers will also need to know which parts of ICT capability offers significant opportunities for teaching and learning in mathematics and how they can be incorporated in existing scheme of work. The use of ICT needs to be purposeful and to add value to the teaching and learning of mathematics and should not just be seen simply as a bolt on or merely for status. It needs to be carefully integrated into mathematics lessons, with a clear rationale for its use.

9.9.3 THE ROLE OF SCHOOL MANAGEMENT IN ICT INTEGRATION

The role of school management at any level is to develop, support, and direct the learning community. For the purposes of this paper we will focus on the aim of management for developing, and supporting, a culture of creative use of ICT within the learning and teaching of mathematics. Two general features of ICT applications that enhance the learning experience are software that is **responsive** and techniques that provide **leverage**, making easy something that otherwise required a considerable effort. **Responsive** software is interactive. Interactive software encourages learning by experiment and discovery – the "try it and see what it does" and "why did that happen?" approach. A facility to make changes, with instant feed-back is very useful. Leverage – making easy something that requires considerable effort. Examples of leverage include summing a series up to N terms, result of toss of dice 600 times, replication of formula on a spread sheet and the automatic production of graphs on a graphical calculator. These formerly use to take good amount of time and hence were not done in class room.

9.9.4 ICT DEVELOPMENT CYCLE WITH PHASES

ICT Development Cycle with phases (for preparing mathematics teachers to integrate GeoGebra Tool in their instructions)

Phase one:

familiarization phase - this phase comprised of things namely information, demonstration and hands on and follow up. Information given about ICT was:

ICT can be used as a tool for following:

- ❖ to support teachers in teaching an objective more effectively, in improving lesson design and improving teaching and learning;
- ❖ to enable pupils to engage with learning and to be motivated to improve their learning;
- ❖ to enable pupils to access geometrical, graphical and statistical ideas dynamically and to make connections with their learning;
- ❖ to build pupils' confidence in their mathematical abilities by testing their conjectures, learning from feedback and using reasoning to modify their solutions.

Benefits reaped by pupils by use of ICT are in following areas:

- ❖ using generic software such as databases or spread sheets as a means of making sense of data,
- ❖ using content-free, mathematics-specific software on computers to aid visualization and to help making connections between algebra and geometry,
- ❖ using simple programming languages, such as LOGO, to build increasingly complex mathematical models and relationships in shape and space, number and algebra;
- ❖ using content-specific software, usually targeting specific mathematical skills;
- ❖ processing and interpreting experimental information from data-loggers and
- ❖ using information resources such as the Internet, CD-ROMs or data files.

Phase two: 'Routine Specific Activity'-

This phase Comprised of things namely information, lesson planning and actual use in the teaching. Information : One example of good practice is to identify key modules in schemes of work which will require all mathematics teachers to use ICT in an aspect, say, of the mathematics curriculum.

While planning a lesson, teachers were informed about ICT tools such as: It is important to understand the opportunities that ICT offers and to be aware of the ways that it can enhance the teaching and learning of mathematics. ICT resources are not a panacea for all eventualities. In some situations these will be the best way generally to convey or consolidate a new concepts.

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Teachers can check whether the use of ICT is appropriate by doing following:

- ❖ Allow pupils to investigate or be creative in ways not possible otherwise;
- ❖ Give them access to information not otherwise readily available;
- ❖ Engage them in the selection and interpretation of information;
- ❖ Help them to think through and understand important ideas;
- ❖ Enable them to see patterns or behaviours more clearly;
- ❖ Add reliability or accuracy to measurements;
- ❖ Enhance the quality of their presentations;
- ❖ Save time, spent on measuring, recording or writing.

While planning to use ICT in lessons teachers should consider whether:

- ❖ ICT is really adding value to the lesson?
- ❖ Would the mathematics learning outcomes be achieved as or more efficiently with the use of ICT?
- ❖ Is the identified form of ICT (both hardware and software) the most appropriate one to use?

1. Good lesson plan:

Good lessons using ICT begins with clarity of purpose in its use. Most often this comes with experience, and through thoughtful planning and collaboration between teachers integrating ICT into a scheme of work. Less successful use of ICT in core subject teaching typically stems from weak links between the computer task and the lesson objectives.

2. Lesson Planning and Teaching:

Keeping all these points in mind, teacher must develop their lesson plans. These plans should be discussed in an informal meetings of a group of teachers, followed by actual teaching in the classrooms.

3. Outcome

This group of teachers could thus develop good teaching modules in this process. Some of these are listed below. These examples are classified in ways in which ICT can provide opportunities for students in learning mathematics:

4. Learning from feedback

The computer often provides fast and reliable feedback, that is non-judgmental and impartial. This can encourage students to make their own conjectures and to test out and modify their guess about out-come.

Module of Triangle and polygon – Student can move the vertexes of a triangle at random by mouse and record the sum the three angles and them conclude for himself that, "the sum of three angles of a triangle is 1800 " . Similar module can be made for polygon of side N to conclude, "that sum of the angles of a polygon of N sides is (N-2)*pi"

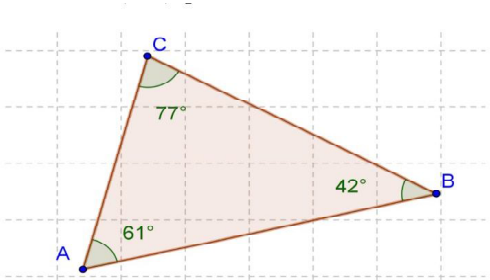

Figure 1: Sum of Three Angles of a Triangle

Observing patterns: The speed of computers and calculators enables students to produce many examples when exploring mathematical problems. This supports their observation of patterns and help to extrapolate and/or generalize. Module of shake hand problem – One can try this staring from 2 persons leading to one shake hand. 3 persons leading to 3 shake hands and so on. Observing pattern the student may come up with some general formula. Alternately formula may be given and student can validate it for different numbers

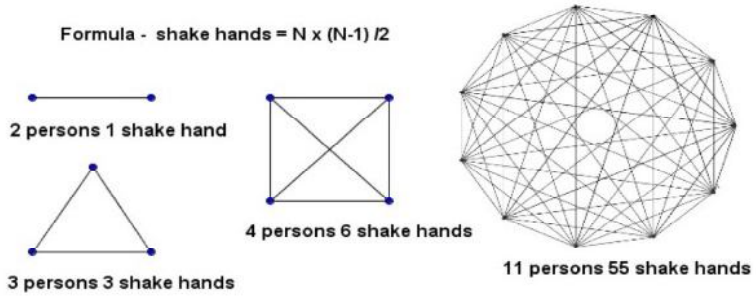

Figure 2: Pattern Observation

Seeing connections: The computer enables to formulate tables of numbers and graphs to be linked readily. Changing one of the parameters

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and observing changes in the others helps students to understand connections between them. This is demonstrated by an animated module of area of triangle in GeoGebra.

Students are asked make a note of following observations:

- Change Height by keeping same Base and observe variation in area and perimeter
- Change Base by keeping same Height and observe variation in area and perimeter
- Shift Apex horizontally so the Height and Base remain same. Now observe the change in area if any and perimeter.

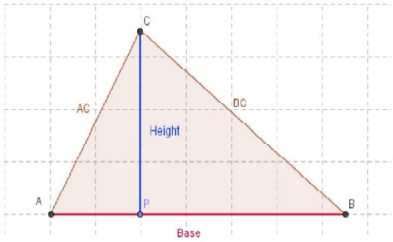

Figure 3: Area of Triangle

Working with dynamic images: Students can use computers to manipulate diagrams dynamically. This encourages them to visualize the geometry as they generate their own mental images. GeoGebra and many soft-wares including paint, have facility to scale, mirror, rotate or flip images. Student can imagine and then validate by carrying out transformations. Such a module is developed for the use

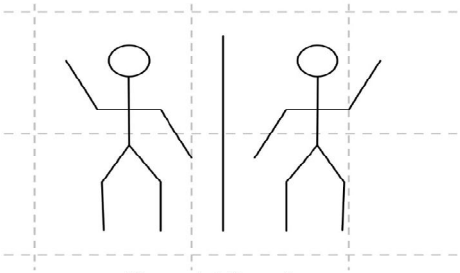

Figure 4: Mirror Image

Exploring data: Computers enable students to work with real data which can be represented in a variety of ways. This supports interpretation and analysis, viz a large number observations are needed in statistical experiments. Computer can show these by removing the drudgery. Best fit module – Here student plots readings from an experiment leading to linear relationship. S/he plots the line by judgment and then checks the accuracy of judgment by getting the plot by computer based on least root mean square variation. One can also see the effect on movement of line by moving some of the reading points.

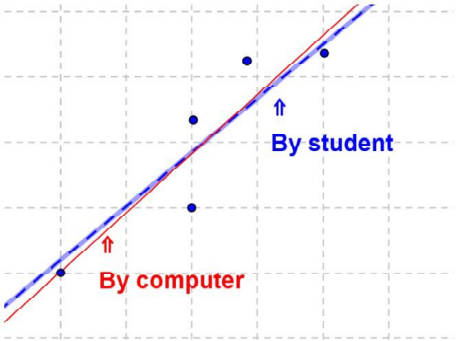

Figure 5: Best Fit Straight Line

Conclusion: If we deliver training with clarity of purpose and proper ICT support, considering the requirements of teachers (to have face to face personalized support) teachers are able to start the use of ICT in their teaching.

EVALUATION

1. Write about teaching-learning process.
2. Discuss the elements of lesson plan.
3. Write short notes on year plan and lesson plan.
4. Explain period plan with the help of example.
5. What do you mean by learning evidences? What factors should be kept in mind while collecting learning evidences?
6. Briefly explain group learning.
7. Explain briefly about planning ICT Applications in teaching learning of Mathematics.
8. How laboratory work should be plan.Briefly explain**.**
9. What factors teachers should consider while planning to use ICT in lessons?

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