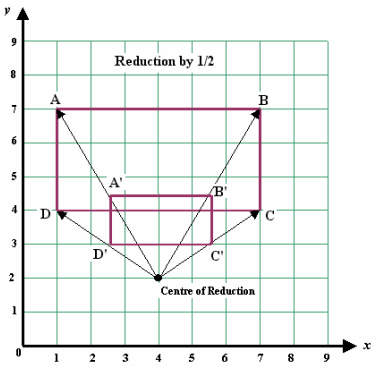
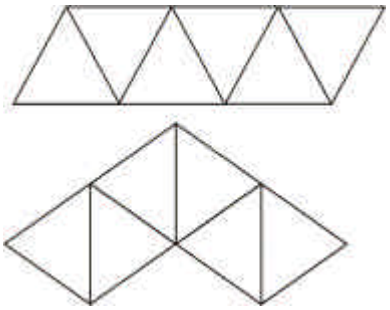
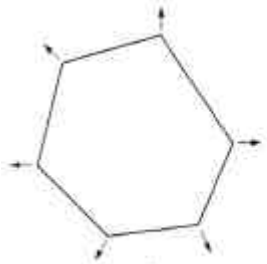
Mathematics/Science Strand
Mathematics

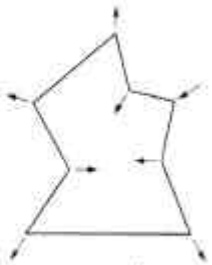
Unit 4: Enrichment Topics in Space and Measurement

Module 4.1 Line Design and Symmetry
Module 4.2 Transformation, Scale and Similarity
Module 4.3 Investigating Polygons
Module 4.4 Geometric Activities
Module 4.5 Measurements






convex polygon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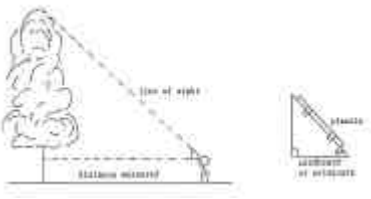

Lecturer Support Material

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PASTEP

Primary and Secondary Teacher Education Project

Australian Agency for International Development (AusAID)
GRM International

Papua New Guinea-Australia Development Cooperation Program

Unit outline

Unit	#	Modules
Unit 4 **Enrichment Topics in Space and Measurement**	**1**	**Line Design and Symmetry (Core)**
	2	**Transformation, Scale and Similarity (Core)**
	3	**Investigating Polygons (Core)**
	4	**Geometric Activities (Core)**
	5	**Measurements (Core)**

Icons

 Read or research

 Write or summarise

 Activity or discussion

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[Notes]

Lecturer Support Material

This *Lecturer Support Material* has been developed to assist lecturers in the teaching and assessing of *Unit 4: Enrichment Topics in Space and Measurement*.

The material consists of:

- An introduction to the unit, which includes information on the overall rational for the unit as well as recommended teaching approaches and suggestions on how the unit can be integrated into practicum activities.
- Module outlines, setting out a suggested sequence of learning activities and identifying topics which could be taught within each module. Ideas for assessment activities are also provided
- A Unit Glossary

Suggestions have been made about what content should be covered within the unit as well as recommending an approach to teaching the material. It is envisaged that by working through the suggested sequence of leaning activities lecturers will be modelling good practices for teaching mathematics that students can then apply in their own teaching.

Student Support Material has also been developed for the unit *'Enrichment Topics in Space and Measurement'* to accompany this *Lecturer Support Material*. The *Lecturer Support Material* should be read in conjunction with *the Student Support Material* as the *Lecturer Support Material* makes reference to activities and material contained only within the *Student Support Material*.

It is not expected that the students will work only from the ideas and suggestions contained within the *Student Support Material*. Additional ideas and activities are set out in the *Lecturer Support Material* to compliment the student material. The lecturer will need to make decisions about how to present the material and make decisions about what activities will be covered during lecture periods and what students will be required to do during their study time.

When using this material it is recommended that lecturers:

- Read through the whole unit prior to planning the course overview
- Select the modules and topics to be cover in the time available
- Plan the activities that will be presented to the students
- Select the material from the *Student Support Material* that will be used to support the teaching of the unit
- Develop the assessment tasks for the unit.

It is important to remember that this material is support material only. While lecturers are encouraged to try out the suggested activities within the material, it is hoped that people will also include their own ideas. This material, along with the *Student Support Material* should be seen as a living, working document which can be reviewed and changed to suit the curriculum needs of the Primary Teachers Colleges and new ideas and trends in the teaching of mathematics.

Unit 4: Enrichment Topics in Space and Measurement

The Mathematics course seeks to develop beginning teachers who are:

- confident in their ability to teacher mathematics across the Primary School, are familiar with the Primary School Mathematics Syllabus and have a strong understanding of the mathematical concepts covered within it
- aware of the factors which impact on the teaching and learning of mathematics
- resourceful, creative, life long learners
- inclusive of all people, regardless of gender, social, cultural and language background.

Rationale

Spatial ideas and measurement activities play a vital role in many of our day-to-day activities. Activities such as describing our surroundings, planning our time, manipulating objects, and carrying out many simple everyday tasks require an understanding of space and measurement concepts. Because of the relevance and usefulness of these concepts, the Space and Measurement strand has an essential place in the primary school curriculum. Future teachers therefore need to further develop their own understandings in these areas so they can become confident and competent teachers.

Aims

This unit aims to produce beginning teachers who are:

- able to solve a range of space and measurement problems
- able to articulate their mathematical thinking
- confident and competent to teach space and measurement concepts to primary school children (grades 3 to 8)

Objectives

As a result of studying this unit students will:

- create line designs
- identify and create symmetrical designs
- be familiar with Euclidean and non- Euclidean transformations
- be able to produce a scale drawing
- identify characteristics of polygons
- construct 3-D shapes
- be able to identify attributes to be measured in an object and the appropriate standard unit to use

Unit outline

Enrichment Topics in Space and Measurement is a 3-credit point unit.

To successfully complete this unit students complete the following core modules:

Module 4.1	Line Design and Symmetry
Module 4.2	Transformation, Scale and Similarity
Module 4.3	Investigating Polygons
Module 4.4	Geometric Activities
Module 4.5	Measurements

Each of these modules should take between 6 to 9 hours of lectures to complete. It is also expected that students will spend an equivalent number of hours of non-contact time studying the ideas and concepts raised in this unit.

A detailed description of each module in included in this Lecturer Support Material.

Sequencing of modules within the unit

When considering the teaching of this unit it is suggested that time is made available at the start of the unit to develop an overall view of the concepts and understandings to be developed throughout the unit.

It is recommended that modules be taught in the sequence in which they appear in the Lecturer Support Material. The understandings developed in the earlier modules will support the concepts which are introduced in the remaining modules.

At the conclusion of the unit it will be important to spend some time reviewing the work covered in all the modules and considering the overall implications for the teaching of space and measurement in the primary schools. A unit evaluation should also be carried out.

A suggested sequence for the delivery of this unit (3 credit points over 12 weeks) is outlined below.

Enrichment Topics in Space and Measurement

Week	Activity
1	Introduction to the unit, including discussion on the work to be covered in each module, assessment tasks, study expectations.
2-3	Module 4.1: Line Design and Symmetry
4-5	Module 4.2: Transformation, Scale and Similarity
6-7	Module 4.3: Investigating Polygons
8-9	Module 4.4: Geometric Activities
10-11	Module 4.5: Measurements
12	Review of the unit, implications for the teaching of space and measurement in the primary school, unit evaluation

Teaching approaches

The approach recommended to teach this unit is a student centred, activity based approach. Lecturers are encouraged to build upon and respect students' different experiences, and to provide a range of purposeful and challenging activities. A supportive learning environment should be established, encouraging students to take risks and to learn from one another.

The skills and understanding developed during ***Unit 1 'Problem Solving and Investigations'*** should be reinforced during this unit. Students should be provided with an opportunity to solve problems, complete investigations, work co-operatively and to discuss their mathematical thinking.

While exploring space and measurement concepts students will engage in a range of mathematical activities. These activities will further develop students' own mathematical understandings as well as their ability to teach space and measurement concepts in a primary school context.

Suggested strategies to use in the delivery of this unit include:

- discussions, small group and whole class, open and structured, between student and teacher and among the students themselves
- seminar presentations
- research and investigation activities
- co-operative group learning
- demonstrations
- peer teaching
- micro-teaching.

Although the unit consists of a number of different modules lecturers are encouraged to adopt a holistic approach to their teaching. Connections and relationships between the concepts

developed in the various modules need to be established and the understandings developed in early modules built upon throughout the unit.

When teaching selected activities from this material, lecturers will be modelling appropriate strategies that can easily be adapted to the primary school context. Class activities, followed by opportunities for group and individual work, the recording of mathematical ideas, the displaying of student work, the use of class discussions, with an emphasis on the process rather than the product, and establishing a classroom environment conducive to learning is the approach recommended in the teaching of this unit. These approaches need to be made explicit to students and consideration given to their effectiveness in the teaching of mathematics.

Inclusive curriculum

In the delivery of this unit it is expected that every person will be provided with the opportunity to participate in, and contribute to, activities without fear or favour. Activities should be presented to cater for a range of abilities and should be gender inclusive.

When developing a gender inclusive program lecturers will need to consider:

- **Language**. The language we use shapes and represents the way we think, therefore the language we use needs to be inclusive. It is important to use language that includes woman and to avoid generic terms such as 'man'.
- **Access and participation**. It is necessary to ensure that both male and female students receive an equal share of the lecturer's time and attention. Both male and female students need to be treated equally and given the same opportunities to participate in discussions, ask questions and contribute to the classroom conversations. Both female and male students should have equal access to classroom resources.
- **Teaching strategies**. Examples used in the teaching of the unit need to include both female students and male students. Also students learn in different ways so a range of different teaching strategies and assessment tasks need to be developed to accommodate these differences.

When students are considering the teaching of space and measurement in the Primary School context, attention should be given to catering for all children, including those with special needs. Students will need to be encouraged to focus on what children with a range of special needs can do and consider how activities can be adapted to cater for these children.

Activities planned by students to teach in the primary classroom will also need to be inclusive, presenting positive and non-stereotypical representations of people.

Language issues

Language factors contribute significantly to children's mathematical learning and mathematics teachers have an important role to play in assisting students to acquire the specialised language of mathematics. Teachers need to establish the connections between the everyday concepts, the everyday language, and the formal language, skills, and symbols of mathematics. Teachers also need to be aware of the language and cultural diversity of children, and how this will impact on the teaching and learning of mathematics.

When teaching this unit, lecturers will need to raise students' awareness of these issues through providing opportunities for students to explore different cultural perspectives and express their mathematical ideas in a variety of ways. Opportunities should be provided for students to use everyday language, vernacular, Tok Pisin, English, symbols, graphs, charts, written and oral texts when sharing their mathematical understandings.

When students are planning for the teaching of space and measurement in the Primary School context, they will be required to consider how they can support children in developing appropriate language to discuss the mathematical ideas. Particular consideration will be given to developing strategies to supporting children who speak English as a second language, and who are in the process of bridging from the vernacular to English.

Multigrade teaching

In implementing this unit, lecturers will need to consider how they can cater for the range of student ability levels. By providing opportunities for group work, presenting activities at a range of levels and allowing students to select from these, strategies suitable for use in a multi-grade setting will be modelled. When presenting this unit and deciding how to implement space and measurement activities into the primary school context, consideration will be given to modelling strategies suitable for use within a multigrade classroom.

Assessment activities

Assessment is the process of identifying, gathering and interpreting information about student learning. The main purpose of assessment is to improve student learning and the quality of the learning programs. Assessment should be undertaken at the beginning of the unit (diagnostic), during the unit (formative) and at the end of the unit (summative).

A variety of assessment strategies should be used and students should be given opportunities, in a variety of contexts, to demonstrate in an authentic manner, what they know, understand and can do. The assessment strategies used need to be sensitive to the diversity that exists amongst students and take into consideration gender, culture, and language differences.

The content that is being covered, the learning objectives being assessed and the style of teaching and learning being used, will influence the method of assessment used. When developing assessment tasks lecturers will need to ensure that:

- the requirements of the task are set out clearly
- the assessment tasks chosen are relevant to the objectives and allow students to demonstrate appropriate outcomes
- marks or grades reflect the relative importance of each part of the task
- the language used is familiar to students and ideas clearly expressed
- items are not too difficult or too easy
- it does not contain bias
- a marking scheme is developed and applied consistently

The number of assessment tasks for the unit will be determined by college policy. Suggested assessment tasks have been included for each module and lecturers will need to decide on

which assessment tasks they will develop, taking into consideration the learning objectives for the entire unit.

Suggested assessment strategies for this unit include:

- oral presentation e.g. seminars, tutorials,
- project work
- investigations
- peer and micro teaching
- producing teaching resources and creating designs
- report writing – with a focus on inquiry, analysis and reflection
- examination.

Practicum suggestions

When studying this unit students should be provided with opportunities to:

- observe teachers teaching space and measurement activities
- practice teaching space and measurement activities
- critically reflect on these experiences.

The following is a list of suggestions as to how this unit may be incorporated into Practicum activities such as school experience, demonstration lessons and block teaching. These ideas would need to be negotiated with the Professional Development strand.

Demonstration lessons

Students observe teachers presenting space and measurement activities to children. During these observations students can keep a record of:

- what the teacher is doing
- what the children are doing
- the type of questions asked
- how the children and the classroom are organised (group or individual work, learning centres)
- what the children are learning
- what language is being used
- what difficulties the children are experiencing
- what concrete materials are being used
- how the children are being assessed.

Following these observations conduct a class discussion critically reflecting on student findings. The discussions could incorporate topics such as:

- the prior understandings children needed to participate in the activity
- identification of the new learning that took place
- the difficulties children experienced and how these could be overcome

- the strategies adopted by the teacher to develop children's understandings and to support the development of mathematical language
- how you could assess the children's learning
- how you would follow up this lesson
- critical reflection on the effectiveness of the lesson and recommendations.

School experience

Involve students in microteaching, working with a small group of children over a number of weeks. Students can work with children and plan, teach and evaluate a sequence of space and measurement lessons using a variety of different strategies. Students can try out ideas such as:

- teaching in context
- using concrete materials
- developing children's mathematical language
- recording mathematical thinking in different ways
- supporting children bridging from the vernacular to English when learning mathematics.

Have students observe a number of different teachers from across the primary school, teaching space and measurement lessons. Students can write a journal reflecting on what they have learnt about the teaching of space and measurement from these observations.

At the end of this period spend time critically reflecting on the experience, sharing what has been learnt and making recommendations for future teaching.

Block teaching

Students can:

- plan a series of space and measurement activities
- teach these activities
- evaluate their teaching.

On the completion of block teaching and when students return to the mathematics class, follow up activities should be planned to:

- share successful experiences and identify the reasons why these experiences where successful (good planning, strong understanding of the content area to be taught, use of concrete materials, concepts taught in context etc)
- discuss problems experienced, the reasons why these occurred and possible solutions
- identify the areas where students require additional support and assistance
- make recommendations for future teaching experiences.

Unit evaluation and reflection

On the completion of the unit an evaluation should be compiled. This should include input from both staff and students reflecting on the teaching and learning that took place during the unit. The information collated during the evaluation process should inform the review and ongoing development of the unit.

Below is an example of focus questions a lecturer may use to review the unit. A student evaluation form is also included as well as information on how the data gathered can be analysised.

Focus questions for lecturer reflection

To determine the effectiveness of the practices and methodologies employed and the content covered in a unit of work, lecturers need to reflect on their teaching. When reflecting on our teaching the areas we can consider are:

- the content of the unit
- the methodologies used in delivering the unit
- the assessment activities
- the co-ordination of the unit.

To help us reflect on our teaching we can ask ourselves a number of questions about each of these areas.

Content of the unit

- Did the content support the objectives of the unit?
- Were the activities sequenced logically?
- Was the content relevant? Did the content help the students to become competent beginning primary school teachers?
- Do you think the students are now more confident to teach this subject in the primary school?
- What recommendations can you make?

Methodology

- How did you deliver the content to the students? Were these strategies effective?
- Were the students aware of the strategies you were modelling and how they could use these strategies in their own teaching?

Assessment of the Unit

- How clear were the assessment tasks?
- How many tasks were given to students? Was this sufficient/too few or too many?
- Did you give students enough time to complete each assessment task?
- Do the students' assessment results display what you expected of the course?
- What are your recommendations?

Unit Co-ordination

- How well did you co-ordinate this unit?
- Did you produce any materials for students? Were these appropriate?
- Did you communicate effectively with other lecturers who were involved in teaching the same unit?

After considering each of these questions we can then make recommendations about the future of this unit.

Focus questions for student reflection

Below is a list of focus questions which could be used to stimulate student discussion when evaluating the unit.

- What have you learnt from this mathematics unit this semester?
- What have been the highlights/strengthens of this unit?
- What problems have you encountered with this unit?
- Has this unit helped prepare you to be a beginning primary school teacher? If so, how? If not, why do you think this?
- What comments can you make about the level of work covered in this unit?
- What recommendations can you make to improve this unit?

Student unit evaluations

Unit: _____ Class: _____

Instructions: Put an 'X' in the appropriate box.

Indicators	Strongly Agree (5)	Agree (4)	Not sure (3)	Disagree (2)	Strongly Disagree (1)
1. The objectives of the unit were clearly outlined.					
2. The unit content was clearly related to the objectives.					
3. The student support material helped my understanding of the unit.					
4. The library was able to provide me with additional references.					
5. The assignments were related to the unit objectives.					
6. The instructions to do the assignments were clear.					
7. The assignments were scheduled to allow enough time for preparation.					
8. I obtained useful feedback on my assignments.					
9. Assignments were returned in time to help me with this unit.					
10. Teaching staff were available for consultation.					
11. There were sufficient opportunities to discuss the unit content in class.					
12. Demonstrations and practical activities were useful to my learning.					
13. I have improved in my ability to talk and write about this unit.					
14. I have improved my knowledge and skills in this unit area.					
15. The overall quality of teaching was good					
16. The physical facilities (rooms, labs, equipment) were adequate for the unit					
17. This unit was challenging and at an appropriate level.					
18. I have developed my co-operative learning skills during this unit.					
19. All students (male & female) were provided with an equal opportunity to participate in all activities.					
20. I would recommend this unit to other students.					

Student Unit Evaluation – Notes

The Student Unit Evaluation seeks to determine how students perceive the quality of a Unit though various indicators, objectives, texts, facilities, assignments, and teaching. It is important to note that there is a difference between **Unit quality** and **students' perceptions of Unit quality**. What is being determined here are only students' perceptions. Feedback from students is only one pointer which when linked to other forms of review such as lecturer peer review and self-assessment of a Unit, can provide the basis for improving student learning in a Unit.

From a completed Unit evaluation it is possible to compare the different indicators by calculating a **Mean** score for each of them. Each Indicator Mean score is calculated by multiplying the number of students responding for each preference, by the preference value. The preference values are 5 for Strongly Agree; 4 for Agree; 3 for Not Sure; 2 for Disagree; and 1 for Strongly Disagree.

Example of the calculation of Indicator Mean scores

Number of students: 22

The objectives of the unit were clearly outlined

Indicators	**Strongly Agree (5)**	**Agree (4)**	**Not sure (3)**	**Disagree (2)**	**Strongly Disagree (1)**	**Total**	**Mean**
Student responses	4 (4x5=20)	9 (9x4=36)	3 (3x3=9)	5 (5x2=10)	1 (1x1=1)	76	76/22 = **3.45**

The unit content was clearly related to the objectives

Indicators	**Strongly Agree (5)**	**Agree (4)**	**Not sure (3)**	**Disagree (2)**	**Strongly Disagree (1)**	**Total**	**Mean**
Student responses	2 (2x5=10)	4 (4x4=16)	3 (3x3=9)	8 (8x2=16)	5 (5x1=5)	56	56/22 = **2.54**

Making sense of the results

You can see from these examples what students' general perceptions are. While they thought that the objectives of the Unit were clear, they did not think the content of the Unit was well related to its objectives. A lecturer may have to decide whether stronger links between objectives and content are necessary, whether the objectives should be redefined, or whether students should be made more aware of the links that do exist between objectives and content. To make an informed decision about the Unit, a lecturer would probably need to compare this information with the rest of the evaluation, take note of students' comments at the end of the evaluation, do a self-assessment of the Unit and go through the Unit with other lecturers seeking their opinions (Peer Review).

As a guide, Units probably need fine-tuning where a particular Indicator Mean score is much lower than those of other Indicator Mean scores in that Unit; or any Indicator Mean score is below 3.0. It is possible to calculate an overall Unit Mean by adding all the Indicator Mean scores and dividing by the number of Indicators (20). The overall Unit Mean score can be compared with other Unit Mean scores in the Strand or across Strands to give a picture of which Units students perceive as being of higher or lower quality.

Resources

Butchers Paper
Markers
Compass
Protractor
Coloured pencils
Graph paper
Ruler
Cardboard
Plywood
Pins and/or nails
Cotton
Paint
Newspapers
Scales
Protractors
Clock
Thermometer
Scissors
Polygons
Geometric Shapes
Dot paper
Range of different size boxes
Primary Mathematics Syllabus documents

References

Booker, G., Bond, D., Briggs, J., Davey, G., (1997) *Teaching Primary Mathematics* (2nd Ed), Addison Wesley Longman Australia

Department of Education Papua New Guinea (1998), *Lower Primary Mathematics Syllabus Grade 3-5*,

Department of Education Papua New Guinea (draft 1999) *Upper Primary Mathematics Syllabus Grade 6-8*

Green, Wally, (1998) *Report on Mathematics Education in Community teachers Colleges in PNG, Fourth Phase, Activities Observations and Recommendations*, OHE – ADB –IDP, Papua New Guinea Higher Education Project.

Green, Wally. *Topics in Geometry* Department of Education, PNG

Swan, K., Adamson, R., Addison, J. Asp, G., Cocking, M., FitzSimons, G., Lovitt, C., & Orr, M. (1997), *Nelson Maths for the CSF 7*, Nelson

Module 4.1: Line Design and Symmetry

Module 4.1 Line Design and Symmetry is a core module in the ***'Enrichment Topics in Space and Measurement'*** unit. Spatial ideas are used for a wide variety of practical purposes and are basic to solutions to many design problems. During this module students will develop their understanding of concepts of design and symmetry through opportunities to create their own line designs and explore the symmetry in a variety of different shapes.

Objectives

By the end of this module students will be able to:

- draw and construct line designs
- identify lines of symmetry in a range of shapes
- identify rotational symmetry in shapes.

Concepts and skills to be developed

- Points, lines, rays, line segments, angles, curves, geometrical figures
- Relationship between lines, curves and patterns
- Drawing skills
- Oral and written communication skills
- Artistic skills

Topics

- Line design
- Symmetry
- Line Design and Symmetry in the Primary School

Suggested teaching strategies

- Individual work
- Class discussion
- Construction

Suggested assessment tasks

- Create a line design
- Identify symmetry (line and/or rotational) in a range of different objects and shapes

Resources

Paper
Markers
Compass
Protractor
Coloured pencils
Graph paper
Ruler
Cardboard
Plywood
Pins and/or nails
Cotton
Paint
Butchers paper
Markers
2 dimensions shapes
Clay or plasticine
Map of PNG
Torch
Cans
Cardboard

References

Booker, G., Bond, D., Briggs, J., Davey, G., (1997) *Teaching Primary Mathematics* (2nd Ed), Addison Wesley Longman Australia

Department of Education Papua New Guinea (1998), *Lower Primary Mathematics Syllabus Grade 3-5*,

Department of Education Papua New Guinea (draft 1999) *Upper Primary Mathematics Syllabus Grade 6-8*

Green, Wally, (1998) *Report on Mathematics Education in Community teachers Colleges in PNG, Fourth Phase, Activities Observations and Recommendations*, OHE – ADB –IDP, Papua New Guinea Higher Education Project.

Green, Wally. *Topics in Geometry* Department of Education, PNG

Swan, K., Adamson, R., Addison, J. Asp, G., Cocking, M., FitzSimons, G., Lovitt, C., & Orr, M. (1997), *Nelson Maths for the CSF 7*, Nelson

A suggested sequence of learning activities

Introduction

Drawing Working in small groups ask students to discuss, list and draw a variety of designs found in the environment, e.g. billums, baskets, mats, walls, string designs, armbands, necklaces, body designs. Label and make a class display of the different designs.

Discussion Conduct a class discussion identifying features of the various designs. Use this opportunity to define mathematical terms used in line design and symmetry e.g. straight lines, curved lines, line symmetry, rotational symmetry, angles, rays, line segments.

Topic 1 – Line design

Modelling Refer students to the *Student Support Material Topic 1: Line Design.* Construct line designs with students by:

- joining corresponding points on intersecting lines, triangles, quadrilaterals and circles
- joining points in different ways e.g. 1 to 2 or 1 to 3 instead of 1 to 1
- drawing equal cords in a circle
- joining points on a grid

Student Support Material 4.1 Activities 1 to 4

Display Ask students to create their own line designs and display these *Student Support Material 4.1 Activity 5.* Students may use pencil and paper or concrete materials such as cardboard, plywood, pins, nails, cotton to construct three-dimensional models.

Display and discuss the finished products.

Designs Refer students to the *Student Support Material 4.1 Extension Activity 1*

Topic 2 – Symmetry

Definitions Display a number of different shapes and designs which illustrate:

- no symmetry
- line symmetry
- rotational symmetry

Working with students to identify which shapes have: no symmetry, line symmetry and/or rotational symmetry and develop a definition for these terms.

Classification Refer students to the *Student Support Material Topic 2 Symmetry*. Ask students to complete *4.1 Activity 6* which requires them to classify a range of shapes according to whether they:

- have line symmetry
- have rotational symmetry
- have both line and rotational symmetry
- are asymmetrical.

Have students study the line designs they have created previously in *Topic 1: Line Designs* to identify any symmetrical patterns.

Learning Centre Establish a learning centre where students complete a range of activities which explore symmetry. For example set up tables where students to do:

- Origami
- Folding and cutting paper to create symmetrical designs
- Painting
- Collecting objects from the natural environment and investigate symmetry (line and rotational) e.g. face of a person, leaves, insects, geometric designs, hibiscus and frangipani flowers
- Creating designs and shapes which meet certain criteria e.g. a triangle which has exactly two lines of symmetry.

Topic 3 – Line design and symmetry in the primary school

Review Discuss the importance, purpose and application of design and symmetry in real life situations e.g. carvings, billums, baskets, walls.

Review the Primary School Mathematics Curriculum to see how concepts of line design and symmetry are taught across Grade 3 to 8.

Planning Have students plan line design and symmetry activities suitable to teach at various levels in the primary school (Grade 3 to 8).

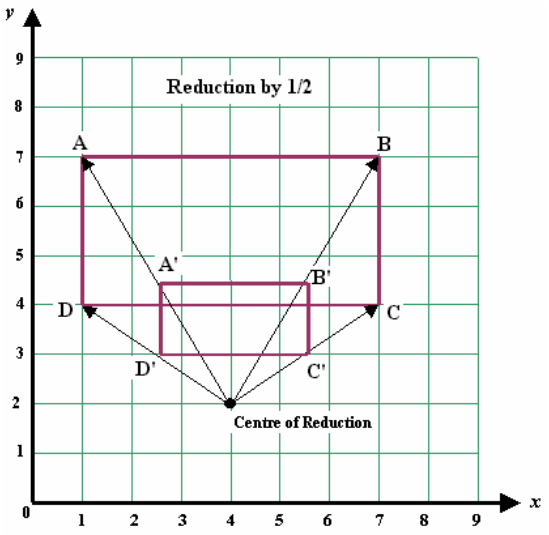
Extension Activity

3-D symmetry Refer students to the *Student Support Material 4.1 Extension Activity 2 and 3 which e*xplores plane and rotational symmetry in 3D shapes.

Conclusion

Journal Writing Ask students to write a reflective journal which focuses on what knowledge has been acquired during this module. Have students share their journals with peers.

Module 4.2 Transformation Scale and Similarity



Module 4.2 Transformation, Scale and Similarity is a core module within the ***'Enrichment Topics in Space and Measurement'*** unit. During this module students will investigate and experiment with concepts of transformations. Through the activities presented they will develop their skills and perceptions of reflections (flips), translations (slides) and rotations (turns). As a result they will be able to use the skills and knowledge learnt to develop and reinforce child's spatial concepts when teaching in the primary grades.

Objectives

By the end of this module students will be able to:

- describe both Euclidean and non-Euclidean transformations
- move shapes using Euclidean and non-Euclidean transformation
- identify similarities and congruencies in transformed shapes
- use principles of ratio and proportion to enlarge and reduce shapes.

Concepts and skills to be developed

- Euclidean and non-Euclidean transformation
- Scale
- Similarities and congruency
- Ratio and proportion
- Perimeter, area, surface area and volume
- Angles
- Artistic and creative skills

- Investigation and problem solving skills
- Calculations

Topics

- Euclidean transformation
- Non-Euclidean transformation
- Congruency and similarity
- Scale and similarity
- Dilation
- Teaching transformation

Suggested teaching strategies

- Group work
- Investigations
- Exercises

Suggested assessment tasks

- Draw a scaled model of an object.
- Investigate what happens to the properties of a shape when they are reduced or enlarged. For example if the transformation is 2:1, what happens to properties such as perimeter, area and volume? Generalise.

Resources

Butchers paper and cardboard
Markers
2 dimensions shapes
Clay or plasticine
Map of PNG
Torch
Cans

References

Booker, G., Bond, D., Briggs, J., Davey, G., (1997) *Teaching Primary Mathematics* (2nd Ed), Addison Wesley Longman Australia

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Swan, K., Adamson, R., Addison, J. Asp, G., Cocking, M., FitzSimons, G., Lovitt, C., & Orr, M. (1997), *Nelson Maths for the CSF 7*, Nelson

A suggested sequence of learning activities

Introduction

Role play

Get students to make different shapes using their body e.g. crouch down low and make your body as small as possible, slowly stretch up high to be as tall as you can, make yourself as wide as possible.

Discuss how they have changed their body shape, while other attributes stayed the same (e.g. mass).

Definition

Introduce the term transformation to students and develop a class definition.

Topic 1 – Euclidean and non-Euclidean transformations

Exploring moving shapes

Provide each student with a 2-D shape. Have students move the shape around so that it is in different position. See how many different ways that the shape can be moved. Ask the students to record the different movements made.

Class discussion

Have students discuss the different ways that the shapes were moved from one position to another e.g. flipped over, rotated, slip. Discuss if the movement caused the object to change its attributes in any way.

Euclidean Transformation

Introduce the students to the three types of Euclidean transformations and discuss how the size and shape of the object does not change in Euclidean transformations.

i. Translation
ii. Reflection
iii. Rotation

Refer students to the *Student Support Material 4.2 Activity 1* and ask them to complete the activity.

Non –Euclidean transformation

Provide students with a piece of clay or plasticine. Have then mould it into different shapes without tearing or joining new pieces e.g. make a ball, a flat disc, a sausage, a tower, a cube etc.

Discuss how the clay/plasticine was transformed, with the shape and size of the objects created changing.

Introduce the idea of different types of non- –Euclidean transformation

- Topological
- Projections
- Dilations

Refer students to the *Student Support Material 4.2 Activity 2* and complete the projection activity

Topic 2 – Congruence and Similarity

Investigation Ask students to find two shapes which are exactly the same. Draw the objects and ask them to explain how they know that the two shapes are exactly the same.

Definition Introduce students to the terms congruence and similarity.
Refer students to the *Student Support Material Topic 2* and ask them to complete *4.2 Activity 3 and 4* and have them complete the activities investigating congruency.

Topic 3 – Scale and Similarity

Map reading Provide students with a map of PNG. Ask them to identify various places and estimate the distance between places. Discuss the scale on the map and what it represents. Use the scale, to calculate distances.

Group activity Have students work in small groups. As a class choose a common scale, and ask each group to draw a map of a different area of the college. On completion, join each group's map together to produce a college map. Discuss.

Scale drawing *Refer students to the Student Support Material Topic 3 Scale and Similarity*. Working in pairs provide each group with a 2D shape. Ask students to draw the shape and then to draw a scale version of this shape (larger or smaller). Have students write down what they can tell you about the relationship between the two shapes. Highlight the relationships between the angles and the ratio between the corresponding sides.

Exercises Refer students to the *Student Support Material 4.2 Activities 5 and 6* and complete the activities.

Topic 4 – Dilation

Demonstration

Organise students into groups. Provide each group with a torch, a can, and a polygon cut out of cardboard. Have people place the shape on top of the can so that it is held parallel to the table. Ask students to hold the torch at various heights and in various positions above it and to notice the shadow you get each time. Have students consider the following questions:

- How does the shape of the shadow compare with that of the original polygon?
- Is the shadow always the same shape?
- Does the height of the torch change the size of the shadow?
- Does the position of the torch change the size of the shadow?
- How do the angles of the shadows compare to the angles of the polygon?

Have students comment on their findings and compare results for the different polygons.

Activities Refer students to the *Student Support Material 4.2 Activity 7* and complete the dilation activities.

Topic 5 – Teaching Transformation

Review Mathematics Syllabus Ask students to review the Primary Mathematics Syllabus documents and support materials (Teachers Guide and Pupil Book) and see how the following concepts are covered:

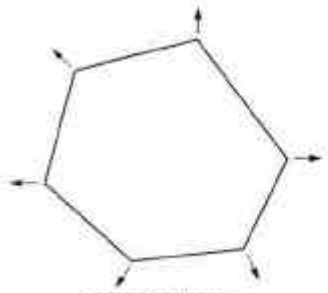
- Transformation
- Scale

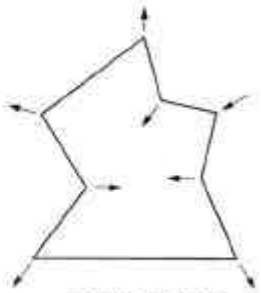
Lesson Planning Have students plan a mathematics lesson for a specific grade level which teaches concepts of transformation or scale.

Conclusion

Journal Writing Have students write a reflective journal stating the main ideas which they learnt during this module. Share journals and discuss.

Module 4.3: Investigating Polygons





Module 4.3 Investigating Polygons is a core module in *the* ***'Enrichment Topics in Space and Measurement'*** unit. During this module students will be involved in classifying activities and identifying the characteristics of various 2D and 3D shapes. Investigation activities will be carried out where students will explore the properties of polygons, in particular their angle sums.

Objectives

By the end of this module students will be able to:

- identify polygons, differentiating between regular and irregular polygons
- calculate the angle sum of different polygons
- identify interior and exterior angles of polygons
- review the Primary Mathematics Syllabus to consider how the topic 'Angles' is taught.

Concepts and skills to be developed

- Interior and exterior angles
- Relationship between the area and length of polygons
- Geometric properties of polygons (angles, sides, shape)
- Investigative and problem solving skills
- Oral language skills (explaining, clarifying)
- Drawing
- Measuring
- Calculation
- Recording, interpreting, reading skills

Topics

- Regular and Irregular polygons
- Angles
- Teaching Angles in Primary Schools

Suggested teaching strategies

- Group work
- Investigation
- Problem solving

Suggested assessment tasks

- Create a teaching aid which distinguishes between one of the following:
    a. Plane and solid shapes
    b. Regular and irregular polygons
    c. Convex and concave polygons
    d. Interior and exterior angles

- Produce a resource that could be used to teach the concept of 'angle'.

Resources

Butchers paper
Markers
Cardboard
Scissors
Polygons
Primary Mathematics Syllabus documents and support material

References

Booker, G., Bond, D., Briggs, J., Davey, G., (1997) *Teaching Primary Mathematics* (2nd Ed), Addison Wesley Longman Australia

Department of Education Papua New Guinea (1998), *Lower Primary Mathematics Syllabus Grade 3-5,*

Department of Education Papua New Guinea (draft 1999) *Upper Primary Mathematics Syllabus Grade 6-8*

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A suggested sequence of learning activities

Introduction - Shapes

Classifying Refer students to the *Student Support Material 4.3 Activity 1* and have students produce their own set of shapes (2-D and 3-D shapes, including different types of triangles, squares, quadrilaterals). Ask students to classify the shapes according to their own criteria. Have students explain their classification.

Have students draw a chart classify the shapes according to whether they are solid or plane. Label shapes and develop a definition for plane and solid figures.

Topic 1 – Regular and irregular polygons

Group activity Have students work in small groups. Provide each group with a set of plane figures - some with all straight edges (polygons, convex and concave) and some with curved edges. Have students:

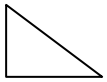
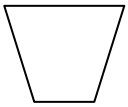
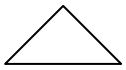
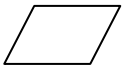
i. sort plane shapes according to whether they have curved or straight edges

ii. Distinguish between plane shapes with all straight edges (polygons) and those with some curved edges. Develop a definition of a 'polygon' e.g. A polygon is a plane figure which has 3 or more line segments as sides i.e. all straight sides.

Using the polygons ask students to sort the shapes according to the number sides they have

Have students construct a table where they draw and label the shapes according to the number of sides.

Polygons

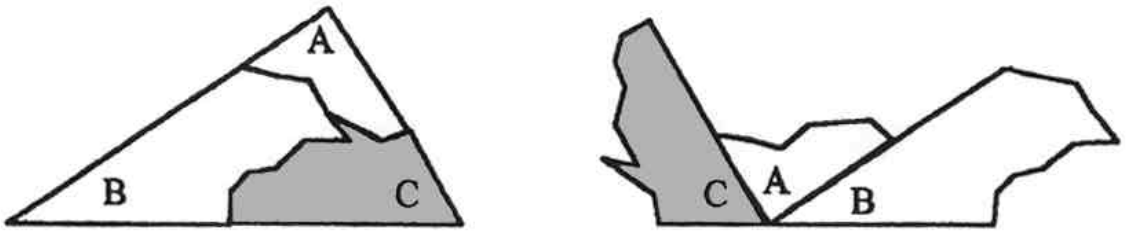
3 Sides	4 Sides	5 Sides	6 Sides
 Right angled triangle	 Trapezium		
 Isosceles triangle	 Parallelogram		

Ask students to consider the different properties of the various polygons and to classify the polygons according to different criteria (e.g. not according to the number of sides). Discuss classifications e.g. regular and irregular polygons, convex and concave

Definition Distinguish between regular and irregular polygons. Discuss the difference between convex and concave polygons.

Topic 2 – Angles of polygons

Triangles Have students investigate the 3 interior angles within a triangle. Demonstrate with students that the 3 angles in any triangle add up to 180 degrees e.g. draw a triangle, rip it into three parts and put the vertices side by side.

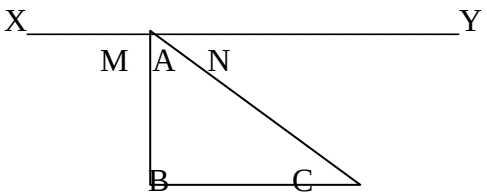


Revise with students their understanding of corresponding and alternative angles to prove that the three angles in any triangle add up to 180 degrees.

For example, if we draw a triangle ABC and then draw a line XY through A parallel to BC, and mark the angles M and N, we can see that:

M is alternate to B, so M = B

N is alternate to C, so N = C



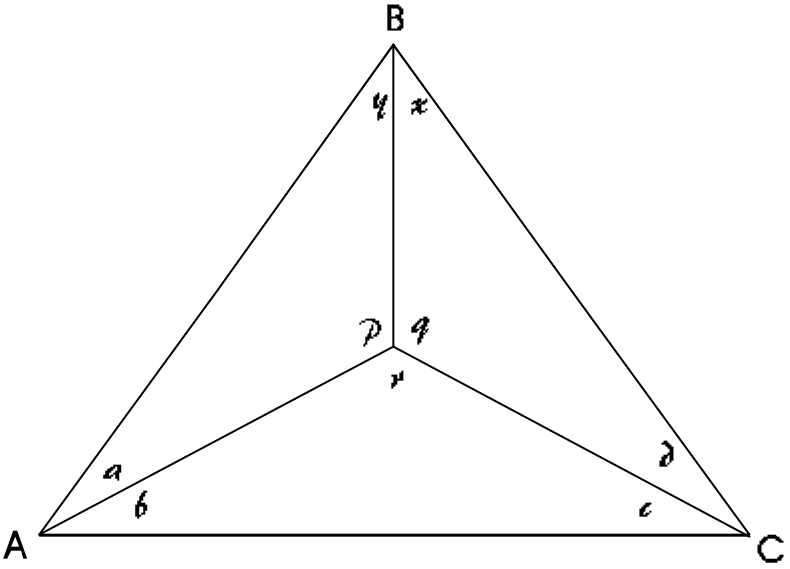
If we substitute B for M and C for N. we can see that the angles at the top of the figure are A, B, C, and that they form a straight line, which is 180^0. Therefore the interior angles ABC also have the angle sum of 180^0 or two right angles.

Investigation Refer students to the *Student Support Material 4.3 Activity 2* and complete the investigation into the Angle sum of a quadrilateral.

Demonstration

Work through a demonstration of the two approaches you can use to calculate the angle sum of a polygon e.g.

1. Draw diagonals from one vertex to all other vertices to form triangles. Count the number of triangles formed to calculate the angle sum.
2. Choose a point in the interior of the polygon and from this draw diagonals to all vertices.



$$p + q + r = 360^0$$

$$a + p + y = 180^o$$

$$b + c + r = 180^0$$

$$x + d + q = 180^0$$

$$a + p + y + b + c + r + x + d + q = 3 \times 180^0 = 540^0$$

Therefore $(a + b) + (c + d) + (x + y) = 540^0 - 360^0$

So $A + B + C = 180^0$

Have students use the same idea to calculate the angle sum of a quadrilateral divided into 4 triangles.

Investigation Using the ideas obtained from the above activities have students investigate the angle sum for a convex polygons with 'n' number of sides - *Student Support Material 4.3 Activity 3.* Construct a table to show findings. Encourage students to look for common factors (i.e. 180, 360, 540, 720….) and to look for the relationship between angle totals and the number of sides.

Students should discover that to find the angle sum of a polygon the number you multiply by 180 is the number of sides minus 2.

The formula for a polygon with n sides is therefore 180 (n - 2)

Number of sides of polygon	*Angle total*
3 sides	180^0 or (1 x 180)
4 sides	360^0 or (2 x 180)
5 sides	540^0 or (3 x 180)
6 sides	720^0 or (4 x 180)
7 sides	
8 sides	
9 sides	
10 sides	

Topic 3 – Teaching angles in the primary school

Angles Have students examine the Primary Mathematics Syllabus and support materials (Teacher Guides and Student Books) to see how the topic of 'Angles' is covered.

Language Working in small groups have students list down the words which would need to be introduced to children to teach angle activities. Ask students to think of the everyday language they would use as well as the maths specific language e.g. full turn, half turn, acute angle, degrees.

Teaching angles Refer students to the reading in the *Student Support Material 4.3 Activity 4* and have them complete the activity outline. Students will need to plan a lesson related to angles.

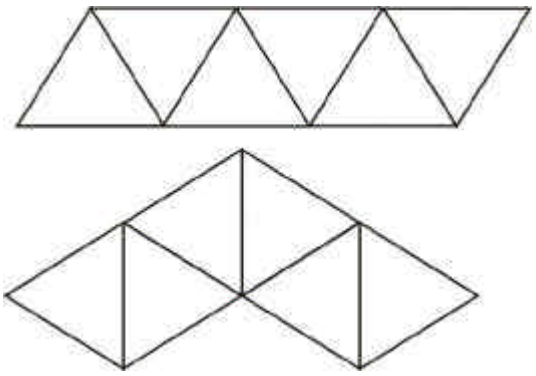
Extension activity – Pierced polygons

Investigation Refer students to the *Student Support Material 4.3 Activity 5*. Have them investigate the sum of interior angles of a pieced polygon of the form (n/m) – gon in terms of right angles where n represents the number of sides in the outer polygon and m the number of sides in the inner polygon. Hints for solving this investigation can be found in 'Topics in Geometry' by Wally Green.

Conclusion

Review Have students write down what they know about polygons. Discuss students writing as a whole class.

Module 4.4: Geometric Activities



Module 4.4 Geometric Activities is a core module within the ***'Enrichment Topics in Space and Measurement'*** unit. Geometry is one of the basic areas of mathematics, so it is essential that primary teachers have a good understanding of the geometrical concepts that will be presented to children. During this module students will have an opportunity to construct 3-D geometrical shapes, investigate tessellating shapes and explore geometrical concepts.

Objectives

By the end of this module students will be able to:

- construct a variety of 3-D shapes
- describe and identify patterns, properties and relationships of different shapes (2-D, 3-D)
- create tessellating designs using a combination of plane shapes
- review how patterns are taught in Primary School Mathematics Syllabus
- create designs using tangrams
- investigate pentominoes.

Concepts and skills to be developed

- Geometrical shapes and patterns
- Geometrical properties of 3-D shapes
- Spatial relationships
- Constructing 3-D shapes from 2-D nets
- Artistic and creative skills
- Measurement and calculations
- Investigation
- Manipulative
- Problem Solving
- Scale

Topics

- Two-dimensional Shapes
- Tessellation
- Three-dimensional Shapes
- Teaching Shapes in the Primary School
- Tangrams
- Pentominoes

Suggested teaching strategies

- Co-operative group work
- Investigation
- Construction
- Oral presentation

Suggested assessment tasks

- Develop teaching aids to support the teaching of geometry in the primary school classroom
- Construct a mobile of different 3-D Shapes

Resources

Butcher's paper
Chart paper
Markers
Geometric Shapes
Graph paper
Dot paper
Range of different size boxes

References

Booker, G., Bond, D., Briggs, J., Davey, G., (1997) *Teaching Primary Mathematics* (2nd Ed), Addison Wesley Longman Australia

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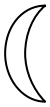
A suggested sequence of learning activities

Introduction - Shapes in the environment

Drawing Ask students to spend some time outside sketching some of the shapes which they see in the surrounding environment. On return to the classroom have students work in small groups to share their drawings. As a group develop a chart illustrating the shapes they have found and their characteristics e.g.

Shape (picture)	**Description/name**	**2-D or 3-D**	**Characteristics**
	Window frame of classroom - rectangle	2-D	4 sides, opposite sides of equal length, 2 pairs of parallel sides, 4 right angles, symmetrical (line and rotational)
	Water tank – cylinder	3-D	2 circular faces at right angles to a curved surface, solid, symmetrical
	Banana – curved sides	3-D	Solid, curved edges

Display charts

Definition Develop a class definition of two-dimensional and three-dimensional shapes.

Topic 1 – Two-dimensional shapes – plane geometry

Classification Provide students with a range of plane geometric shapes. Include triangles (equilateral, and isosceles), quadrilaterals (trapezium, and parallelogram such as a rhombus, rectangle, square, diamond, and rhomboid), pentagons, hexagons, octagons, decagons and dodecagons.
Ask students to classify the shapes and to justify their groupings.

Consider the different types of triangles and quadrilaterals and their characteristics e.g.

Triangles

- 3 equal sides and 3 equal angles – equilateral triangle
- 2 equal sides and 2 equal angles – isosceles triangle
- no sides of equal length – scalene triangle

Quadrilaterals

- 1 pair of parallel sides – trapezuim (sometimes referred to as a trapezoid)
- 2 pairs of parallel sides – parallelogram:
  - 4 equal sides – rhombus
  - 4 right angles – rectangle
  - 4 equal sides and 4 right angles – square
  - 4 equal sides and no right angles – diamond
  - Adjacent sides unequal and no right angles – rhomboid
  - Two pair of adjacent sides equal and all angles less than 180^0 – kite
  - Two pair of adjacent sides equal and one angle greater than 180^0 – arrowhead

(from Booker, G., Bond, D., Briggs, J., Davey, G., (1997) Teaching Primary Mathematics (2nd Ed), Addison Wesley Longman Australia p 295)

Investigation Refer students to *Student Support Material 4.4 Activity 1* and have them complete the investigation into Euler's Rule.

Euler's rule states that:

If you add together the number of vertices (V) and the number of regions (R), and then take away 2, the answer is always equal to the number of edges (E). This rule can be written using the following symbols

V + R – 2 = E

Topic 2 – Tessellations

Investigation Have students investigate examples of tessellations found in the environment e.g. in craftwork, in the home, in nature. Make a display of tessellating patterns discovered.

Re-look at the plane shapes classified in Topic 1. Have students investigate these according to whether they tessellate or not. Consider why some shapes tessellate and others do not.

Consider regular and semi regular tessellations. Have students create their own semi-regular tessellating pattern (use graph paper or blocks)

Refer students to the *Student Support Material 4.4 Activity 2* and have them determine which regular polygons will tessellate, and which will form a 'semi-regular' tessellation when combined with a second regular polygon. For example consider the points where the tessellating shapes meet. The sum of the angles about each point is 360^0.

Extension Activity: Making shapes that tessellate

Drawing Have students make shapes that tessellate by:

i. Drawing irregular shapes with more than 4 sides on square dot paper
ii. Making identical changes to the opposite sides of a square, rhombus or parallelogram
iii. Changing one side of an equilateral or isosceles triangle and rotating onto another equal side. Extend this idea to 'kites' and other figures
iv. Using pentomino pieces – some will tessellate using flips, slides and turns

(Some of these methods are outlined in Wally Green 'Topics in Geometry' p59-60)

Topic 3 – Three dimensional Shapes

Small group activity Provide the class with a range of boxes. Have students undo the sides of the boxes and identify the structure of the net. Ask students to draw the net for a cube and construct their own cube. Identify strategies used to join the sides together e.g. tabs attached

Pair work Working in pair's construct a range of 3-D shapes in various sizes.
Create class mobiles using the different shapes. Have students display the nets they used to construct the various shapes.

Identify the characteristics of the various 3-D shapes constructed.

For example there are five regular polyhedrons (also called platonic solids), tetrahedron, hexahedron (cube), octahedron, dodecahedron, icosahedron. Each regular polyhedron has faces which are congruent regular polygons and are exactly the same shape and size, and the internal angles are the same size.

Reading Consider the mathematical language children would need to describe the characteristics of different 3-D shapes. Refer students to *Student Support Material 4.4 Activity 3* and complete it.

Investigation Have students explore the surface area (SA) and volume (V) of the various rectangular solids. Look for relationships and patterns. See what happens to the ratio SA/V for a figure of fixed proportions, for example a rectangular solid with edges 1:1:2.

Extension Activity: Scale Drawing

Have students construct a scale model of a given object e.g. a chair, a table, a bookcase, a bed. Discuss the process involved (measurements, calculations, diagrams, how the model was constructed).

Topic 4 – Teaching shapes in the primary school

Class Discussion Review scope and sequence of Primary Mathematics Syllabus (Lower and Upper Primary), drawing attention to geometric activities.

Reading Refer students to the reading 'Basic Skills in Geometry' in the *Student Support Material 4.4 Activity 4*. Read the article and discuss the implications for us as primary school teachers.

Micro teaching Ask students' to plan, organise and teach a small group of children on topics related to Geometric activities, e.g. 2-D and 3-D activities, tessellations (Grade 3 to 8) incorporating ideas from the reading.

Student journal Ask students to write a journal which reflects on their strengths and weaknesses during their microteaching. Share journals and discuss common issues.

Topic 5 – Tangrams

Chinese tangram Have students construct their own seven-piece tangram set based on the model provided in the *Student Support Material 4.4 Activity 5*. Have students' complete the activity and create the figures illustrated.

Investigation Have students use the tangram pieces to:

- Form as many quadrilaterals as possible using any number of pieces
- Make other polygons

Discuss findings.

Topic 6 – Pentominoes

Polyominoes Introduce the class to polyominoes which are shapes that are formed by joining squares together by joining edges. Consider:

- Monomino (1 square)
- Domino (2 squares)
- Tromino (3 squares)
- Tetromino (4 squares)
- Pentomino (5 squares)

Construction Have students construct different pentominoes and draw them on square paper (there are 12 different pentominoes). Ask students to classify them:

- as polygons according to their number of sides
- according to whether they have line symmetry only, rotational symmetry only, both line and rotational symmetry, neither line nor rotational symmetry

Student Support Material 4.4 Activity 6

Investigation Working in small groups have students complete one of the investigations found in the *Student Support Material 4.4 Activity 7***.**

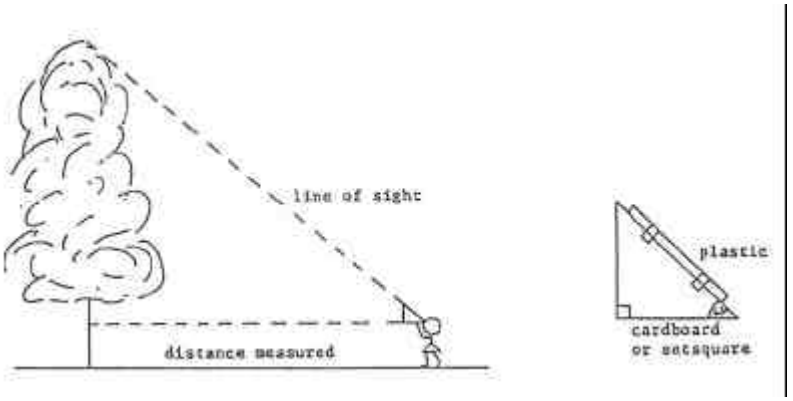
Extension Activity: Hexiamonds

Investigation Refer students to the *Student Support Material 4.4 Activity 8* and ask them to complete the investigation into heximonds.

Conclusion

Class discussion Review the main ideas presented within this module and the implications for us as primary teachers.

Module 4.5 – Measurements



Module 4.5 'Measurements' is a core module within the unit ***'Enrichment Topics in Space and Measurement'.*** Measurement is an essential part of any primary mathematics program as an understanding of measurement concepts is necessary for managing different situations which occur in everyday life. During this module students will have the opportunity to further develop their own skills in measurement, as well as investigate various method of indirect measurement. Consideration will be given to the teaching of measurement concepts in the primary school.

Objectives

By the end of this module students will be able to:

- identify different traditional methods of measurement commonly used in PNG
- distinguish between direct and indirect measurement
- identify and use different units of measurement
- plan for the teaching of measurement in the Primary School

Concepts and skills to be developed

- Direct and indirect measurement
- Units of measurement
- Length, area, surface area, volume, capacity, weight, mass, money, time, temperature
- Estimation
- Measuring calculations
- Recording and organising information
- Investigation
- Research

Topics

- Measurement in PNG traditional culture
- Indirect and direct measurement
- Units of measurement
- Teaching measurement in the primary school

Suggested teaching strategies

- Group work
- Research
- Investigation

Suggested assessment tasks

- Create a teaching aid which illustrates the standard unit and related units, and their symbols for measuring a particular attribute e.g. length – standard unit is metre, (m) related units are: centimetres, (cm) millimetres, (mm) kilometres (km).
- Investigate traditional measurement practices and present a report on findings.

Resource

Newspapers	Butchers paper and chart paper
Markers	Mirror
Rulers	Scales
Protractors	Clock
Thermometer	Straws

Reference

Booker, G., Bond, D., Briggs, J., Davey, G., (1997) *Teaching Primary Mathematics* (2nd Ed), Addison Wesley Longman Australia

Department of Education Papua New Guinea (1998), *Lower Primary Mathematics Syllabus Grade 3-5*,

Department of Education Papua New Guinea (draft 1999) *Upper Primary Mathematics Syllabus Grade 6-8*

Green, Wally, (1998) *Report on Mathematics Education in Community teachers Colleges in PNG, Fourth Phase, Activities Observations and Recommendations*, OHE – ADB –IDP, Papua New Guinea Higher Education Project.

Green, Wally. *Topics in Geometry* Department of Education, PNG

Swan, K., Adamson, R., Addison, J. Asp, G., Cocking, M., FitzSimons, G., Lovitt, C., & Orr, M. (1997), *Nelson Maths for the CSF 7*, Nelson

A suggested sequence of learning activities

Introduction

Newspaper review

Provide the class with a number of newspapers. Ask students to review the newspapers and list down instances of measurement of length, area, volume, mass, angles, time and temperature. Ask them to note down:

- what attribute is being measured e.g. length
- what unit is commonly used e.g. kilometre
- what object is measured e.g. distance from one place to another

Revision

Refer students to the *Student Support Material 4.5 Introduction.* Revise the different attributes that can be measured and the units used e.g. standard unit and the smaller and larger units. Create a chart together as a class like the one below.

Quantity	Standard unit	Smaller unit(s)	Larger unit(s)
length	metre (m)	centimetre (cm) millimetre (mm)	kilometre (km)
mass	gram (g)	milligram (mg)	kilogram (kg)
time	hour (h)	second (s) minute (min)	day (d) year (y)
area	square metre (m^2)	square centimetre (cm^2) square millimetre (mm^2)	hectare (ha)
volume	cubic metre (m^3)	cubic centimetre (cm^3)	
capacity (volume of fluids)	litre (L)	millilitre (mL)	
speed	kilometres per hour (kmh^{-1})	metres per second (ms^{-1})	
temperature	degrees Celsius (^0C)		
angle	degree of plane angle (^{0})		

Topic 1 – Measurement in Traditional PNG culture

Guest speaker

Invite a community member to come to the class and talk with students about how a particular attribute is/was measured traditionally (this could be a lecturer or a community elder with strong knowledge in this area). Ask them to talk about:

- What was measured and for what purpose?
- How the measurement was done?
- What objects or materials were used?

- Is this method is still practiced today?

If possible allow students an opportunity to practice using the method of measurement described.

Investigation Ask students to work together in mixed Provincial groups. Refer students to the *Student Support Material 4.5 Activity 1* and have each group select one of following measurement quantities.

Length, Mass, Time, Area, Volume, Speed

Students will need to investigate how this type of measurement was/is carried out by different traditional cultural groups.

If students have limited knowledge, encourage them to speak to other students, lecturers and community people to extend their understandings. The following questions (adapted from Hanrahan, HTTC, 1996) may help students with their investigation:

- When is the attribute measured and for what things? Why?
- What materials or objects are used to do the measuring?
- Are there constant units for the measurements or do the units change each time the measuring is done?

Have students create a display of their findings and discuss the similarities and differences in how the same attribute is measured by different cultural groups.

Presentation Display students' investigation into traditional ways of measuring and allow students an opportunity to view the work completed by others and to discuss findings.

Implications for teaching Ask students to consider how these methods of measuring compare to those taught in primary schools. Discuss with the students their believes about:

- The value of maintaining traditional knowledge
- The role of schools in teaching traditional knowledge
- How traditional understandings may support the teaching of the concepts covered in the primary school curriculum.

Students with differing views may wish to debate the issues.

Topic 2 – Direct and Indirect measurement

Measuring

Ask students to nominate the tallest and shortest person in the class. Have the class organise themselves in to order according to height (students should do this without rulers and through a process of direct comparison). Make a list of the maths language that was used during the process e.g. tall, short, taller, shorter, tallest, shortest, average, same height, long, small, (also include Tok Pisin and Tok Ples words which were used).

Discuss the process used to order the class and the concepts and skills needed to do this (understanding of the concept of length, language to describe length, ability to compare and arrange things in order).

Set up a range of measuring activities which require the students to complete direct and indirect measurements, eg:

- Compare the width of a table and the width of a door
- Which is further from the classroom, the mess or the expressive arts classroom
- The area of a table surface in the maths classroom when compared with a table in the library
- The capacity of 2 containers
- The mass of two objects

Have students complete the activities and discuss the process they worked through to solve the problems.

Discussion

Conduct a class discussions which considers the importance of developing children's direct and indirect measurement skills.

Problem Solving

Ask students how they would find the height of an inaccessible object such as a tall building. Discuss strategies and allow people an opportunity to find the height of a building.

Refer students to the *Student Support Material 4.5 Activity 2* and have them work through the indirect measurement methods outlines.

Topic 3 – Units of Measurement

Measuring using non-standard units

Ask students to identify non-standard units which they could use to measure a range of different attributes e.g. length, time, area, volume. Have each student complete a measurement activity using non-standard unit e.g. how many paces it is from the classroom to the library/ how many swings of a pendulum does it take to sing the song 'happy birthday'? Compare results and discuss the reasons for variations.

Reading

Refer students to the *Student Support Material 4.5 Activity 3* and the reading 'Reasons for introducing measurement to children through the use of non-standard units'.

Discuss with students the ideas raised in the reading and about the importance of introducing measurement to children through the use of non-standard units.

Standard units

Ask students to write a brief statement about why standard units are needed for measurement (e.g. eliminate ambiguities, to facilitate communication, enhance precision in measurement). Share writing and discuss the main ideas raised as a class.

Measuring Objects

Provide students with a range of measuring tools e.g. scales, rulers, protractor, clock, thermometer, and a range of different objects and/or situations e.g. a piece of string, a bottle, a card asking them how long it takes to walk from the classroom to the library, a bag of rice, a piece of material etc.

Ask students to measure the various objects for relevant attributes using an appropriate tool e.g. scales to find the weight of a bag of rice. Have students record their results on a table. Discuss results.

Note: The activities planned should build on students knowledge and support them in areas where they may have difficulties e.g. activities which require students to calculate capacity, volume, mass, angles may be more challenging than activities which require student to measure the length and area.

Object/Activity	Attribute measured	Measuring tool	Standard unit	Symbol	Result
Walking from the classroom to the library	Time	Clock	Hour	h	1 min 15 s
Piece of material	Area	Ruler	Square metre	m^2	1.5 m^2

Discussion Discuss the different types of quantities measured and the units used e.g. the standard and the smaller and larger units. Discuss the relationship between the various units and how you can convert from one to the other e.g. centimetres to metres. Have students complete *Student Support Material 4.4 Activity 4*

Puzzle/quiz Write the units and the attributes measured on a set of flash cards. Play a card game where students have to match the cards according to unit and attribute e.g. area & m^2

Have students develop a quiz on units of measurements which could be used with primary school children. For example:

- I am 1000 times bigger than one millimetre, who am I?
- I am the standard unit for measuring time, who am I?

Topic 4 – Teaching Measurement in the Primary School

Discussion Discuss with students 'Why teach measurement in Primary School?' Outline the importance of teaching measurement because of its value in many everyday situations.

Review Have students review the primary school mathematics curriculum and see the measurement topics which are taught and the activities recommended. Highlight the topics that are covered and the sequential developed from Grades 3 to 8.

Reading Have student read the article 'Learning Sequence for Measurement' in the *Student Support Material 4.5 Activity 5*. Complete the activity and discuss student findings.

Lesson planning Have students choose a measurement topic from the primary syllabus. Ask students to plan a sequence of lessons which allow children to work through the sequence outlined in the reading. A number of steps may be covered in one lesson. For example:

Lesson 1: Identifying the attribute and comparing and ordering

Lesson 2: Comparing and ordering and Non Standard units

Peer teaching Have students choose one lesson from their sequence and teach it to their peers.

Conclusion

Journal writing Have students choose one of the following topics and complete a journal. Working in groups, ask students to share their journals and to discuss the ideas presented.

- Explain what is meant by direct and indirect measurements and give examples. Discuss their importance in develop children's measurement skills.
- Discuss the advantages and disadvantages of modern and traditional measurements
- Discuss the importance of teaching measurement in Primary school

Unit Glossary

Asymmetry — Not having symmetry. An object line symmetry or rotational symmetry is described as asymmetrical.

Concave polygon — A concave polygon is a polygon where one or more of its vertices points into the inside of the polygon.

Congruent — A shape or object is said to be congruent when they are exactly alike in all aspects i.e. same size and shape.

Convex polygon — A convex polygon is a polygon where all of its vertices point to the outside of the polygon.

Curve — A line of which no part is straight.

Direct measurement — When two or more objects are measured directly against one another e.g. two pencils placed side by side and their length compared, lifting two pawpaws to compare their mass.

Euclidean transformation — The process by which a shape changes position but does not change its shape or size e.g. position changed through reflection (flips), rotation (turns) or translation (slides).

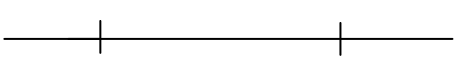
Indirect measurement — When two or more objects are measured through the use of an intermediary e.g. the width of the table and the width of a door are measured by using hand spans.

Irregular polygon — A plane shape in which not all sides are equal in length and at/or at least one angle is different in size from the other angles.

Line of symmetry — The line that divides something in half so that one half is the mirror image of the other half. This line is sometimes called an axis of symmetry.

Line segment — Part of a straight line e.g.

Line segment



Metric system — A decimal system of weights and measures. The base units for length is metre (m), for mass is kilogram (kg) and for area is square metres (m^2).

Non Standard units	Arbitrary units which are used to help us measure e.g. hand span, paces, are non-standard units that can be used to measure length.
Non-Euclidean Transformation	the process by which a shape changes and size and/or shape are not retained.
Pentomino	A pentomino is formed by joining five squares side by side.
Plane shape	A plane shape is a shape that can be drawn on a flat surface. It is a two-dimensional object.
Platonic solids regular polyhedrons	A three-dimensional shape where all the plane faces are identical in shape and size, all edges are the same length, all angles are the same and all vertices are identical. These shapes are symmetrical. There are 5 platonic solids – tetrahedron, cube, octahedron, dodecahedron and an icosahedron.
Point chord	A line joining two points on a circumference.
Polygon	A plane shape which has 3 or more line segments as sides, e.g. all straight sides such as a hexagon.
Polyhedron	A three-dimensional shape with plane faces.
Polyomino	A plane shape made of squares of the same size, each square being connected to at least one of the others by a common edge.
Ray	A half line. It has a starting point but no end
Regular polygon	A polygon is regular if its sides are equal in length and its angles are equal in size.
Regular tessellation	When a single regular shape is used to cover a surface it is called a regular tessellation.
Rotational symmetry	A shape or design that can be rotated to cover the original in less than a full turn is said to have rotational symmetry.

Semi-regular tessellation:	When combinations of regular shapes are used to cover a surface then the result is called a semi-regular tessellation.
Similarity	Similar figures have the same shape but not necessarily the same size. One is the scale model of the other. In similar figures corresponding angles are equal and the ratio of corresponding sides is constant.
Solid shape	A solid shape is a figure with three-dimensions, usually length, width and height.
Standard units	Units of measure that are accepted by agreement as the basis for a system of measurement e.g. the metre, the kilogram are standard units of the metric system.
Symmetry	A shape has symmetry or is symmetrical when one half of the shape can fit exactly over the other half.
Tangrams	A Chinese puzzle made up of square cut into 7 pieces, five triangles (two small, one medium size and two large), a parallelogram and a square.
Tessellate	If a surface can be completely covered by the repeated use of a single shape, without overlapping, then that shape is said to tessellate.
Three-dimensional shapes or solids	Shapes which have length, width and height e.g. cubes, pyramids, cylinders.
Transformation	The process by which the shape, position or size of an object is changed e.g. enlarged, flipped, rotated.
Two-dimensional shapes or plane shapes	Plane shapes have two dimensions – length and width or length and height – and lies wholly on or within a single flat surface or plane. This means they lack depth, the third dimension.