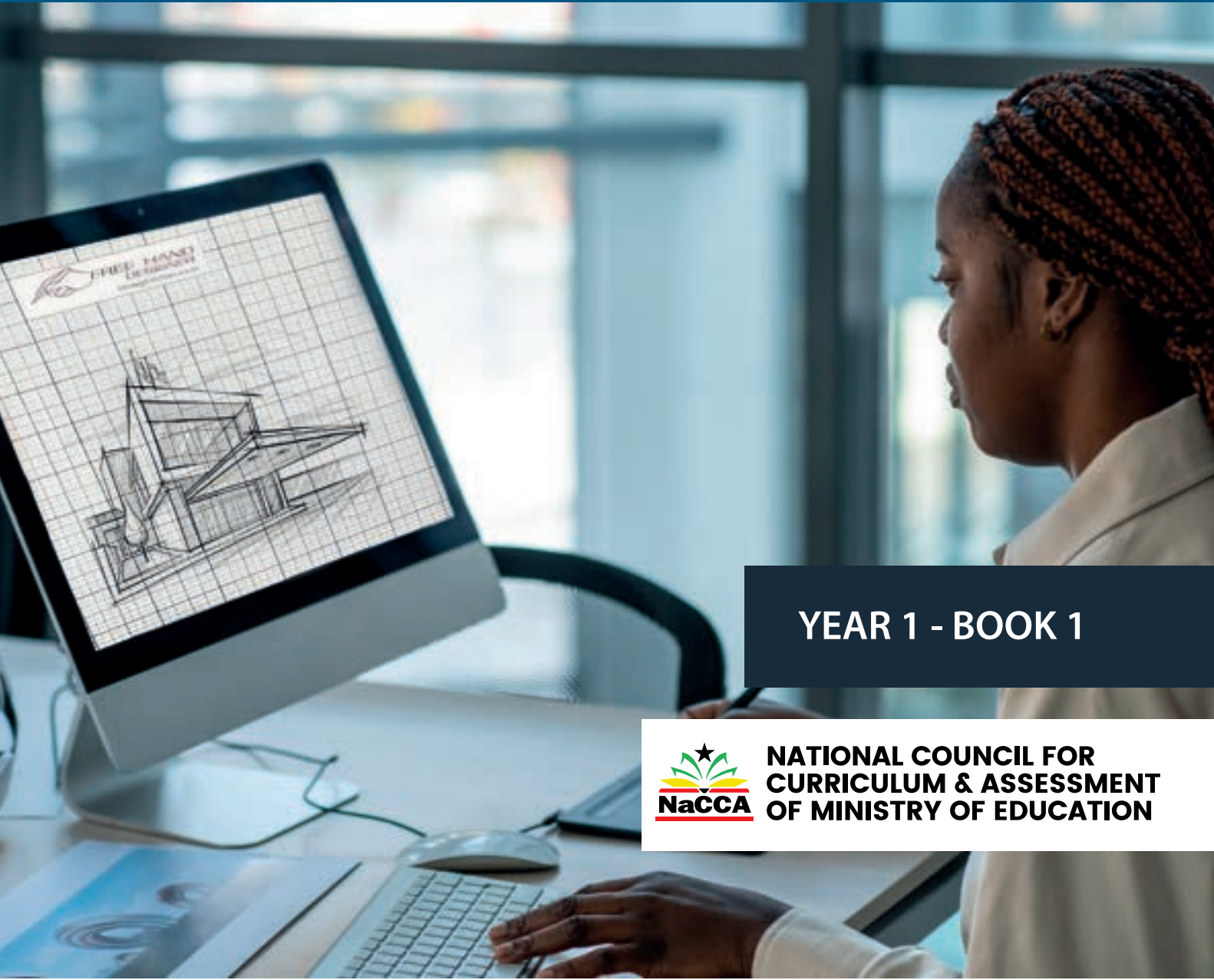
MINISTRY OF EDUCATION

Design and Communication Technology

TEACHER MANUAL



YEAR 1 - BOOK 1

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

MINISTRY OF EDUCATION

REPUBLIC OF GHANA

Design and Communication Technology

Teacher Manual

Year One - Book One

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

DESIGN AND COMMUNICATION TECHNOLOGY TEACHER MANUAL

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INTRODUCTION

The National Council for Curriculum and Assessment (NaCCA) has developed a new Senior High School (SHS), Senior High Technical School (SHTS) and Science, Technology, Engineering and Mathematics (STEM) Curriculum. It aims to ensure that all learners achieve their potential by equipping them with 21st Century skills, competencies, character qualities and shared Ghanaian values. This will prepare learners to live a responsible adult life, further their education and enter the world of work.

This is the first time that Ghana has developed an SHS Curriculum which focuses on national values, attempting to educate a generation of Ghanaian youth who are proud of our country and can contribute effectively to its development.

This Teacher Manual for Design and Communication Technology covers all aspects of the content, pedagogy, teaching and learning resources and assessment required to effectively teach Year One of the new curriculum. It contains this information for 24 weeks of Year One. Teachers are therefore to use this Teacher Manual to develop their weekly Learning Plans as required by Ghana Education Service.

Some of the key features of the new curriculum are set out below.

Learner-Centred Curriculum

The SHS, SHTS, and STEM curriculum places the learner at the center of teaching and learning by building on their existing life experiences, knowledge and understanding. Learners are actively involved in the knowledge-creation process, with the teacher acting as a facilitator. This involves using interactive and practical teaching and learning methods, as well as the learner's environment to make learning exciting and relatable. As an example, the new curriculum focuses on Ghanaian culture, Ghanaian history, and Ghanaian geography so that learners first understand their home and surroundings before extending their knowledge globally.

Promoting Ghanaian Values

Shared Ghanaian values have been integrated into the curriculum to ensure that all young people understand what it means to be a responsible Ghanaian citizen. These values include truth, integrity, diversity, equity, self-directed learning, self-confidence, adaptability and resourcefulness, leadership and responsible citizenship.

Integrating 21st Century Skills and Competencies

The SHS, SHTS, and STEM curriculum integrates 21st Century skills and competencies. These are:

- **Foundational Knowledge:** Literacy, Numeracy, Scientific Literacy, Information Communication and Digital Literacy, Financial Literacy and Entrepreneurship, Cultural Identity, Civic Literacy and Global Citizenship
- **Competencies:** Critical Thinking and Problem Solving, Innovation and Creativity, Collaboration and Communication
- **Character Qualities:** Discipline and Integrity, Self-Directed Learning, Self-Confidence, Adaptability and Resourcefulness, Leadership and Responsible Citizenship

Balanced Approach to Assessment - not just Final External Examinations

The SHS, SHTS, and STEM curriculum promotes a balanced approach to assessment. It encourages varied and differentiated assessments such as project work, practical demonstration, performance assessment, skills-based assessment, class exercises, portfolios as well as end-of-term examinations and final external assessment examinations. Two levels of assessment are used. These are:

- Internal Assessment (30%) – Comprises formative (portfolios, performance and project work) and summative (end-of-term examinations) which will be recorded in a school-based transcript.

- External Assessment (70%) – Comprehensive summative assessment will be conducted by the West African Examinations Council (WAEC) through the WASSCE. The questions posed by WAEC will test critical thinking, communication and problem solving as well as knowledge, understanding and factual recall.

The split of external and internal assessment will remain at 70/30 as is currently the case. However, there will be far greater transparency and quality assurance for the 30% of marks which are school-based. This will be achieved through the introduction of a school-based transcript, setting out all marks which learners achieve from SHS 1 to SHS 3. This transcript will be presented to universities alongside the WASSCE certificate for tertiary admissions.

An Inclusive and Responsive Curriculum

The SHS, SHTS, and STEM curriculum ensures no learner is left behind, and this is achieved through the following:

- Addressing the needs of all learners, including those requiring additional support or with special needs. The SHS, SHTS, and STEM curriculum includes learners with disabilities by adapting teaching and learning materials into accessible formats through technology and other measures to meet the needs of learners with disabilities.
- Incorporating strategies and measures, such as differentiation and adaptative pedagogies ensuring equitable access to resources and opportunities for all learners.
- Challenging traditional gender, cultural, or social stereotypes and encouraging all learners to achieve their true potential.
- Making provision for the needs of gifted and talented learners in schools.

Social and Emotional Learning

Social and emotional learning skills have also been integrated into the curriculum to help learners to develop and acquire skills, attitudes, and knowledge essential for understanding and managing their emotions, building healthy relationships and making responsible decisions.

Philosophy and vision for each subject

Each subject now has its own philosophy and vision, which sets out why the subject is being taught and how it will contribute to national development. The Philosophy and Vision for Design and Communication Technology is:

Philosophy: The present and future generations of learners will apply technology to solve problems in their environment through creativity and innovative application of concepts for the production of artefacts. This will be done through the support of skilled and innovative teachers who are to prepare learners for life-long learning as well as introducing them to the world of work and adult life.

Vision: Equip learners with 21st century skills: critical thinking, creativity, collaborations and innovation as well as good citizenship and competencies to identify increasingly complex societal problems and use appropriate technological skills to solve them. Thus, it prepares learners for life-long learning and introduces them to world of work and adult life.

ACKNOWLEDGEMENTS

Special thanks to Professor Edward Appiah, Director-General of the National Council for Curriculum and Assessment (NaCCA) and all who contributed to the successful writing of the Teacher Manuals for the new Senior High School (SHS), Senior High Technical School (SHTS) and Science Technology, Engineering and Mathematics (STEM) curriculum.

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SECTION 1: CONCEPTUAL DRAWING

UNIT 1: CONCEPT SKETCHES

Strand: Conceptual drawing

Sub-Strand: Concept sketches

Learning Outcome: *Apply knowledge and skills of the concept sketches to generate and create designs using freehand drawing by applying rendering techniques in designing as well as the principles of perspective drawing and proportion.*

Content Standard: Apply understanding and techniques of concept sketches in designing

INTRODUCTION AND UNIT SUMMARY

This unit introduces learners to the fascinating world of concept sketches and its application in designing. These preliminary drawings serve as the basics for creative projects, allowing ideas to take shape and evolve. Through hands-on exercises, demonstrations, and critical discussions, learners are expected to put their ideas and concepts into meaningful sketches for designing.

Teachers are to allow learners the freedom to imagine and genuinely generate concept sketches, individually or in groups.

Concept sketches are visual representations of an idea for something that has yet to come into existence. It is the creative process used in animated feature films, video games, and television to design characters, vehicles, props, and environments.

The unit also covers basic shapes and forms, rendering techniques, perspective and proportions.

The weeks covered by the unit are:

Week 1: *Explain concept sketches and their applications in designing*

Week 2: *Use basic shapes, forms and rendering techniques in designing*

Week 3: *Use the principles of perspective drawing and proportion in designing*

SUMMARY OF PEDAGOGICAL EXEMPLARS

When it comes to teaching concept sketches**,** there are several effective pedagogical strategies that enhance the learning process. These include:

- Environmental observation
- Managing talk for learning
- Collaboration/Group work
- Project-based learning
- Problem-based learning

Effective teaching strategies impact learner engagement, understanding, and overall academic achievement, by incorporating these pedagogical approaches, the teacher can create a dynamic and enriching learning experience for the learners.

ASSESSMENT SUMMARY

The assessments to be used to monitor learning progress during instruction should include both formative and summative assessments which emphasise on learners' ability to:

- genuinely imagine and practically generate concept sketches for designing.
- explain concept sketches and their applications in designing.
- use basic shapes, forms and rendering techniques in designing.
- use the principles of perspective drawing and proportion in designing.

Keep track and provide learners with prompt feedback on their performances and any feedback on their understanding of key concepts for targeted instructional support.

Week 1

Learning Indicator(s): *Explain concept sketches and their applications in designing*

Theme or Focal Area 1: Concept Sketches

A concept sketch serves as a powerful communication tool for designers, architects, and artists to convey their initial ideas and design into sketches. These sketches are not meant to be detailed or precise; instead, they capture the essence of a concept.

Definition: A concept sketch is a freehand drawing that communicates the most critical aspects of a design. Whether it is for a construction project, a product, or any creative project, concept sketches provide a visual representation of an idea.

Figure 1.1.1: *Examples of concept sketches*

Types of Sketches

1. Interior sketching
2. Fashion sketching
3. Industrial sketching
4. Travel sketching

Interior sketching

Fashion sketching

Industrial sketching

Travelling sketching

Figure 1.1.2: *Types of sketches*

Tools and Materials used for Sketching

Using the right tools and materials enhances the appearance of sketches. The following are examples of tools and materials used for sketching:

- Pencils
- Sketch pads
- Erasers
- Pencil sharpener
- Drawing pens or ink
- Blending stumps
- Charcoal

Figure 1.1.3: *Tools and materials for sketching*

Lines

Lines are a fundamental element that artists use to convey various meanings, emotions, and visual effects in their artwork. Line art comes in different shapes, sizes and length, examples of lines include, spiral, horizontal, vertical, curved, zig zag and many more.

Horizontal lines: These lines add a sense of calm and stability, making the viewer feel a sense of tranquillity, they are associated with rest and peace. Used to suggest horizon, horizontal lines give the impression of distance and depth.

Vertical lines: Ignite the sense of power and upward movement; these lines create strong visual impact and symbolise growth progress and authority.

Diagonal lines: Create a sense of movement, tension and excitement as they break away from the stability of vertical and horizontal lines.

Zig zag lines: Bring vibrant and dynamic rhythm in the composition. They create a sense of movement and action. Depending on how they are used zig zag lines can evoke feelings of excitement or tension.

Curved lines: Guide the lines through composition connecting a sense of elegance and tranquillity, they add visual interest and create a sense of movement and rhythm.

Line quality/weight

Line quality is a term used in art to describe the thinness or thickness of a line. Line quality can suggest different effects, such as value, texture, depth, material, lighting and weight. Line quality can make drawings look more realistic, expressive and readable.

Line consistency

Refers to how closely related the elements (lines) within a design or composition are in terms of their visual characteristics. When creating visual art, graphic design, or other visual compositions, maintaining consistent lines can significantly impact the overall aesthetic and readability.

Line consistency comprises of the following:

1. **Stroke weight**: Consistent stroke weight ensures that lines have the same thickness throughout the design. Varying stroke weights can create visual imbalance or confusion.
2. **Line style**: Whether using solid lines, dashed lines, or other styles, maintaining consistency helps unify the design. For example, if you are creating an infographic, using the same style for all connecting lines ensures clarity.

3. **Alignment**: Lines should align properly with other design elements. For instance, if you are designing a grid-based layout, ensuring that all horizontal, vertical or diagonal lines align precisely contributes to a cohesive look.
4. **Direction**: Consistent line direction (horizontal, vertical or diagonal) creates harmony, avoids abrupt changes in line direction unless intentional for emphasis.
5. **Spacing**: Equal spacing between lines (such as grid lines or text baselines) enhances readability. In typography, consistent line spacing is crucial for legibility.

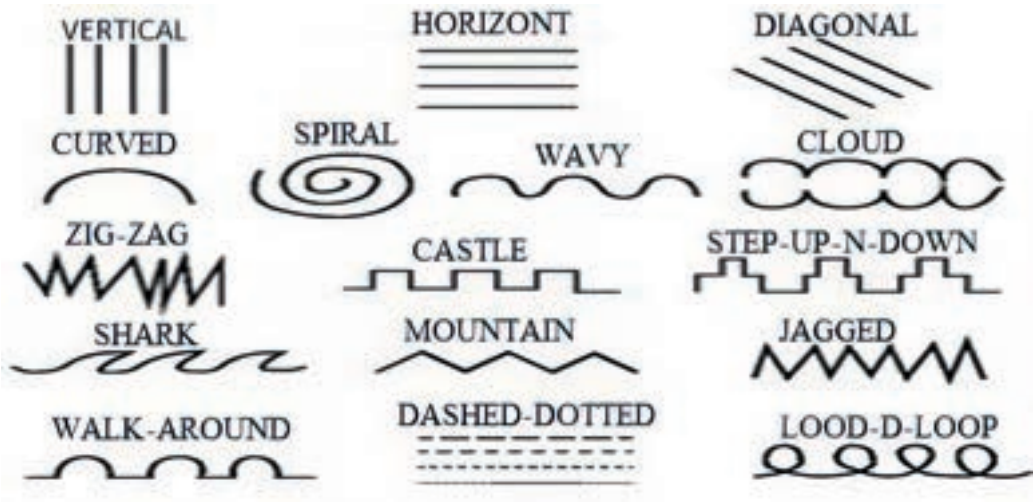


Figure 1.1.4: *Types of lines: the artist view*

Table 1.1.1: Types lines used by engineers

Type	Line	Description	Application
1		Continuous Thick	Visible outlines, Visible edges.
2		Continuous Thin	Dimension lines, Projection lines, Leader lines, Imaginary lines of intersections, Outlines of revolved sections.
3		Continuous Thin freehand	Boundaries of Limits of Partial or Interrupted views.
4		Continuous Thin Zig-Zag	Long break lines
5		Dashed Thick	Hidden outlines, Hidden edges.
6		Dashed Thin	
7		Chain Thin	Centre lines, Lines of Symmetry, Trajectories.
8		Chain Thin and Thick at ends & Changes of Direction	Cutting Planes
9		Chain Thick	Indication of lines or surfaces to which special treatment required.
10		Chain Thin Double Dash	Outlines of adjacent parts, Alternate and Extreme positions of movable parts, Centroidal lines, Initial outlines, Prior to forming.

Application of Concept Sketches

1. **Architecture**: Architects use concept sketches to explore layout, site plans, circulation patterns and settlements. These sketches help architects respond to project briefs and envision the overall form and character of a construction project.

2. **Product design**: Industrial designers create concept sketches to generate ideas for new products or the reengineering of existing ones. These sketches allow designers to visualise how a product might look and function.
3. **Interior design**: Interior designers use concept sketches to plan spatial layouts and furniture placement. Sketches convey the intended mood, colour schemes and overall aesthetics of an interior space.
4. **Urban planning and landscape design**: Concept sketches aid in understanding site conditions, topography, and natural features. Urban planners use sketches to outline zoning, green spaces, and infrastructure.
5. **Art**: Artists use concept sketches to generate realistic and fascinating artwork, they develop around the concept sketches by modifying and improving it to achieve the desirable result.

Learning Task

1. Explain concept sketches.
2. Identify the types of sketches.
3. Explain line consistency and line weight.
4. Explain the importance of concept sketches in designing.

Pedagogical Exemplars

Managing talk for learning, collaboration, critical thinking

In mixed-ability groups present to learner's different types of sketches. Allow learners to observe the sketches and present their findings in a whole class discussion. Ensure the groups consist of both the AP, P and HP learners.

Research, group work, communication, critical thinking

In their groups assist learners to research and discuss concept sketches, types of sketches, their application in the design process, as well as tools and materials used for sketching. Provide access to the internet, relevant videos and charts etc. Ensure AP and P learners participate in the research and discussions. Support learners to present their findings in a group presentation, allow the P learners to lead the presentation.

Key Assessment (DoK)

Level 1

1. List three types of sketches.
2. State two reasons why sketches are important in the design process.

Level 2

3. Explain concept sketches through any medium.

Level 2

4. Explain the following:
   i. Line quality/weight.
   ii. Line consistency.

Week 2

Learning Indicator(s): *Use basic shapes, forms and rendering techniques in designing*

Theme or Focal Area 2: Basic Shapes, Forms and Rendering Techniques in Designing

Rendering

The primary goal is to enhance the appearance of images. This appearance should have an impact on the aesthetics of the image or object.

Shapes and forms

Shape: A shape refers to a two-dimensional (flat surface) enclosed area. It represents the outline, outer boundary or surface of an object. Everything we see in our environment has a shape. Some common two-dimensional shapes include squares, rectangles and ovals.

Form: Is something you can potentially hold in your hand. Unlike shapes, forms are three dimensional and have depth and volume. Without shading or perspective, an image can still look like a shape. Some basic three-dimensional forms include spheres, pyramids and cubes.

Creating forms from shapes

Usually created with basic two-dimensional shapes that are transformed into three-dimensional forms. For example, a circle is transformed into sphere, triangle into a pyramid and a square into a building block for the cube.

The relationship between shapes and forms occurs in both art and in science. Refining skills, experimenting with shading, perspective and composition can breathe life into a design.

Rendering Techniques

Shading

Shading is a fundamental rendering technique used by artists to add depth, dimension and realism to their artwork. Artists add colour, texture to objects in a scene giving them a more realistic appearance. The shading process manipulates light and dark levels to add natural effects and make objects appear voluminous. There are various shading techniques of which three will be discussed in year one. The other techniques will be discussed in year two.

- Hatching

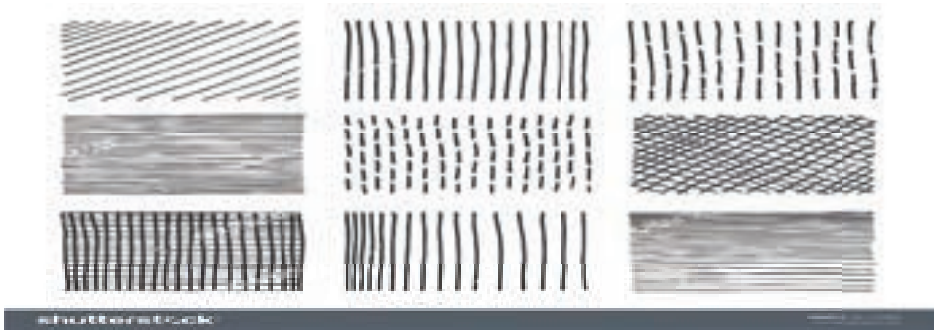


Figure 1.1.5: *Shading by Hatching*

- Stippling

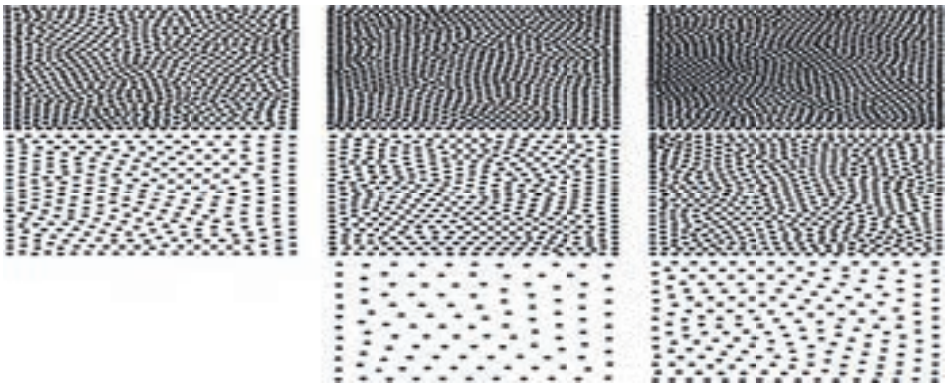


Figure 1.1.6: *Shading by Stippling*

- Scribbling

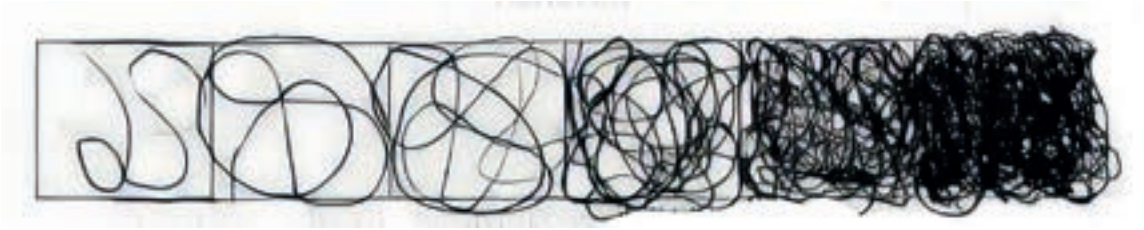


Figure 1.1.7: *Shading by scribbling*

Rendering is not often made using just one technique but a combination of several techniques in one work to help achieve more stunning and accurate results.

Note: Teachers should elaborate on the rendering techniques with the aid of sketches, pictures, videos and board illustrations to enhance learners' comprehension.

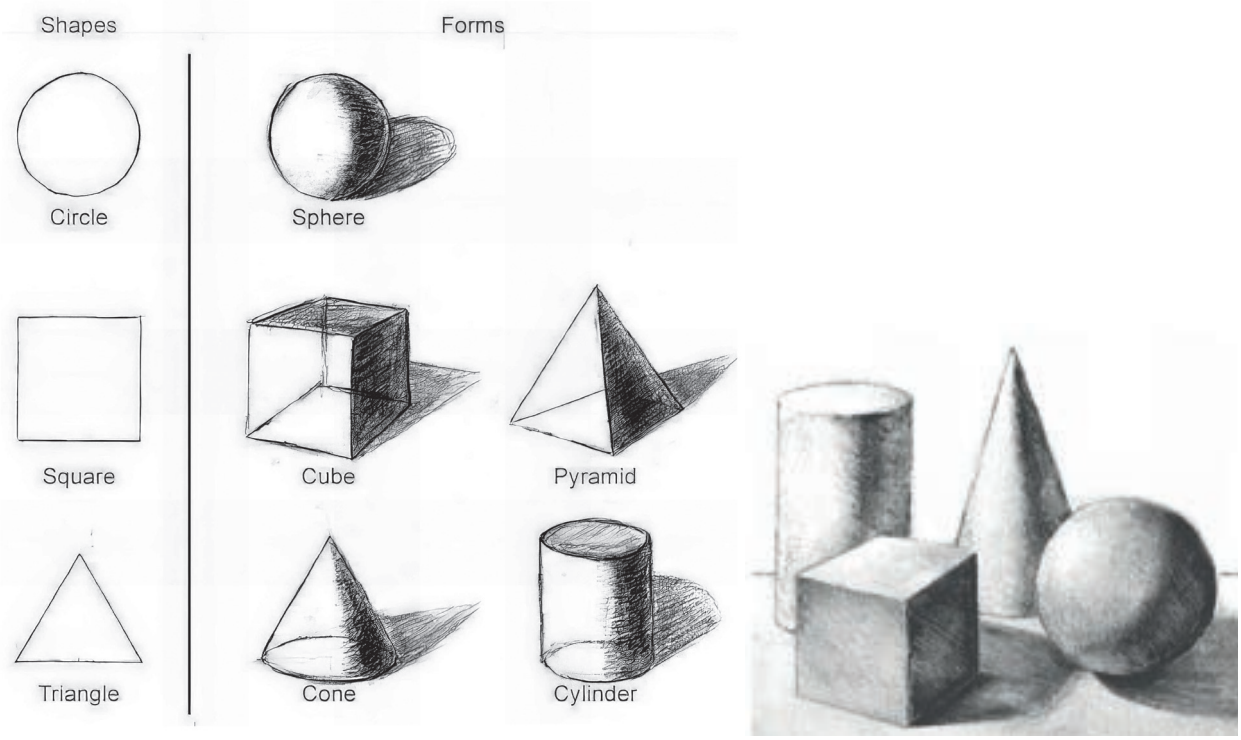


Figure 1.1.8: *Rendered objects using the various techniques*

Learning Task

1. State rendering techniques that are used in artwork.
2. Select basic shapes and use them to create an object.
3. Use rendering techniques to render the object created.

Pedagogical Exemplars

Group work, research, communication, critical thinking, collaboration

In groups, learners use relevant resources such as photographs, videos, drawings and board illustrations to identify and record the various rendering techniques used in designing. Support AP and P learners by attending to them regularly.

Individual activities, manipulative skills, critical thinking

Guide learners to use freehand sketches to draw and render various shapes and forms with one or more of the rendering techniques they are familiar with. Encourage learners to draw both organic and inorganic objects.

Observation, appreciation, critical thinking

Assist learners to paste their artwork on the classroom walls to create a gallery and encourage learners to appreciate each other's artwork. Learners provide constructive feedback to their classmates.

Key Assessment (DoK)

Level 1

1. State three rendering techniques that are used in artwork.

Level 2

2. Select two basic shapes and use them to create an object.
3. Use two or more rendering techniques to render the object created.

Week 3

Learning Indicator(s): *Use the principles of perspective drawing and proportion in designing*

Theme or Focal Area 3: Principles of Perspective Drawing and Proportion in Designing

Perspective drawing is a technique used by artists and designers to create the illusion of depth. Both perspective and proportion contribute to the overall impact of art and design. Whether drawing, sculpting or creating digital graphics, mastering these principles enhances creative expression.

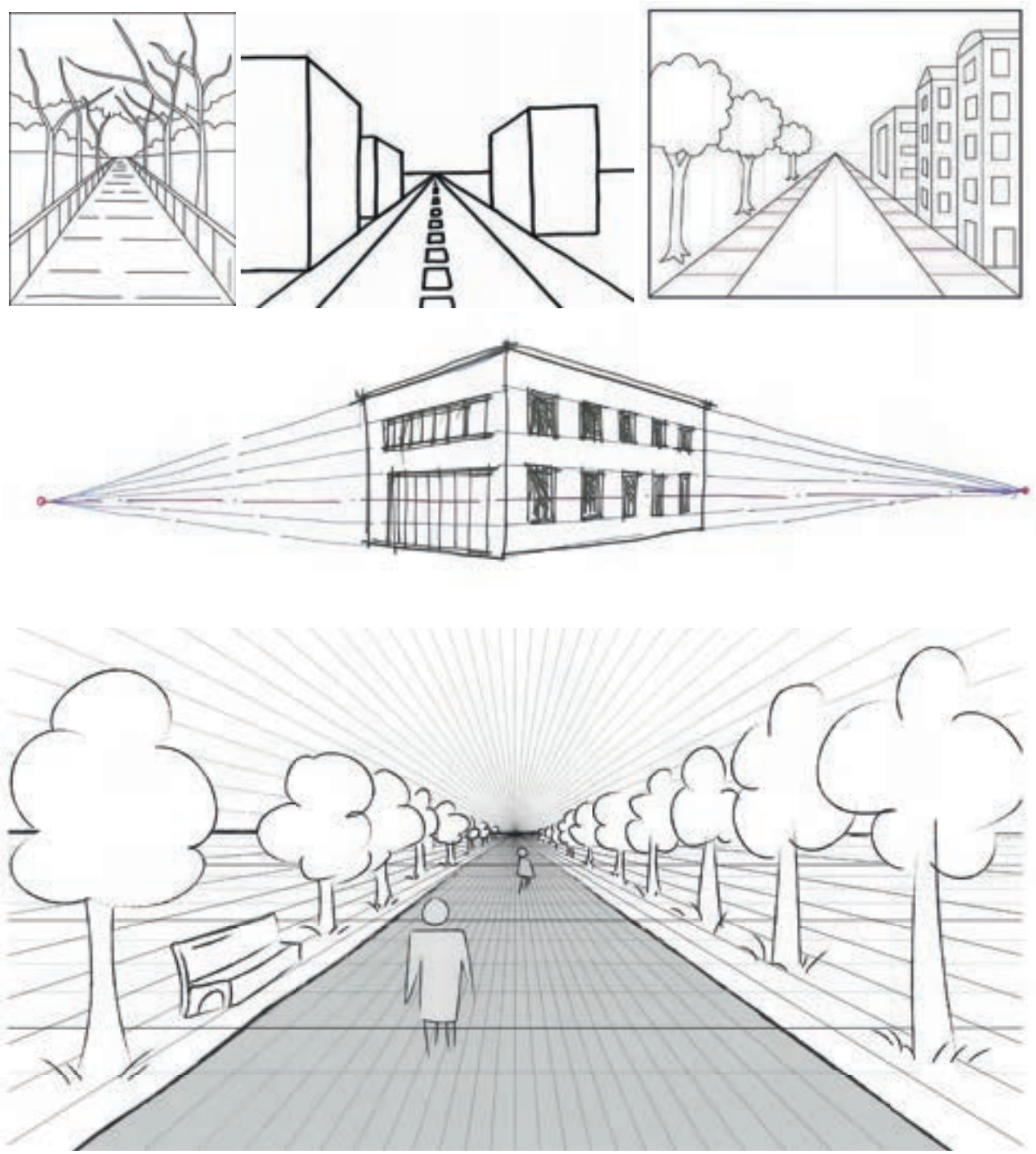


Figure 1.1.9: *Types of perspective drawing*

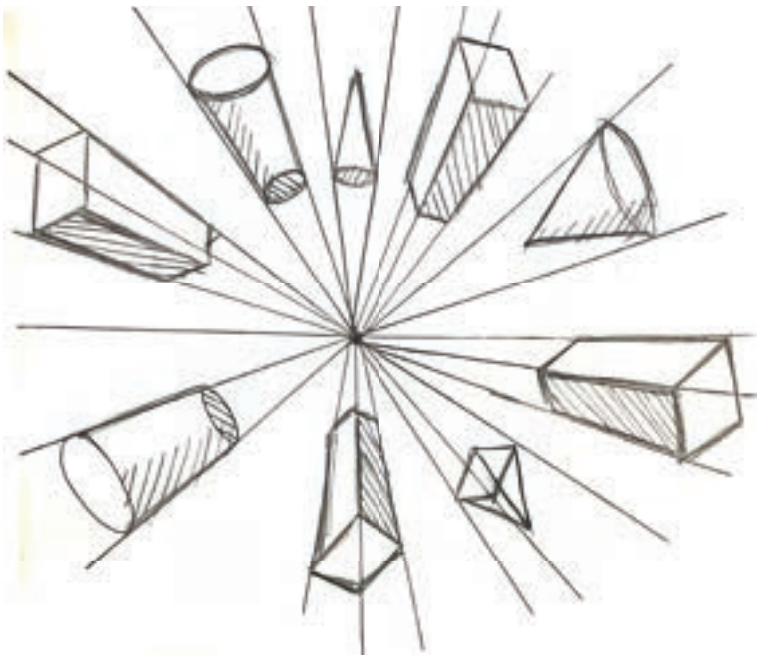


Figure 1.1.10: *One-point multiple perspective drawing*

Principles of Perspective Drawing

Horizon line: Usually at eye level for the viewer however depending on the viewer's height, the horizon line may shift as follows:

- Bird's-eye view/below eye level: Looking down from above.
- Normal perspective/at eye level: Based on our own eye level.
- Worm's-eye view/above eye level: Looking up from below.

Vanishing Points: This is where all parallel lines converge. When standing on the road and looking into the distance, the road seems to meet at a point. The vanishing point is always on the horizon line.

Vanishing Lines: These are the lines that extend from the object to the vanishing point. They help create the illusion of depth in drawings.

Types of Perspective Drawing

One-point perspective: One-point perspective gets its name from the single vanishing point depicted in the art. An image of railroad tracks meeting at a vanishing point on the horizon line is in one-point perspective.

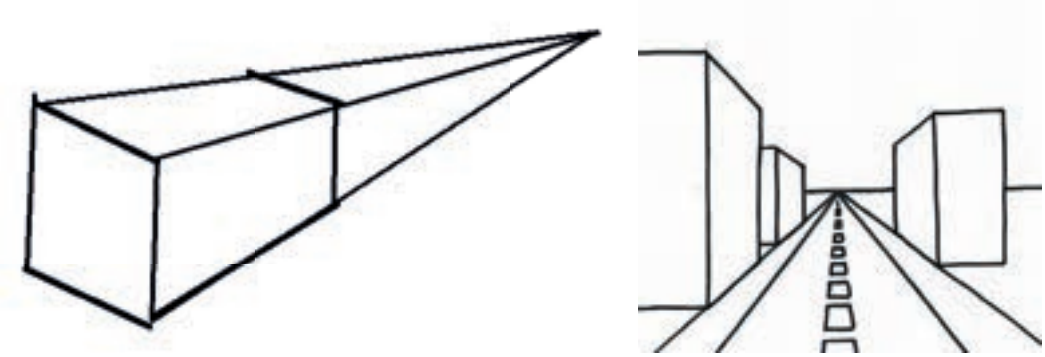


Figure 1.1.11: *One-point perspective drawing*

Two-point perspective: This linear perspective features two vanishing points, often on opposite sides of the artwork on the far left and right. For example, if you draw a box at an angle, the two perpendicular sets of horizontal lines that make up its top edges recede to two different vanishing points.

Figure 1.1.12: *Two-point perspective drawing*

Sketching in Perspective

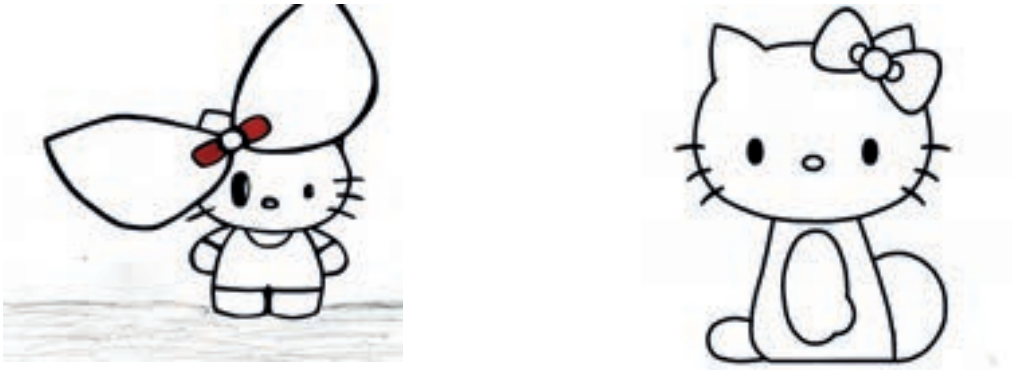
Locating vanishing point(s): Locate the vanishing point(s) away from the object to be drawn. The point(s) can be at eye level, below eye level or above eye level.

Creating depth: To accurately depict perspective, draw lines from the bottom, middle and top of the object to the vanishing point(s). These lines help create the illusion of depth and distance.

Foreshortening: Foreshortening is the change in size that occurs when an object appears shorter or longer due to its angle relative to the viewer. Artists/designers/engineers use foreshortening to convey depth convincingly.

Proportions in Designing

Proportion is a fundamental design principle that plays a crucial role in creating visually pleasing and smooth compositions. It deals with the idea of the relationship of the individual parts of a body to the whole. To put it simply, proportion is about how objects relate to each other in size, scale, shapes and quantities between the various elements of a design.



Non-proportional fascinator *Proportional fascinator*

Figure 1.1.13: *concept of proportion*

Examples:

1. **Size relationships**: Proportion refers to the different sizes of individual parts that make up an object or composition. It involves maintaining balanced size relationships between elements.
2. **Golden ratio**: Artists and designers have long used the **golden ratio** (approximately 1 to 1.618) to create aesthetically pleasing images. Leonardo da Vinci famously applied the golden ratio to calculate perfect proportions in his iconic work, the **Vitruvian Man**.

3. **Hieratic scale**: The hieratic scale is an artistic technique where the most essential object in a painting or sculpture is depicted as the largest. Ancient Egyptians used this scale to emphasise the importance of Pharaohs and gods.
4. **Graphic design**: In graphic design, proportion matters when determining the focal point of a design. Adjusting scale helps highlight tension, contrast and visual hierarchy.

Learning Task

1. Explain perspective and proportion and their relationship to designing.
2. Select an interesting scene from your environment and sketch, making use of perspectives and proportions.

Pedagogical Exemplars

Project-based learning, group activities, collaboration, critical thinking

In mixed-ability groups, task learners to discuss the concept of perspective and proportion related to drawing, using board illustrations, pictures, relevant videos and charts. Ensure the groups consist of AP, P and HP learners.

Observation, group activities, manipulative skills, communication

In groups guide learners on a nature walk in the school environment to observe scenes. Support them to sketch the scene making correct use of perspective and proportion. Ensure all learners participate.

Observation, critiquing, critical thinking, appreciation

Assist learners to paste their drawings on the classroom walls as a gallery and encourage them to appreciate each other's drawings. Learners provide constructive feedback to their classmates.

Key Assessment (DoK)

Level 2

1. Explain perspective and proportion and their relationship to drawing.

Level 3

2. Sit under a tree and sketch an interesting scene making use of perspective, proportion and rendering.

Unit 1 Review

The unit discussed the concepts of sketching to enable learners create concept sketches for designing through hands-on activities. Sketch is a versatile design language primarily used for creating ideas for designing. Learners discussed sketches using relevant resources, lines used in arts and generated new design concepts through concept sketches. Ensuring genuineness and originality of concept, learners worked independently and in groups. The use of differentiated pedagogical approaches ensured engagement and support for all the levels of proficiency in the class.

The assessment strategies were varied and considered various learning abilities and competencies. Written components and practical assessments allowed for a thorough evaluation of learners' understanding and application of sketching techniques. Encouraging verbal, written, and pictorial expression during assessments facilitated deeper comprehension and provided valuable insights for ongoing learning.

References

1. Barber, B. (2001). *The Fundamentals of Drawing*. New York: Barnes & Noble.
2. Design and Communication Technology Curriculum
3. Hlavács, G. (2022). *The Exceptionally Simple Theory of Sketching - Extended Edition*. BIS Publishers.
4. Stanyer, P. (2005). *The Complete Book of Drawing Techniques*. New York: Barnes & Noble.

UNIT 2: OBJECT MANIPULATION

Strand: Conceptual Drawing

Sub-Strand: Object Manipulation in Drawing

Learning Outcome: *Analyse and demonstrate skills in how various objects can be manipulated by freehand drawing in line with the concepts, symbols, metaphors and narratives associated with objects.*

INTRODUCTION AND UNIT SUMMARY

This unit analyses object manipulation using freehand drawing as a fundamental ability that is essential to all forms of artistic expression. The analysis takes into consideration how some freehand techniques in drawing can be used to effectively communicate perspective, depth, and emotion on suitable surfaces. The unit aims to help learners skilfully bring out their ideas through the exploration of techniques such as composition, perspective, proportion and rendering. The unit further explores basic methods for accurately representing objects, placing special emphasis on form comprehension, observational skills and drawing tool proficiency.

Designers can generate solutions by dissecting objects into their most fundamental forms and comprehending how those forms relate to one another. The key to honing this skill is practice, experimentation, and ongoing learning. Object manipulation skills, as presented in this unit, are to help improve creative ability and encourage originality and creativity. This overview provides thorough guidance for designers of all skill levels, highlighting the significance of these principles in creating designs with depth, volume, and realism.

The weeks covered by the unit are:

Week 4*: Analyse and record the concept of object manipulation and manipulation techniques.*

Week 5*: Experiment with various tools and techniques in drawing to manipulate organic and inorganic shapes, forms and objects.*

Week 6*: Use available media and techniques to manipulate objects based on conceptual, symbols, metaphors and narratives associated with objects.*

SUMMARY OF PEDAGOGICAL EXEMPLARS

In teaching lessons on object manipulation in freehand drawing, teachers must adopt an approach to cater for the diverse learner needs. Firstly, there should be a clear learning objective that emphasises what learners need to know, understand and do. Teachers should employ varied pedagogies such as group/individual work, whole class discussion, think-pair-share, role-play etc while encouraging respect for each other's views among the learners.

Learning can be scaffolded by providing accessible resources, such as photographs, videos, relevant texts, and real objects as well as simplified language, to support understanding and participation for all learners. Assessments should align with the learning objectives by providing multiple variations of tasks that evaluate learners' abilities to analyse and manipulate objects using freehand drawing and rendering techniques and their significance in generating designs.

Additional content can be provided to help gifted and talented students to challenge their critical thinking skills. This may involve exploring advanced concepts in object manipulation using freehand drawing and rendering techniques.

Through the use of differentiation strategies, teachers will ensure that all learners, regardless of their learning styles or abilities, can engage meaningfully with the subject matter and develop a deeper understanding and skills in object manipulation using freehand drawing and rendering techniques.

ASSESSMENT SUMMARY

Assessing students' understanding and skills in object manipulation using freehand drawing and rendering techniques requires a multifaceted approach. First, consider the various learning abilities as well as the levels of competencies of the learners. The assessment should look at oral, and written components such as reports, multiple-choice questions and short answer questions that assess learners' knowledge of object manipulation using freehand drawing and rendering techniques as well as the relevance in generating designs.

In addition to the written component, practical assessment where students use varied techniques in freehand drawing and rendering to manipulate simple shapes and forms can be incorporated. Provide learners with photographs, videos or physical examples of these objects, shapes and forms as well as work done by designers and ask them to identify the techniques employed and the significance of such manipulation to the development of designs.

During the assessment, encourage students to express their understanding through both verbal written and pictorial means. Record their responses in a transcript, capturing their observations, interpretations, and insights regarding the materials, methods, drawing and rendering techniques. This transcript will serve as a valuable tool for evaluating individual comprehension and facilitating further discussion and learning in the classroom.

Week 4

Learning Indicator(s): *Analyse and record the concept of object manipulation and manipulation techniques*

Theme or Focal Area 4: Object Manipulation and Manipulation Techniques in Freehand Drawing.

Object manipulation in freehand drawing is representing objects or generating designs without using tools like templates or rulers. This helps designers to generate three-dimensional objects on a two-dimensional surface. It involves the use of technical proficiency and good observation to successfully transfer three-dimensional physical or imaginary design onto a flat surface. Designers normally improve their approaches and styles through the manipulation of items in their drawings.

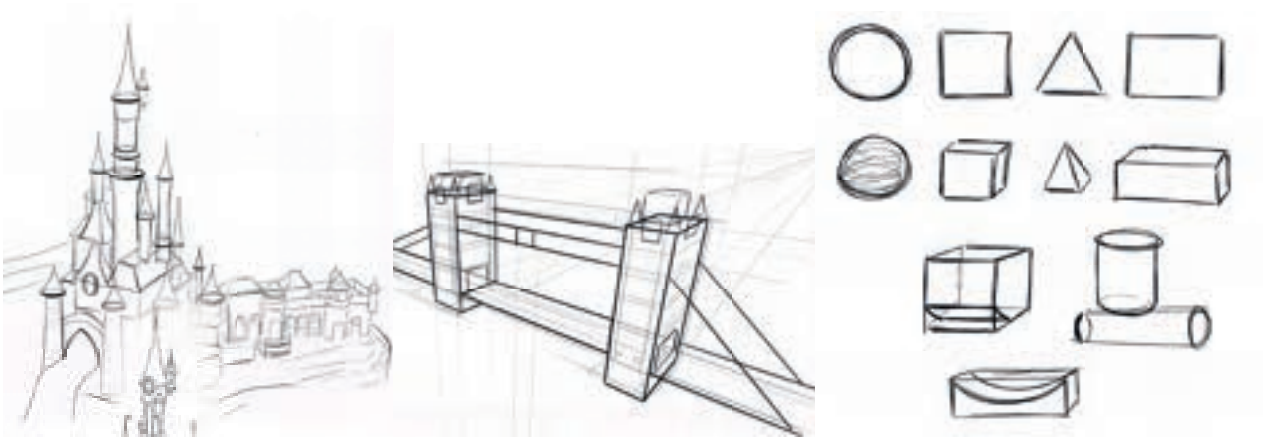


Figure 1.2.1: *Basic shapes to be manipulated.*

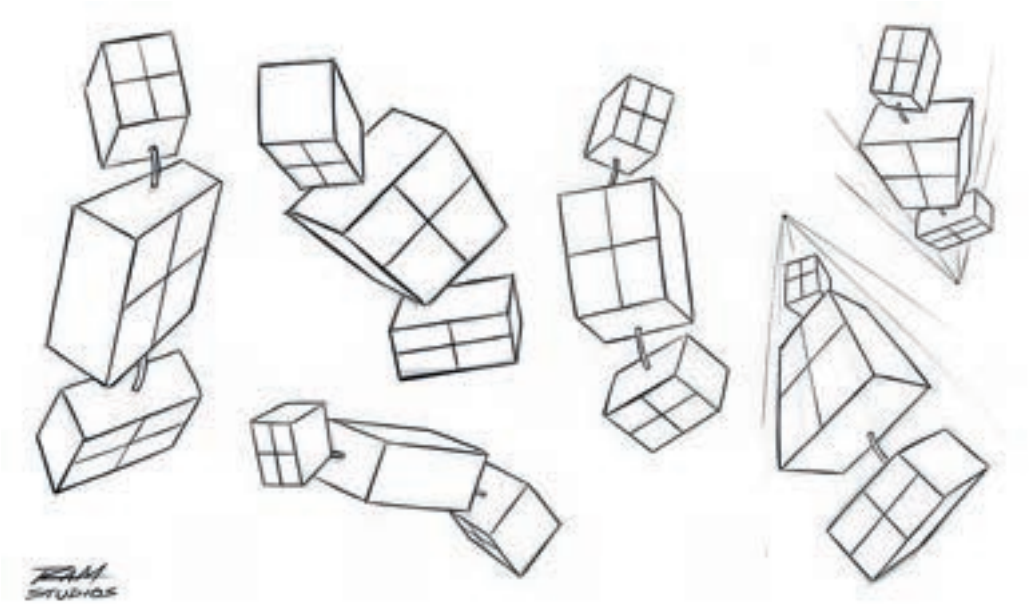


Figure 1.2.2: *Shapes that have been manipulated into human form.*

Most designers start their object manipulation using a freehand drawing by exploring and practising with simple basic shapes. After that, they add details to the new forms that have been generated and then use various rendering techniques such as shading to create depth. The following can be very useful:

- Proportions
- Perspective
- Form and Volume
- Composition
- Line quality
- Rendering materials

Freehand drawing

Freehand drawing is the act of drawing without using tools such as rulers, compasses or stencils. In this practice, the artist or designer uses only hand-eye coordination, intuition and skill to create the lines, shapes and forms directly onto the drawing surface. Freehand drawing is considered a fundamental skill in art and design. It allows designers to express their creativity and capture subjects with a sense of spontaneity and personal style. It's widely used in various art forms, including sketching, illustration, fine art, automobile, mechanical and architectural drafting.

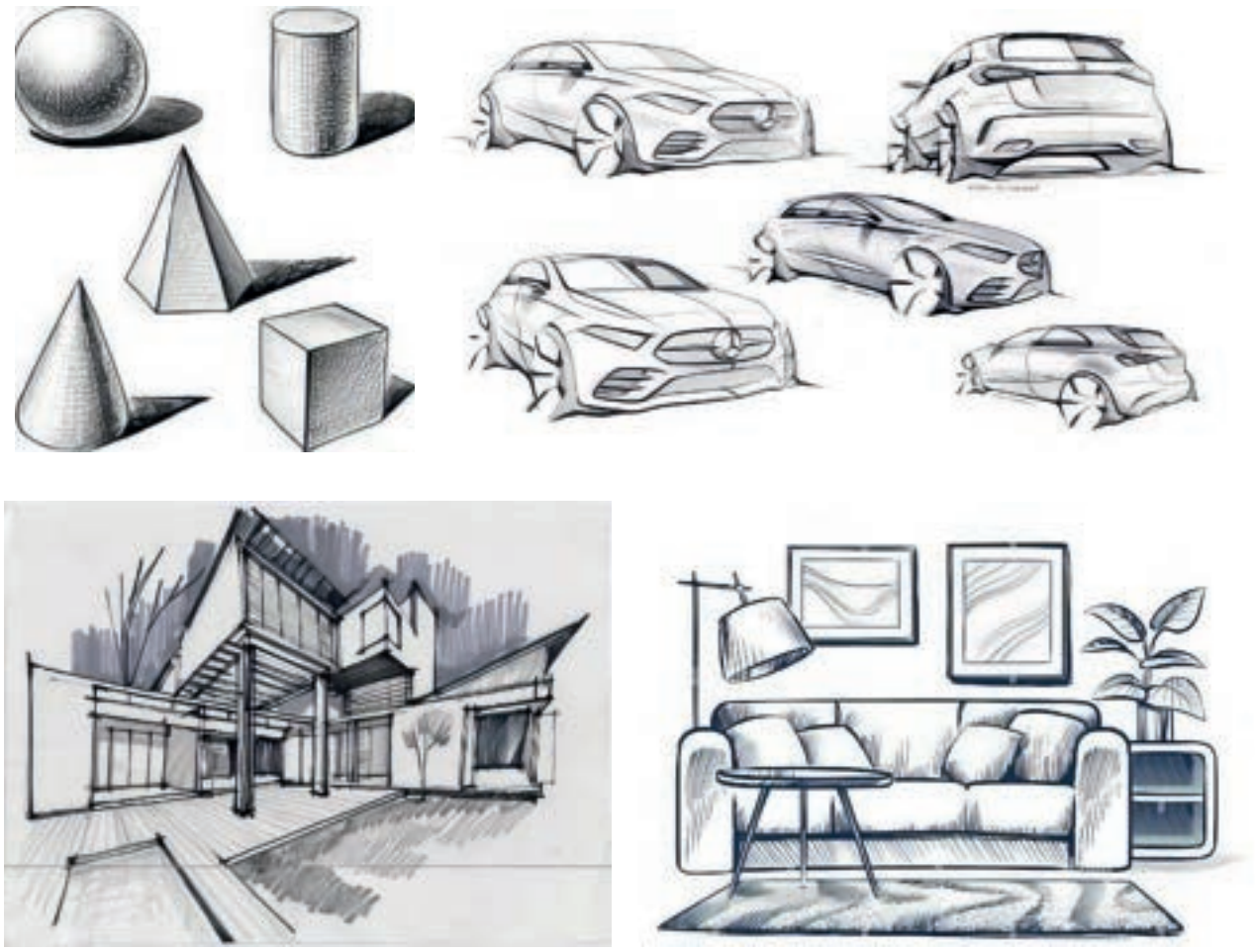


Figure 1.2.3: *Examples of freehand drawing*

Manipulation Techniques in Freehand drawing

Freehand drawing involves a combination of technique, skill and creativity. Designers often combine multiple techniques to generate their designs. They also practise, experiment and observe things in their environment to help them develop a personal style.

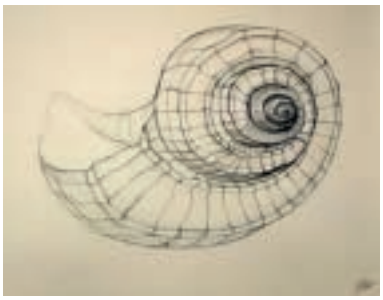
Techniques include:

Contour drawing: Drawing only the outline or contour of an object or subject.

Shading techniques: Such as cross-hatching, stippling, scribbling, blending etc.

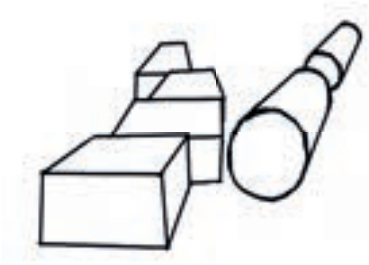
Negative space drawing: Drawing that focuses on the shapes formed around the subject rather than the subject itself.

Foreshortening: A technique used to create the illusion of depth and perspective by depicting objects as shorter than their actual length.



Foreshortening

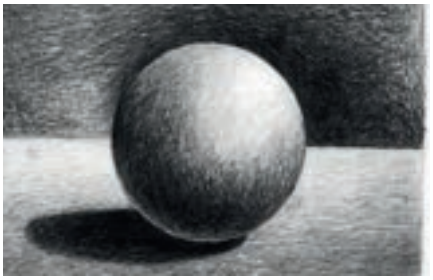
Contour Drawing



Negative Space Drawing

Cross-hatching

Foreshortening



Blending

Figure 1.2.4: *Example of manipulation techniques in freehand drawing*

Learning Tasks

1. Describe the concept of object manipulation and manipulation techniques in freehand drawing through the use of photographs, videos and real objects.
2. Examine and generate a manual/digital annotated album of tools and techniques that can be used in object manipulation in freehand drawing.

Note:

To ensure that learners understand and respond to the indicator; ***Analyse and record the concept of object manipulation and manipulation techniques****, teachers should provide support systems to facilitate learning among learners approaching proficiency, learners who are proficient, and learners of high proficiency level.*

Pedagogical Exemplars

Managing talk for learning, collaboration, communication

Place learners in mixed groups and task them to use the appropriate resources to identify and record the concept of object manipulation and manipulation techniques in freehand drawing.

Collaborative/Group learning, communication, experiential learning

In mixed groups, let learners examine the various tools and techniques that can be used in object manipulation in the freehand drawing.

Project based-learning individual learning skills/collaboration, digital literacy

Working individually, learners generate a manual or digital pictorial table/chart of the various tools and techniques that can be used in object manipulation in freehand drawing.

Key Assessment (DoK)

Level 2

Create a table/chart of tools and techniques that can be used in object manipulation in freehand drawing.

Level 3

Explain the concept of object manipulation and manipulation techniques in freehand drawing.

Level 3

Create a manual or digital pictorial table/chart of the various tools and techniques that can be used in object manipulation in freehand drawing.

Week 5

Learning Indicator(s): *Experiment with various tools and techniques in drawing to manipulate organic and inorganic shapes, forms and objects*

Theme or Focal Area 5: Tools and Techniques Used to Manipulate Specific Objects Through Freehand Drawing

Freehand drawing is an expressive process that relies on the skilful manipulation of tools and techniques to depict specific objects with accuracy and creativity. Using pencils, pens, and markers, together with techniques such as line variation, shading, perspective and proportion, designers can create the illusion of depth, realism and emotion in their drawings. Let us examine how artists use different tools and methods to handle objects when drawing.

Working Nature of Tools used in Freehand Drawing

Pencils, pens, pens and markers are common tools used in freehand drawing. Each tool offers distinct characteristics that influence the outcome.

Pencils: Provide control and precision, allowing artists to create fine lines and intricate details.

Pens and markers: Offer permanence and vibrancy, enabling artists to create crisp outlines and vibrant colours.

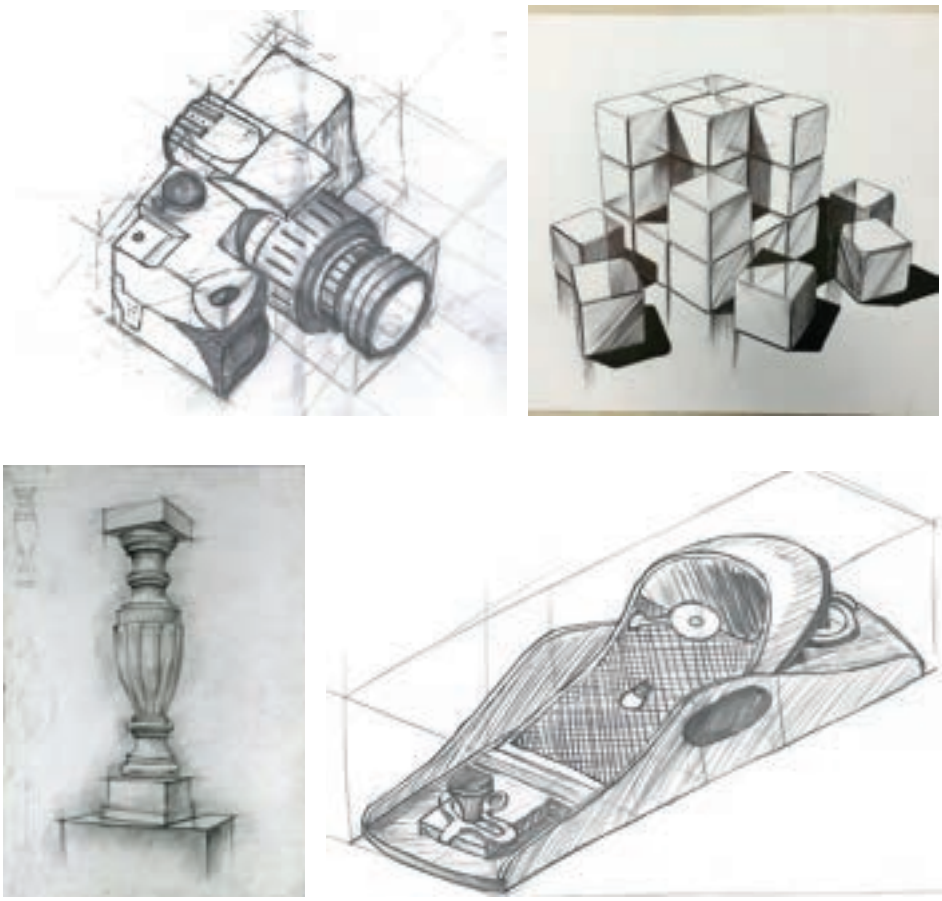


Figure 1.2.5: *Designs made by using pencils and freehand drawing.*

Figure 1.2.6: *Designs made by using pen and freehand drawing.*

Figure 1.2.7: *Designs made by using a marker and freehand drawing.*

Techniques Used to Manipulate Objects Through Freehand Drawing

Line Variation: Is the process of manipulating line thickness and pressure to convey depth and form. Thicker lines can emphasise contours and shadows, while lighter strokes can suggest delicate details or highlights.

Figure 1.2.8 : *Line variation as manipulation technique*

Shading: Is a technique used to create the illusion of volume and texture in a drawing. By varying the density and direction of lines or dots, designers can depict light and shadow, depth and dimension in their drawings. Some of the techniques in shading are hatching, cross-hatching, and stippling.

Perspective: This technique helps the designer to create the impression of three-dimensional space on a two-dimensional surface. In using perspective, designers use methods such as foreshortening, vanishing points, and atmospheric perspective.

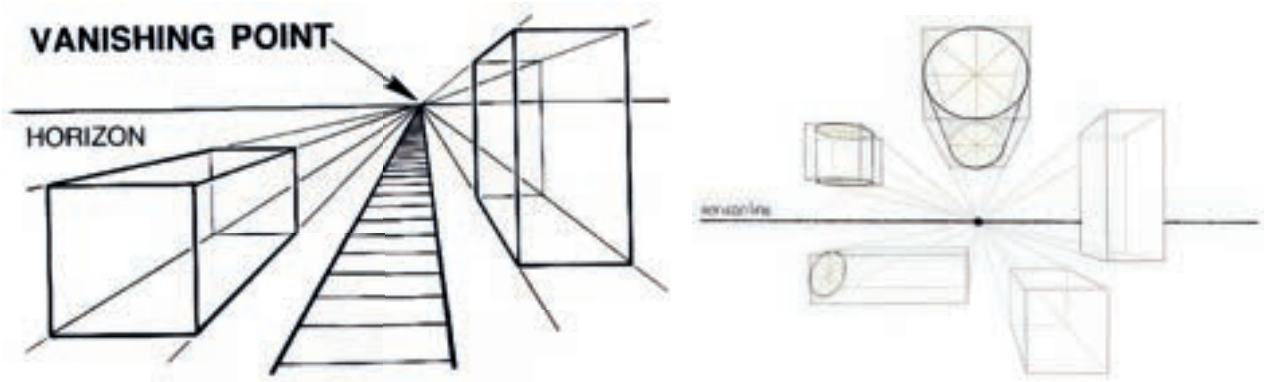


Figure 1.2.9: *Perspective as manipulation technique*

Steps in Generating a Freehand Drawing

Freehand drawing is a creative and spontaneous process where you draw without the aid of tools like rulers or compasses.

The following steps can be very useful when drawing freehand:

- **Gather your materials and tools etc**
- **Choose your subject:** This could be an object, a scene, a person, or anything else that inspires you.
- **Warming up**: This can be doodling, sketching basic shapes, or practising lines and strokes that will help to loosen up your hand.

- **Observing your subject:** You need to look at your subject to observe shapes, proportions, textures, and any other details that stand out to you.
  - **Start with basic shapes:** Begin your drawing by lightly sketching the basic shapes and outlines of your subject.
  - **Build up the details:** Add more detail by capturing the specific features and characteristics of your subject.
  - **Use light and shadow:** Add shading and highlights to your drawing to give it depth and dimension. This can be achieved when you look at the light source and how it affects the shadows and highlights on your subject.

Organic and Inorganic Shapes and Forms

Shapes and forms are seen in our everyday activities. Such shapes and forms can be organic or inorganic.

Organic shapes and forms

Organic shapes and forms are derived from nature, and characterised by irregularity, flowing lines, and dynamic contours. They often take after the shapes of living organisms, plants and landscapes. These shapes suggest a sense of natural beauty and harmony. An example of organic shapes is the intricate patterns of tree branches. Other examples can be seen in the intricate patterns of seashells and other types of spiralling forms of shells.

Figure 1.2.10: *Organic shapes and forms in nature*

Figure 1.2.11: *Man-made organic shapes and forms*

Inorganic shapes and forms

Inorganic shapes and forms are man-made or developed from non-living materials. They often depict geometric precision, straight lines and sharp angles. These shapes are commonly found in architectural structures, machinery and industrial designs. One prominent example of inorganic shapes is the geometric patterns found in modern skyscrapers. The sleek lines and symmetrical designs of buildings like the Burj Khalifa in Dubai. Another example is the hexagonal shape of a wall clock.

Figure 1.2.12: *Inorganic shapes and forms*

Figure 1.2.13: *Man-made inorganic shapes and form*

Learning Tasks

1. Identify and record the concept of object manipulation and manipulation techniques in freehand drawing by using photographs, videos and real objects.
2. Describe the characteristics of organic and inorganic shapes and forms.
3. Use the available tools and techniques in freehand drawing to generate a simple manipulation of organic and inorganic objects.

Note:

To ensure that learners understand and respond to the indicator; ***Experiment with various tools and techniques in drawing to manipulate organic and inorganic shapes, forms and objects*** *teachers should provide support systems to facilitate learning among learners approaching proficiency, learners who are proficient, and learners of high proficiency level.*

Pedagogical Exemplars

Managing talk for learning, collaboration, critical thinking, manipulative skills

Place learners in mixed groups, and task them to examine how tools and techniques are used to manipulate specific objects through freehand drawing. This can be done with the aid of photographs/ drawings and sketches, videos, real objects, etc.

Collaborative/Group learning, communication, observation, critical thinking

In small groups, ask learners to discuss how various designers have used the available tools and techniques in freehand drawing to generate a simple/complex manipulation of objects.

Project based-learning, individual learning skills, critical thinking, manipulative skills

Working individually, learners use the available tools and techniques in freehand drawing to generate a simple manipulation of objects.

Key Assessment (DoK)

Level 2

Use photographs, videos, drawings sketches and real objects to explain how tools and techniques have been used to manipulate specific objects through freehand drawing.

Level 3

Use photographs, videos, drawings sketches and real objects to explain how various designers have used the available tools and techniques in freehand drawing to generate a simple/complex manipulation of objects.

Level 3

Use available tools and techniques to manipulate simple forms and shapes through freehand drawing.

Week 6

Learning Indicator(s): *Use available media and techniques to manipulate objects based on conceptual, symbols, metaphors and narratives associated with objects*

Theme or Focal Area 6: Concept, Symbolism, Metaphors, and Narratives Associated with Objects and Shapes.

Designers in the process of generating ideas using freehand drawing use a lot of forms and shapes. Such forms and shapes have rich symbolism and meaning across cultures and contexts. The symbolism of forms and shapes can vary widely depending on cultural, religious and personal contexts. Let us look at some of the concepts, symbolism, metaphors and narratives associated with some shapes and forms.

Circle: Unity and wholeness: The circle represents completeness, eternity, and the cyclical nature of life.

Harmony: Its symmetrical shape symbolises balance and harmony.

Inclusivity: The absence of corners suggests inclusivity and acceptance.

Triangle: Stability and Strength: Triangles are inherently stable shapes, representing strength and resilience

Balance: The three sides can symbolise balance, with each side representing a different aspect (mind, body, spirit; past, present, future).

Progression: Triangles often suggest direction and movement, pointing upward or downward.

Square/Rectangle: Stability and structure: Squares and rectangles symbolise stability, order, and rationality.

Security: The enclosed shape suggests protection and security.

Earthiness: In some cultures, squares are associated with the earth and the material world.

Spiral: Transformation: Represent growth, evolution and the journey of life.

Eternal change: The continuous movement of a spiral symbolises perpetual change and cyclical renewal.

Cycle of life: Represent the cyclical nature of life, including birth, growth, death and rebirth.

Energy flow: Suggests the flow of energy and the interconnectedness of all things. Transformation: Symbolise transformation, evolution, and personal growth.

Heart: Love and Affection: Universally symbolises love, affection and emotional connection. *Vulnerability*: Its open shape suggests vulnerability and openness.

Life Force: In some cultures, the heart represents the centre of life and vitality.

Star: Guidance and inspiration: Used as symbols of guidance and inspiration, leading the way in the darkness.

Aspiration: The upward pointing star symbolises aspiration, hope, and striving for higher ideals.

Divinity: Stars are often associated with celestial beings and divine forces.

Cross: *Unity of opposite*s: The cross can symbolise the union of opposites, such as heaven and earth or spirit and matter.

Protection: In some cultures, the cross is a protective symbol, warding off evil spirits.

Spiral *Heart* *Squares and Triangles* *Circles and Cylinders* *Triangles*

Figure 1.2.14: *Examples of how shapes have been used in relation to concepts in freehand drawing.*

Learning Tasks

1. Examine the various concepts, symbolism, metaphors, and narratives associated with objects and shapes.
2. Explain the various tools and techniques that can be used in object manipulation in the freehand drawing.
3. Create a manual/digital annotated album of shapes and forms showing the concepts, symbolism, metaphors, and narratives associated with each of the shapes and forms.

Note:

To ensure that learners understand and respond to the indicator ***Use available media and techniques to manipulate objects based on conceptual, symbols, metaphors and narratives associated with objects****, teachers should provide support systems to facilitate learning among learners approaching proficiency, learners who are proficient, and learners of high proficiency levels.*

Pedagogical Exemplars

Managing talk for learning

Place learners in mixed groups, and task them to examine the concept, symbolism, metaphors, and narratives associated with objects and shapes. This can be done with the aid of photographs/drawings and sketches, videos, real objects, etc.

Collaborative/Group learning

In small groups, learners discuss how various designers have used the available tools and techniques in freehand drawing to generate a simple/complex manipulation of objects in line with the concepts, symbolism, metaphors, and narratives associated with those objects.

Project Based-Learning, individual learning skills, critical thinking, manipulative skills

Working individually, learners use the available tools and freehand drawing techniques to generate a simple manipulation of objects in line with the concept, symbolism, metaphors, and narratives associated with those objects.

Key Assessment (DoK)

Level 2

Explain how tools and techniques have been used to manipulate specific objects through freehand drawing. Learners can use photographs, videos, drawings, sketches and real objects.

Level 3

Explain how designers have used the available tools and techniques in freehand drawing to generate a simple and a complex manipulation of objects in line with the concepts, symbolism, metaphors, and narratives associated with those objects. Learners can use photographs, videos, drawings sketches and real objects.

Level 4

Use the available tools and techniques in freehand drawing to create a digital or manual album of shapes and forms to show the concepts symbolism, metaphors and narratives associated with each of the shapes and forms.

Unit 2 Review

This unit on object manipulation through freehand drawing presents a comprehensive approach to improving artistic expression. By delving into techniques such as composition, perspective and rendering, learners are equipped to effectively communicate depth and emotion. The emphasis on form comprehension and observational skills fostered a foundation for creativity and originality.

The unit stressed the importance of catering to diverse learner needs through the use of varied pedagogies to ensure engagement and respect for differing viewpoints. Scaffolding learning through accessible resources and simplified language further supported inclusivity.

The assessment strategies outlined are multifaceted and considered various learning abilities and competencies. Written components and practical assessments allowed for a thorough evaluation of learners' understanding and application of freehand drawing techniques. Encouraging verbal, written, and pictorial expression during assessments facilitated deeper comprehension and provided valuable insights for ongoing learning.

Overall, the unit offered a robust framework for both learners and teachers, promoting skill development and fostering a deeper appreciation for object manipulation through freehand drawing.

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UNIT 3: PATTERN DESIGN

Strand: Conceptual Drawing

Sub-Strand: Pattern Design

Content Standards: Demonstrate knowledge and skill in the use of tools, materials and freehand drawing techniques to create templates and patterns as the basis for design in the community.

Learning Outcome: *Apply the understanding and skills of creating templates and patterns to develop freehand-drawn templates and patterns as solutions in the community.*

INTRODUCTION AND UNIT SUMMARY

This unit uses a practical approach that combines imagination with functionality, using freehand drawing techniques to create templates and patterns for communities. The content focuses on technical skills and encourages learners to apply their knowledge to real-world challenges by developing the ability to analyse design needs, conceptualise solutions, and create interesting and effective templates and patterns.

This approach promotes critical thinking, problem-solving skills and appreciation for the role of design in shaping the world. Through projects, learners will come to understand the power of freehand drawing in designing and its impact on communities to enhance everyday experiences.

The content extends beyond skills development to foster an understanding of the value of freehand drawing in template and pattern design. Through critical analysis and investigative inquiry, learners explore the diverse sources and applications of templates and patterns within their communities, gaining insight into their role in addressing real-world challenges and shaping communal environments. Pattern design facilitates holistic learning, where technical skills merge with imagination and community engagement as the foundation of technical design.

Weeks covered by the section are:

Week 7*: Analyse the sources and use of templates and patterns in the community.*

Week 8*: Investigate the designing and creation processes of templates and patterns.*

Week 9*: Use appropriate materials, tools and freehand drawing techniques to design and create 2-dimensional and 3-dimensional patterns as interventions for challenges in the community.*

SUMMARY OF PEDAGOGICAL STRATEGIES

The unit employs various pedagogical strategies to provide learners with meaningful learning experiences. These include experiential, collaborative, problem-based and project-based learning approaches which encourage exploration, critical thinking and creative problem-solving. Learners work in small groups, using brainstorming, observation and various learning pedagogies to uncover the sources and uses of templates and patterns within their community. They also engage in small group discussions, examining the definitions, common sources, and diverse applications of templates and patterns. They analyse designs created by professionals, using varied resources and real-world objects to deepen their understanding of their design principles and processes. Collaborative efforts lead to the generation of comprehensive tables and charts outlining tools, materials and techniques used in template and pattern creation. Learners then apply this knowledge by replicating existing designs and designing their own 2-dimensional and 3-dimensional patterns to address real challenges

within their community. This project-based approach fosters creativity, innovation and practical application of learned skills. By embracing these diverse pedagogical approaches, pattern design learning becomes a transformative journey, equipping learners with the skills, knowledge and confidence to make meaningful contributions to their communities and beyond.

SUMMARY OF ASSESSMENT STRATEGIES

Templates and patterns are crucial for cultural expression and problem-solving in communities. Assessing learners' understanding of these concepts involves a complex approach that progresses from foundational knowledge to critical application. Strategies for assessing learners at various levels include recalling and reproducing factual information about the sources and uses of templates and patterns in their community, including traditional crafts, cultural artefacts and community practices. Learners should define templates and patterns and describe their common sources and uses in Ghana, including indigenous art and traditional craftsmanship. Learners should critically think about the reasons behind creating these templates and patterns, including preserving cultural identity, transmitting heritage, aesthetic expression, functional necessity and adaptation to environmental conditions. Applying knowledge and skills to address real-world challenges using templates and patterns should be assessed within extended critical thinking. Engaging students in progressively challenging assessments can foster a deeper understanding of their techniques and the learning process.

Week 7

Learning Indicator(s): *Analyse the sources and use of templates and patterns in the community*

Theme or Focal Area 7: Templates and Patterns

What is a Template?

A template in technical drawing is a pre-designed tool or stencil used to create consistent shapes, symbols or patterns on a drawing surface. Made from durable materials like plastic or metal, templates have precise outlines or markings that ensure uniformity and efficiency in the drafting process. They are commonly used in fields like engineering, architecture and design to reproduce standard elements like circles, squares, arrows and symbols, enhancing the clarity and precision of technical drawings.

Types of Templates

Basic technical drawing involves simple shapes and fundamental templates, which serve as foundational tools for beginners. These templates provide guidance and structure, helping them develop drafting skills and an understanding of fundamental principles. Common types include:

1. **Basic shapes template:** This type of template includes outlines of simple geometric shapes such as circles, squares, triangles, rectangles, and ovals which helps beginners practice drawing and understanding fundamental shapes accurately.

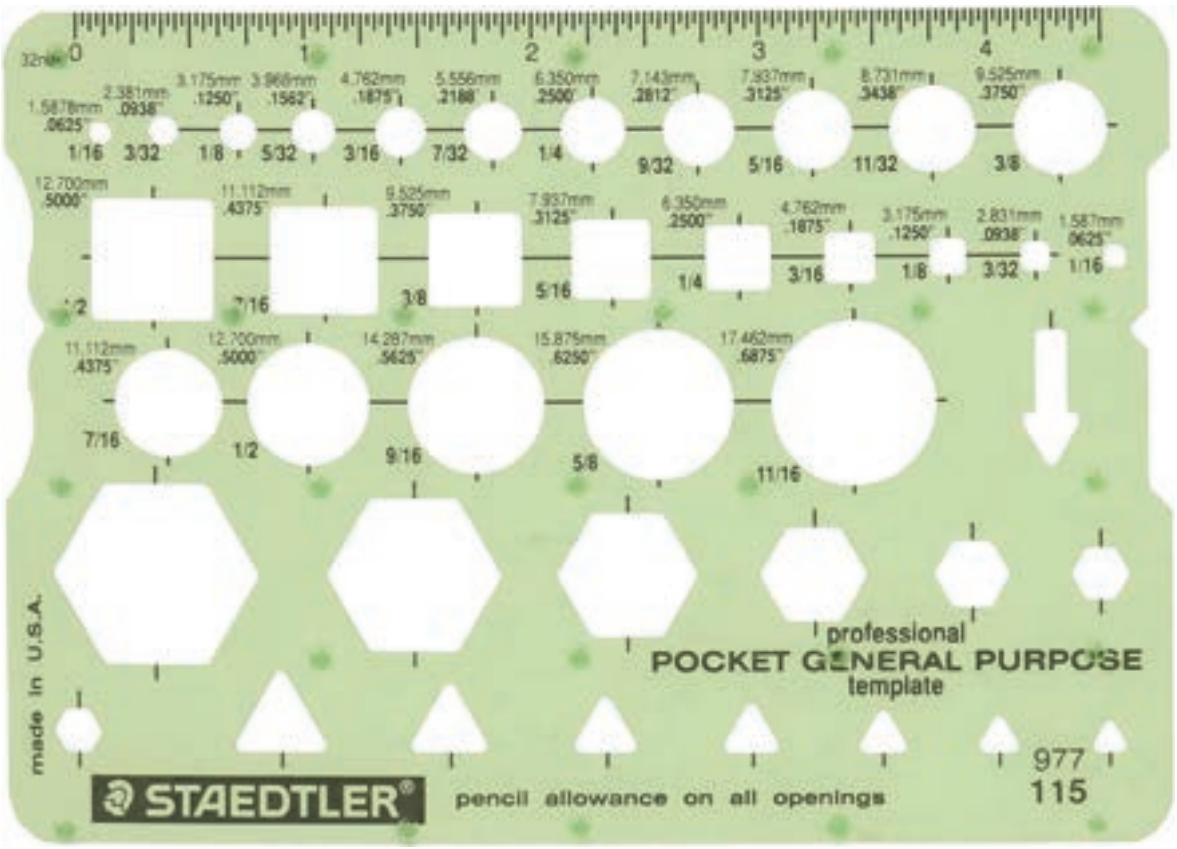

Figure 1.3.1: *Basic Shape Templates*

2. **Line weight template:** A line weight template features lines of varying thicknesses that range from thin to thick, to assist learners in practising line weight consistency and understanding how line thickness can convey depth and emphasis in technical drawings.

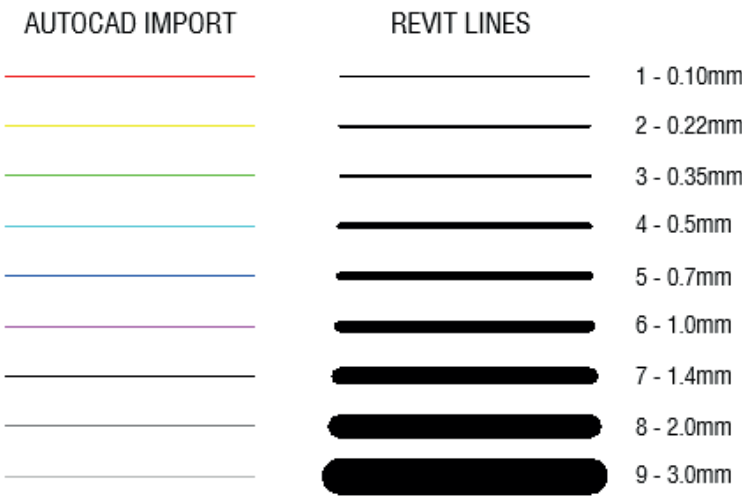

Figure 1.3.2: *Line weight Chart*

0.7mm – Thickest

0.5mm – Thick

0.35mm – Thin

0.25mm – Thinner

0.18mm – Thinnest

Figure 1.3.3: *Pen points for line weights*

3. **Lettering template:** A lettering template contains standardised lettering styles and sizes for titles, labels and annotations in technical drawings. It helps maintain uniformity and legibility of text throughout the drawing.

Figure 1.3.4: *Lettering Template*

Scale template: Scale templates provide standard scales, such as 1:10, 1:20 or 1:50 which are used to accurately represent measurements and dimensions in drawings. They help beginners understand and apply scale principles in technical drawing.

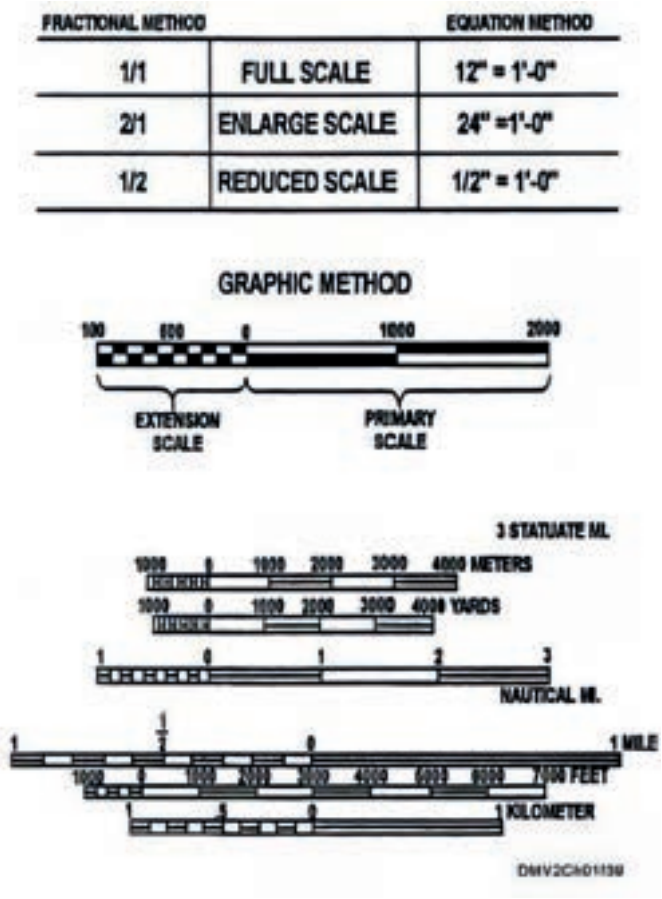

Figure 1.3.5: *Scale Template*

4. **Grid template:** Grid templates feature grids of evenly spaced horizontal and vertical lines. They aid in aligning and positioning elements within a drawing, improving overall neatness and organisation.

Figure 1.3.6: *Grid Templates*

5. **Symbol template:** A symbol template contains commonly used symbols and icons relevant to basic technical drawings such as arrows, circles, squares, triangles and organic elements like trees, humans and foliage. It assists in practicing symbol recognition and placement.

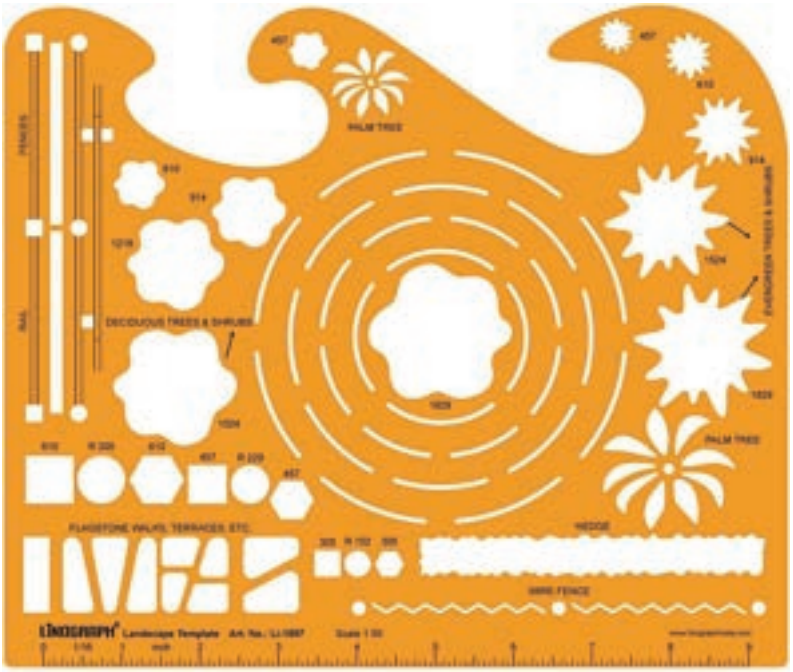

Figure 1.3.7 Symbol Template

6. **Dimensioning template:** Dimensioning templates include pre-marked lines and arrows for indicating dimensions such as length, width, and height in technical drawings. They help beginners learn how to dimension accurately and consistently.

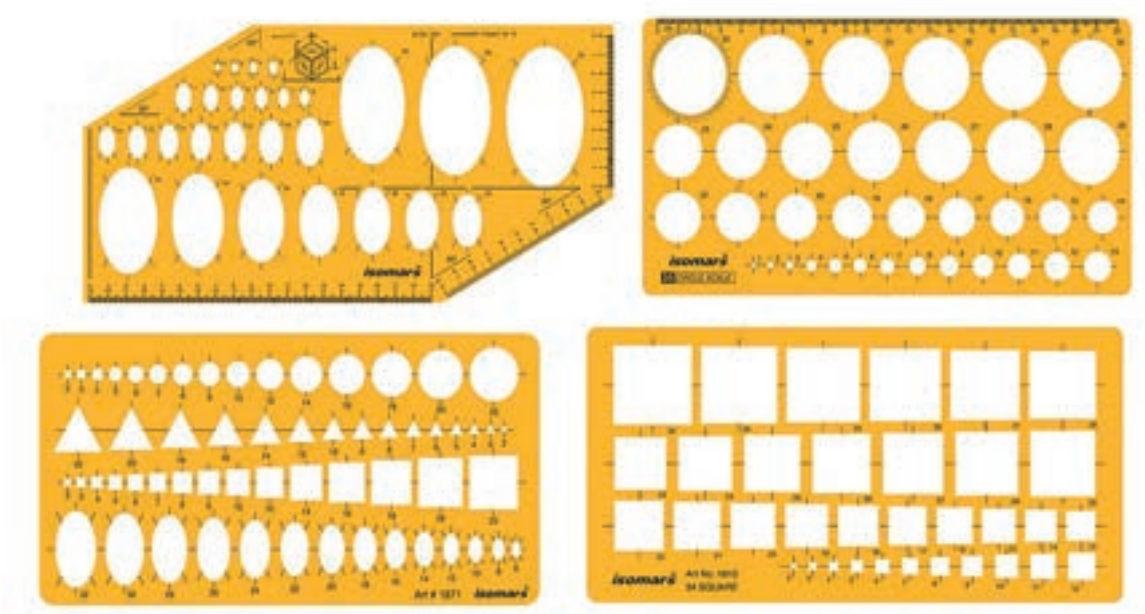

Figure 1.3.8: *Dimensioning Template*

Freehand Templates

Freehand drawing prioritises expression over technical accuracy allowing for more fluid and open-to-interpretation templates. These designs offer designers inspiration for unique, expressive work that allows for a variety of styles and interpretations. Freehand design templates include:

1. **Abstract shapes template:** The abstract shapes template offers a range of abstract shapes and forms, promoting creativity and experimentation in design and composition.

Figure 1.3.9: *Abstract shape template collections*

2. **Nature-inspired template:** A nature-inspired template incorporates elements from the natural world such as leaves, flowers, shells and branches, enabling artists to include organic motifs and textures in their designs.

Figure 1.3.10: *Nature-inspired template for continuous design*

3. **Fantasy creatures' template:** This template is a creative tool that inspires artists to create fantastical worlds and characters, featuring outlines of mythical creatures like dragons, unicorns, mermaids, and fairies.

Figure 1.3.11: *Fantasy creatures' template*

4. **Graffiti style template:** A graffiti-style template is a design that incorporates graffiti-inspired elements like bold lettering, urban symbols and spray paint effects, allowing artists to explore street art aesthetics.

Figure 1.3.12: *Graffiti style template*

5. **Tribal patterns template:** Tribal pattern templates, derived from traditional indigenous art, offer artists a framework for intricate, culturally rich designs, incorporating freehand geometric shapes, lines, and motifs.

Figure 1.3.13: *Ghanaian Template Pattern*

Figure 1.3.14: *Ethnic template pattern*

Figure 1.3.15: *Adinkra template pattern in Ghana*

6. **Zentangle template:** Zentangle templates are intricate designs featuring repetitive patterns and shapes. They are used to create calming and meditative designs the focus on complex and visually appealing compositions.

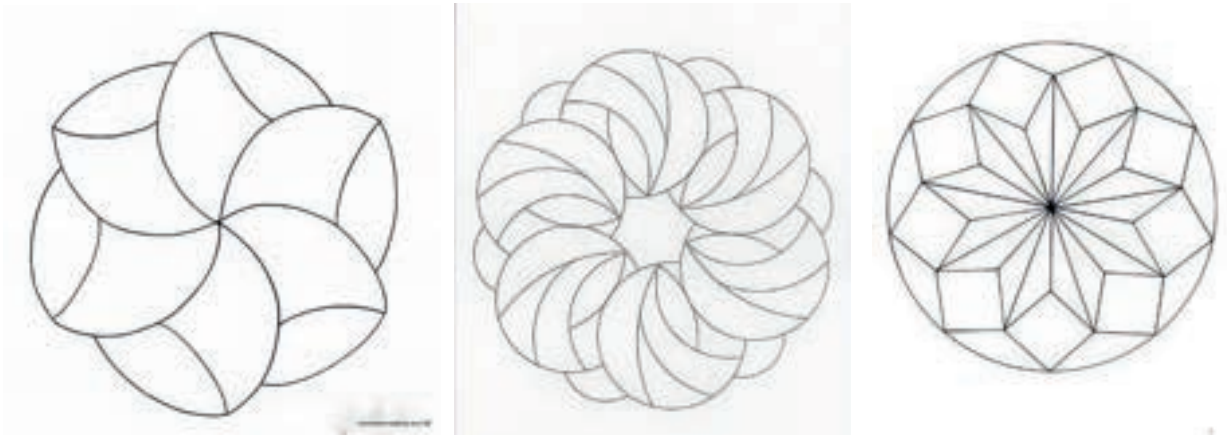

Figure 1.3.16: *Zentangle templates*

7. **Futuristic designs template:** Futuristic design templates incorporate futuristic elements like robots, spaceships, and technological symbols, allowing artists to explore imaginative future visions and science fiction themes.

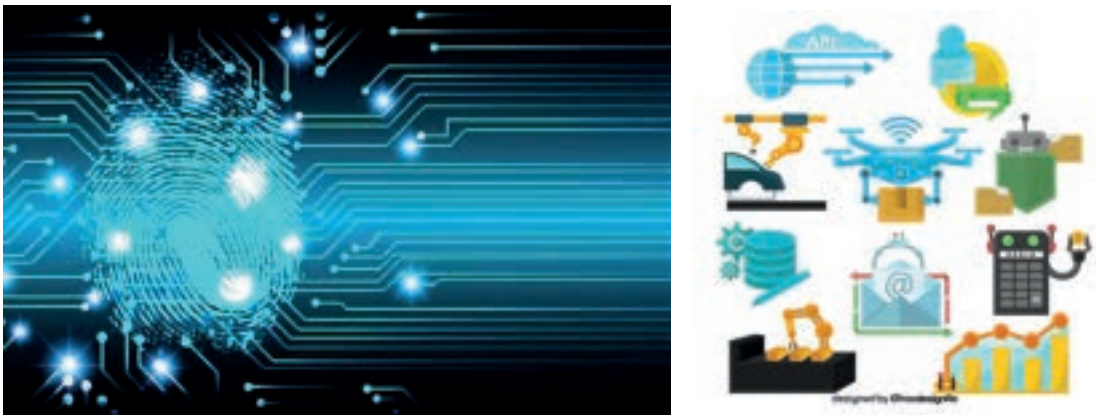

Figure 1.3.17: *Futuristic design templates*

8. **Mandala template:** Mandala templates are circular designs with intricate patterns, used for creating symmetrical and decorative artwork with spiritual or meditative significance.

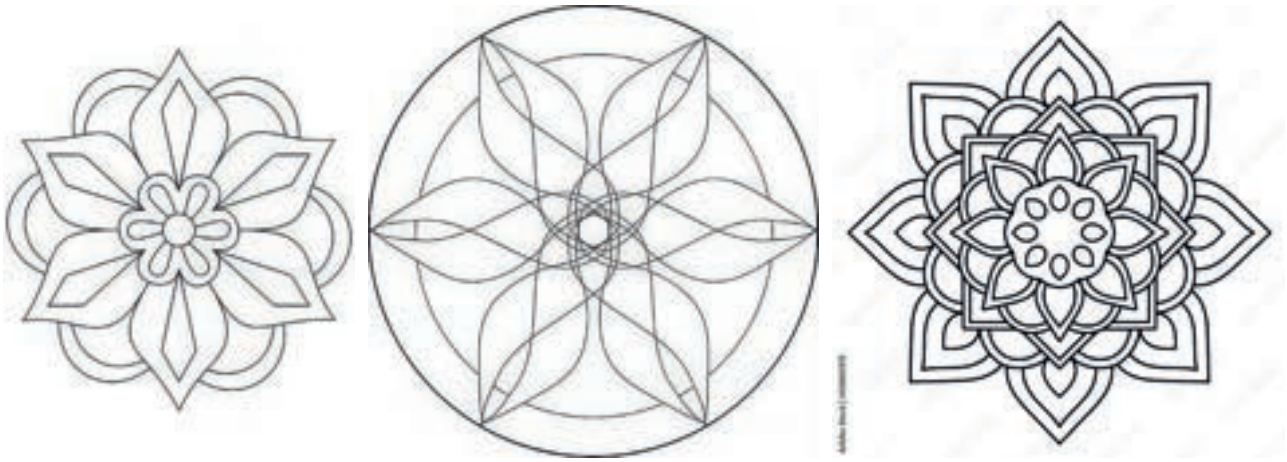

Figure 1.3.18: *Mandala templates*

What is a Pattern?

Patterns in technical drawing are repetitive arrangements of shapes, symbols, or elements that create recognisable designs or patterns. They enhance aesthetic appeal, indicate materials or surface textures and convey structured information. They are commonly used in fields like architecture, engineering and graphic design to add visual interest, provide visual cues or represent recurring features. Patterns can be geometric, organic or symbolic and are crucial in conveying information and facilitating comprehension in technical drawings.

Figure 1.3.19: *Repeated templates in Adinkra cloth in Ghana*

Sources of Templates and Patterns

Templates and patterns are integral to African cultures, showcasing the continent's rich history, cultural diversity and artistic creativity. They are derived from various sources including ethnic groups, nature, historical legacy and trade and exchange with other countries. Each ethnic group has unique customs, rituals and beliefs which are passed down through generations and reflected in their intricate designs in textiles, pottery and architecture. Nature also inspires African artists and artisans with patterns resembling rhythmic patterns of savannah grasslands, tribal animal markings and geometric shapes. Historical legacies such as the pyramids of Egypt and rock-hewn churches of Ethiopia, showcase the enduring legacy of African templates and patterns. Trade and exchange with the Arab world, Europe and Asia have a fusion of styles and motifs in African art and design, resulting in a rich tapestry of cross-cultural patterns.

Sources of Templates and Patterns in Ghana

Templates and patterns are integral to Ghanaian culture and artistic traditions, serving both practical and symbolic purposes. They are central to Ghanaian art, culture and daily life, promoting artistic expression, cultural preservation and communication. These symbols and motifs, from textile design to architectural ornamentation, showcase Ghana's rich cultural heritage and artistic ingenuity.

The following are some sources and uses of templates and patterns in Ghana:

Sources

Ghana's indigenous art, including Adinkra, Ewe Desi, Ga Samai symbols, Kente and Batakari weaving, and wood carvings serve as a significant source of templates and patterns reflecting cultural practices and beliefs.

The diverse ethnic groups and cultural heritage inspire creative patterns and templates. While the diverse natural environment, including flora, fauna and landscapes serve as inspiration for patterns and motifs in traditional crafts often carrying symbolic meanings related to fertility, abundance and spirituality.

Uses

Templates and patterns are prevalent in Ghanaian textile design, particularly in traditional fabrics like Kente, Batakari and Adinkra cloth which are adorned with intricate geometric patterns and symbolic motifs.

These patterns are also used in architectural ornamentation and decorative arts such as the Sirigu architecture in the Kasina Nankana District.

Ceremonial objects such as masks, drums and ceremonial garments often incorporate symbolic motifs to convey spiritual beliefs and cultural heritage.

Templates and patterns also serve as visual communication conveying messages, stories and cultural values through symbols and motifs. Adinkra symbols, for example, are used to convey proverbs and philosophical concepts in Ghanaian culture.

Everyday objects, such as pottery, utensils, jewellery and clothing also feature templates and patterns to enhance their aesthetic appeal and cultural significance.

***Note**: Research reasons why freehand drawn templates and patterns are created by designers and artisans in the community to use to assess learners' tasks.*

Learning Tasks

Investigate and write a report on the sources and uses of templates and patterns in the local community.

a. Use available sources such as cloth, architecture, books, magazines, journals, online sources and Ghanaian artworks for templates and patterns.

b. Ask designers, artisans and users of templates and patterns for their meanings and reasons why they were created.

c. Make drawings of templates and patterns, take photographs or clip and paste images and photographs from manual and internet sources into a book or album.

d. Add annotations and short notes to identify the artwork.

***Note**: That it is important to seek permission before making drawings or taking any image. Learners must also note the sources where they obtained their information.*

Pedagogical exemplars

Experiential learning, collaborative/group learning

Learners in small groups brainstorm, observe and use other relevant sources to identify and record the sources and uses of templates and patterns in their community. Learners can contribute in their

respective capacities with vernacular responses and records, photographs and images, especially those who seldom speak or contribute in class (AP).

Managing talk for learning

Learners in small groups engage in class discussions on the definitions, common sources and uses of templates and patterns. Encourage learners to use examples from Ghana and other parts of the world. Learners should be encouraged to share their individual experiences from their homes and local communities, especially those in advertisements in public places for (AP) and (P) learners.

Problem-based learning

Learners in groups investigate reasons why existing templates and patterns in the community were created. Learners (HP) should be encouraged to use freehand annotated drawings to categorise specific templates and patterns with respective reasons.

Key Assessment (DoK)

Level 1:

List five sources and five uses of templates and patterns in the community. Responses can include oral responses, freehand drawings, images and photographs.

Level 2:

Define templates and patterns and describe three sources and three uses of templates and patterns in Ghana. Responses should include, but not be limited to, oral responses, freehand drawings, images and photographs and written responses.

Level 3:

Describe five reasons why existing templates and patterns in the community were created. Responses should include annotated drawings with written responses.

Week 8

Learning Indicator(s): *Investigate the designing and creation processes of templates and patterns.*

Theme or Focal Area(s) 8: Design and Creation Processes of Templates and Patterns

The process of designing and creating freehand drawn templates and patterns involves several crucial steps allowing artists and designers to create interesting designs that show their vision.

Creating freehand drawn templates and patterns involves the following steps:

1. **Inspiration and conceptualisation**
   - Begin by gathering inspiration from various sources such as nature, art, architecture and cultural motifs.
   - Develop a concept or theme for the template based on the inspiration gathered.
2. **Sketching and exploration**
   - Use pencil and paper to sketch out rough ideas and concepts for the template.
   - Experiment with different shapes, lines and motifs exploring different compositions and arrangements.
3. **Refinement and detailing**
   - Refine the initial sketches paying attention to details such as line weight, symmetry, and proportion.
   - Add intricate details and embellishments to enhance the appearance of the design.
4. **Inking or finalisation**
   - Once satisfied with the pencil sketches, trace over the lines with ink to create a clean and definitive outline.
   - Alternatively, finalise the design directly with ink, using confident strokes to create a bold and expressive design.
5. **Erasing and clean up**
   - Erase any remaining pencil marks and smudges to ensure a clean and polished final drawing.
   - Use an eraser shield or precision eraser to selectively remove unwanted lines and imperfections.
6. **Testing and adjustments**
   - Test the design by applying it to various surfaces or projects to evaluate its visual impact and usability. The design can also be repeated to develop a PATTERN to see the impact.
   - Make any necessary adjustments or refinements based on feedback and observations.
7. **Digitalisation (optional)**
   - If desired, scan the hand-drawn design into a digital format using a scanner or smartphone camera.
   - Use graphic design software such as Adobe Illustrator or Photoshop to further refine, edit or digitise the design.
8. **Documentation and specification**
   - Document the design process including inspiration, sketches and refinements to keep track of the creative journey.
   - Specify details such as dimensions, colours and materials if the design will be applied to a specific project like stencilling or stamping for PATTERNS.

9. **Application and use**
    - Apply the finalised template to its intended use whether it is for illustration, decoration or functional purposes into a pattern.
    - Share the design with others or incorporate it into projects like wood, crafts, textiles or graphic design.

Popular brands created with freehand drawn templates and patterns

The use of freehand drawn templates and patterns in the design process has proven to be a popular and creative approach, transforming hand-drawn concepts into iconic symbols and successful products in the global marketplace. This list includes popular brands, products and objects. These brands include:

Nike's famous "Swoosh" logo was hand-drawn by Carolyn Davidson in 1971. This simple yet powerful logo has become a symbol of the brand's athletic products.

Figure 1.3.20: *Nike's advertisement illustrating the action of writing*

https://www.designyourway.net/blog/nike-logo/

Figure 1.3.21: *Nike's 1973 logo*

https://indieground.net/blog/nike-logo-history/

Apple's early products such as the Macintosh computer and iPod, began with freehand sketches by Steve Jobs and the design team. These sketches shaped Apple's sleek global brand and style.

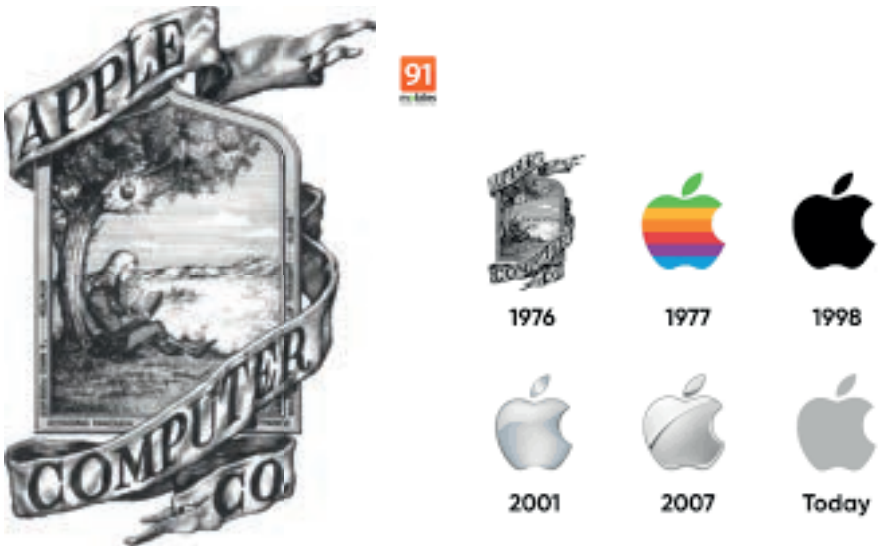

Figure 1.3.22: *Evolution of the Apple Logo*

https://commons.wikimedia.org/wiki/File:Apple_first_logo.png

The iconic **Coca-Cola** logo, created in 1885 by designer Frank Mason Robinson, features a hand-lettered script font. This timeless design remains unchanged and is known worldwide.

Figure 1.3.23: *Coca Cola logo design ca.1885*

https://www.coca-colacompany.com/about-us/history/the-history-of-the-coca-cola-contour-bottle

The famous Adinkra cloth is made from freehand drawn templates that are later developed and carved into stamps and used to create patterns of Adinkra symbol rows and columns in the cloth.

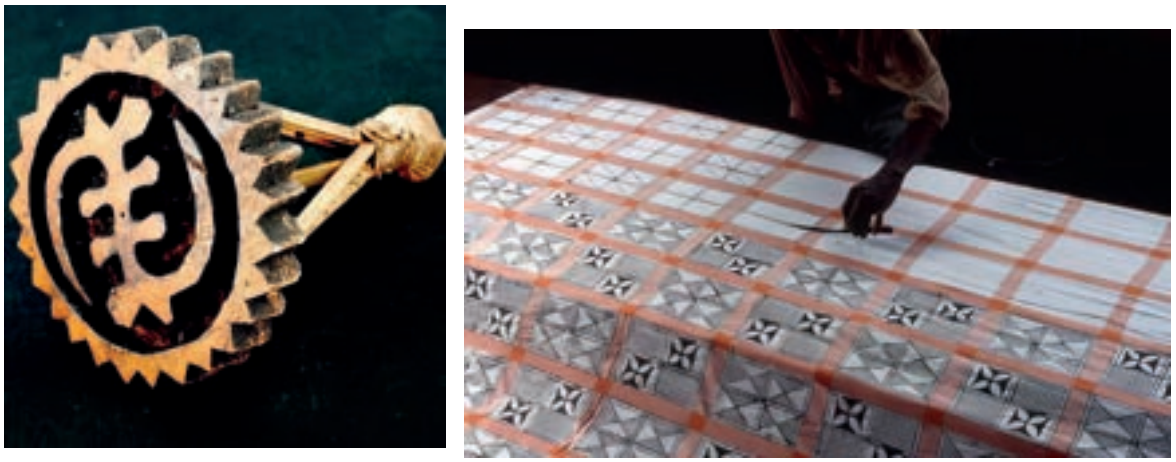

Figure 1.3.24: *Adinkra Symbol template stamp and pattern process*

Learning Task

Create a manual or digital tables or charts showing templates and patterns and the products, tools, materials and techniques used to create them.

Table 1.3.1: Manual/digital table of templates, patterns products, tools and techniques

Templates and Patterns

Product	Tools	Materials	Techniques
Adinkra cloth			

Pedagogical Exemplars

Collaborative/Group learning

Learners in mixed-ability groups analyse various templates and patterns created by designers with the use of photographs, videos, drawings and sketches as well as real objects. Learners should be encouraged to share their experiences and thoughts on templates and patterns objects and products.

Problem-based learning/Group learning

In small groups examine how designers have used available tools, materials and techniques to create their templates and patterns. Learners should be encouraged to use deductive reasoning and simple research strategies to find the processes of some popular template and pattern brands, objects and products created with freehand drawing.

Project-based learning/Collaborative/Group learning

Learners in groups create a manual or digital tables and charts of selected examples of common products, tools, materials and techniques used to create the templates and patterns. Learners are to provide detailed information including product images or freehand drawing objects with the tools, materials and techniques to complete the task.

Note: *Ensure that learners (AP), (P), and (HP) approach the given tasks according to their capabilities. This means that learners are encouraged to aim to excel and surpass their current abilities by pushing themselves to do a little more than they would normally do in similar situations.*

Key Assessment (DoK)

Level 1:

List six template and pattern products, brands and objects in your community. Accept freehand drawings, images and photographs, videos, real objects and written responses.

Level 2:

Use drawings, photographs, videos, sketches and real objects to illustrate templates and patterns created by designers. Learners are expected to equate their illustrations (preferably drawings) with a minimum of ten templates and patterns.

Level 3:

Describe how designers have used tools, materials and techniques to create existing templates and patterns. Accept descriptions for a minimum of four popular templates and patterns.

Level 3:

Create a manual or digital tables and charts of common tools, materials, and techniques used to create templates and patterns.

Week 9

Learning Indicator(s): *Use appropriate materials, tools and freehand drawing techniques to design and create 2-dimensional templates and patterns as interventions for challenges in the community.*

Theme or Focal Area (S) 9: Designing and Creating 2-Dimensional Templates and Patterns as Intervention.

Build on Week 8 Content

Learning Task

1. Create a copy of existing template and pattern designs with the use of appropriate tools, materials and techniques.
2. Identify challenges in the community that can be addressed using templates and patterns.
3. Create 2-dimensional patterns to address challenges in the community with the use of appropriate materials, tools and techniques.

Note: *Guide learners in their selection of designs to imitate, as well as tools, materials and techniques to employ in their work. Encourage them to make informed choices in the selection of challenges facing the community to work on and their proposed 2-dimensional interventions, tools materials and techniques*.

Pedagogical Exemplars

Problem-based learning

Learners in groups use appropriate tools, materials and techniques to imitate existing template and pattern designs. Encourage learners, especially learners (*AP* and *P),* to participate in this task to gain the needed insights and skills for later projects.

Problem-based learning

Learners in mixed-ability groups identify challenges in the community that can be addressed using templates and patterns. Learners should be encouraged to look for simple but obvious challenges and problems in the community that 2-dimensional templates and patterns can address with little effort.

Project-based learning Learners in groups use appropriate materials, tools and techniques to design and create 2-dimensional templates and patterns to address challenges in the community. Encourage learners to keep to the general processes for template and pattern production and plausible techniques close when working to facilitate easy reference and action.

Note: *Teachers can join individual groups as participants, especially at the discussion stage, as well as go back intermittently during the projects to support.*

Key Assessment (DoK)

Level 1: List five challenges in the community that template and pattern design can address. Accept freehand drawings, images and photographs, videos, real objects and written responses.

Level 2: Describe challenges identified in the community that can be addressed with templates and patterns. Accept a minimum of three descriptions of identified challenges that template and pattern design can address.

Level 3: Use appropriate tools, materials and techniques to recreate existing template and pattern designs by imitation.

Level 4: Design and create 2-dimensional templates and patterns to address challenges in the community using appropriate materials, tools and techniques.

Unit 3 Review

The unit explored the role of templates and patterns in the study of technical drawing, to enhance students' knowledge, creativity and problem-solving skills through hands on exploration and collaborative learning. Learners were grouped into small teams and engaged in activities to explore templates and patterns in their community. They used various mediums, such as oral responses, freehand drawings, images, photographs and written records to identify and analyse sources and uses. Through group investigations, learners explored the reasons behind the creation of existing templates and patterns using freehand annotated drawings to categorise specific examples. They also analysed various templates and patterns created by designers using multimedia tools to examine the tools, materials and techniques employed. Groups successfully imitated existing template and pattern designs and created 2-dimensional templates and patterns to address community challenges showing their creativity and problem-solving skills. The unit emphasised the importance of hands-on learning in fostering creativity, critical thinking and community engagement among learners.

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UNIT 4: DESIGN AND REALISATION

Strand: Conceptual drawing

Sub-Strand: Design and realisation

Content Standard:

Apply the concept of designing processes in solving problems.

Learning Outcome: *Demonstrate understanding of the designing process, write a situation to identify a problem in the home.*

Write a brief, investigate, analyse, generate possible solutions, develop the chosen solution and generate the final solution to the problem. (Teachers should consider situations from which problems can be identified). The writing of situations is very important and necessary for this section.

INTRODUCTION AND UNIT SUMMARY

In this unit learners will be introduced to the design thinking process. This will allow them to identify problems in their environment. For example, the school environment which includes the dining hall, dormitory and washrooms or the home environment which includes the kitchen, bedroom and hall. Learners will generate possible solutions to solve the problems identified.

Teachers should place emphasis on the writing of the design brief for problems as this is important and necessary for this unit.

In our everyday activities we use products and services that are the outcome of a design process or that a designer has played a role in creating.

The design process is a systematic and interactive approach to solving problems and creating solutions. It involves several key steps that designers follow across various disciplines to arrive at an effective and efficient outcome.

The weeks covered by the section are:

Week 10: *Describe the processes in designing*

Week 11: *Write a design brief for identified problems*

Week 12: *Generate solutions to solve identified problems*

SUMMARY OF PEDAGOGICAL EXEMPLARS

Teachers should approach the unit as a creative process rather than a linear routine task. The use of a variety of learner centred pedagogical approaches must be used to facilitate the learning process and enhance critical thinking and problem-solving skills among learners.

Examples include general class discussions, ability and mixed-ability group discussions, gender-based discussions, projects and think-pair-share pedagogies. Learners should be encouraged to think ‘outside the box’ to come up with realistic and meaningful design solutions to identified problems in their selected environment.

Encourage learners to provide constructive feedback to their peers, as well as peer reviews. This approach can highlight areas for improvement and offer fresh perspectives. Remember, learner

feedback is a valuable resource for enhancing teaching by actively listening to learners and adapting lessons accordingly.

ASSESSMENT SUMMARY

Provide multiple feedback opportunities for learners to address their different learning abilities. The assessments should be used to monitor learning progress during instruction and should include both formative and summative assessments which emphasise the learners' ability to write briefs for identified problems and generate possible design solutions.

Identify learners' current performance through reviews to determine their stage of development for specific instructional needs. Provide prompt feedback to learners on their performance.

Week 10

Learning Indicator(s): *Describe the processes in designing*

Theme or Focal Area 1: Design Thinking Process

The design thinking process, also known as the engineering method, is a common series of steps that engineers use in creating functional products and processes.

Let's take a closer look at these steps and how you can put the design process into practice for your own projects.

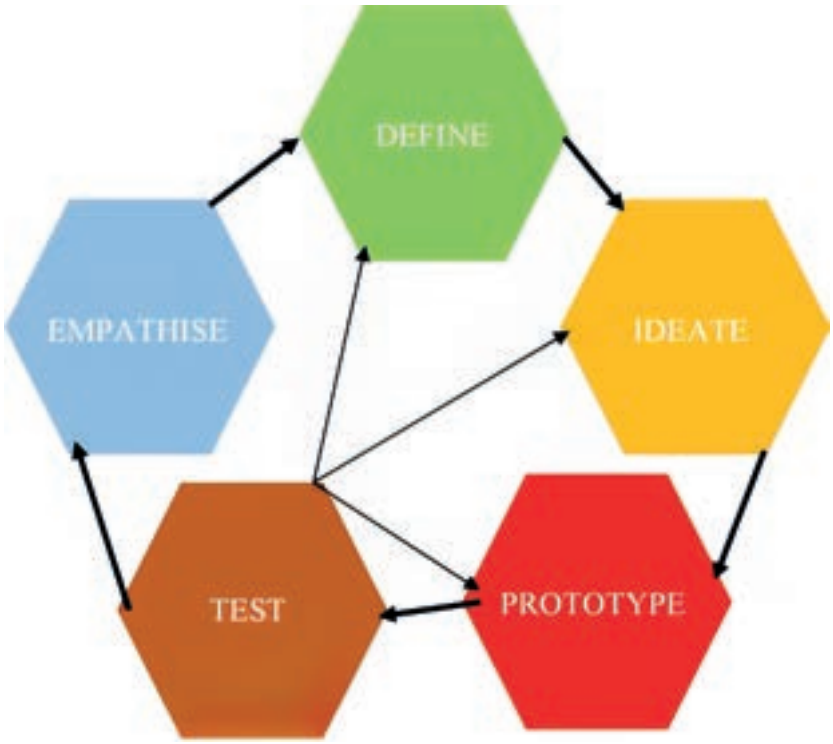


Figure 1.4.1: *Flowchart of Design Thinking Process*

- **Empathise:** Research your users' needs and problems.
- **Define:** State your users' needs and problems clearly and concisely.
- **Ideate/research:** Generate and explore possible solutions.
- **Prototype:** Create and test low-fidelity versions of your solutions.
- **Test:** Evaluate and refine your solutions based on feedback.

Empathise

The first stage of the design process focuses on the user. You want to gain an empathic understanding of the problem you are trying to solve and conduct observations to engage and empathise with your users. You may also want to put yourself in your users' shoes to gain a deeper personal understanding of the issues involved.

Empathy is crucial to problem solving and a human-centred design process as it allows designers to set aside their own assumptions about the world and gain real insight into users and their needs.

The main aim of the Empathise stage is to develop the best possible understanding of your users, their needs and the problems that underlie the development of the product or service you want to create.

Define

In the Define stage, you will organise the information gathered during the Empathise stage. You will analyse your observations to define the core problems identified up to this point. Defining the problem and creating a problem statement must be done in a human-centred manner.

The Define stage will help the design team collect great ideas to establish features, functions and other elements to solve the problem at hand.

Ideate/research

At this stage you have a better understanding of your users and their needs (Empathise stage), and you have analysed your observations (Define stage) to create a user centric problem statement. With this solid background, you and your team members can start to look at the problem from different perspectives and ideate innovative solutions to your problem statement. Brainstorm and Worst Possible Idea are examples of ideate techniques the design team can use.

Prototype

This is an experimental phase with the aim of identifying the best possible solution for each of the problems identified during the first three stages. The solutions are implemented within the prototypes and, one by one, they are investigated and then accepted, improved or rejected based on the users' experiences.

The design team will now produce a number of inexpensive, scaled down versions of the product to investigate the key solutions generated in the Ideate phase. These prototypes can be shared and tested within the team itself, in other departments or with a small group of people outside of the design team.

By the end of the Prototype stage the design team will have a better idea of the product's limitations and the problems it faces. They will also have a clearer view of how real users would behave, think and feel when they interact with the end product.

Test

During this stage Designers test the complete product using the best solutions identified in the Prototype stage.

This is the final stage. Based on how the users feel about the product can lead you to loop back to a previous stage in the design process. You can then proceed with further iterations and make alterations and refinements to rule out alternative solutions. The ultimate goal is to get as deeper understanding of the product and its users.

Learning Tasks

1. Explain the design thinking process and its importance.
2. Describe the processes involved in designing

Pedagogical Exemplars

Collaboration, communication, critical thinking

With the use of relevant videos, charts and the internet assist learners in a whole class discussion to explain the design process and outline the stages involved. Ensure AP and P learners participate in the discussion by asking them leading questions.

Discussion, communication, critical thinking

With the use of a flow chart, assist learners to review and explain all the stages in the design thinking process in a whole class discussion. Ensure AP and P learners take part in the explanation.

Key Assessment (DoK)

Level 2

1. Describe the importance of the design process.

Level 3

2. Using a flowchart explain all the stages involved in the design thinking process.

Week 11

Learning Indicator(s): *Problem identification and brief writing*

Theme or Focal Area 2: Design Brief

Problem Identification (Situation)

Before a design brief can be written a problem needs to be identified (situation) within the learner's environment such as the home, the school, church or market place. It provides essential context and sets the stage for the design work ahead. The entire designing process hinges on problem identification by effectively identifying the problem half of the solution is achieved.

The format for writing a problem statement uses your answers to the questions and the following structure: **who** needs **what** because **why.**

_____ needs _____ because_____

Design Brief

A design brief is a document that outlines the objectives, scope and requirements of a design project. It provides a clear understanding of what is expected and what needs to be delivered to ensure the end product meets the client's expectations and delivers the desired outcomes.

The design brief should provide a clear and concise description of a design project. It should cover the **who, what** and **why** behind the project. For example: 'a new entrance for a school needs to be designed, and why it should be designed'

A design brief typically includes:

- A clear understanding of the problem you are trying to solve.
- A definition of your target audience.
- The scope of the project.
- The project budget and timeline.
- The project goals and objectives.
- A description of the client brand identity.
- Sample designs.

Learning Task

1. Identify a problem in the school environment and write a brief for the identified problem.

   Example - Indiscriminate littering in the school environment.

Pedagogical Exemplars

Group work, observation, collaboration, critical thinking, communication

In mixed-ability groups of no more than five learners, learners walk around and observe the school environment to identify potential problems that need solutions. Ensure that the groups consist of AP, P and HP learners.

Talk for learning, communication, critical thinking

Using the same groups assist learners to write design briefs for the identified problems they found in the school environment. Ensure the AP, and P learners participate in the writing process. Let learners present their design briefs to the whole class for discussion. Allow the HP learners to lead the discussion.

Key Assessment (DoK)

Level 2

1. Identify two situations in the school environment and write a problem statement for these.

Level 3

1. Write a design brief for the problems identified in question (1).

Unit 4 Review

This unit covered the design thinking process, identifying problems in a given environment, writing design briefs for identified problems and generating possible solutions to these problems. Learners were expected to demonstrate effective ways to solve identified problems in their selected environment.

Learners identified problems in their environment that required a solution, through thought provoking pedagogies that emphasised the '**Why, What and How'**, learners developed and selected the most efficient solutions for the identified problems. Learners were encouraged to explain their answers which helped to develop critical thinking and problem-solving skills.

References

1. Design and Communication Technology Curriculum.
2. Chapman C. and Mel P. **(**1998**)** Design and Realisation for Collins GCSE Design and Technology.
3. Woodham M. (2004). A Dictionary of Modern Design. Oxford University Press**.**
4. Rees D. (1989) GCSE CDT-design and realisation. Longman press.

Week 12

Learning Indicator(s): *Generate solutions to solve identified problems*

Theme or Focal Area 3: Generating Solutions to Solve Identified Problems

We all spend a lot of our time solving problems both at school and in our personal lives. Some problems are small, and we solve them easily. But others are complex challenges that take collaboration, creativity, and a considerable amount of effort to solve.

At school, the type of problems we encounter vary from person to person and location. For example, a student in a wheelchair struggling to ascend a stair to a classroom, the alarming rate of flies in the dining hall or a teacher exploring solutions to student indiscipline.

Whatever issues we face, there are some common ways to tackle them effectively. Generating solutions to solve identified problems is part of our everyday life, consciously or unconsciously we generate solutions to problems.

Problem solving is something we do every day. One way of tackling problems is to use a specific and systematic problem-solving procedure.

Procedures for Generating Solutions to Solve Identified Problems

- **Identify and define the problem**

  State the problem as clearly as possible. For example: 'Indiscriminate littering in the school environment'

  Be specific about the behaviour, situation, timing, and circumstances that make it a problem.

- **Generate possible solutions**

  List all the possible solutions; don't worry about the quality of the solutions at this stage.

  Try to list at least 15 solutions, be creative. If you allow yourself to be creative, you may come up with some solutions that you would not otherwise have thought about.

- **Evaluate alternatives**

  The next step is to go through and eliminate less desirable or unreasonable solutions.

  Order the remaining solutions in order of preference. Evaluate the remaining solutions in terms of their advantages and disadvantages.

- **Decide on a solution**

  Specify how the solution will be implemented, and when the solution will be implemented.

- **Implement the solution**

  Implement the solution as planned.

- **Evaluate the outcome**

  Evaluate the outcome and how effective the solution was. Decide whether the existing plans need to be revised or whether a new plan is needed to better address the problem.

- **Not sure of the outcome**

  Return to 'Generate possible solutions' to select a new solution or revise the existing solution and repeat the remaining steps.

Learning Task

1. Generate workable possible solutions to the identified problem in the school environment. Example - Indiscriminate littering in the school environment.

Pedagogical Exemplars

Collaborative/group work, critical thinking, communication

In a mixed-ability groups of no more than five members, assist learners to develop some possible solutions to identified problems they observed in their selected environment. Ensure the group consists of AP, P and HP learners.

Observation, critical examination, communication, critical thinking

Using demonstration, guide learners to critically examine how their solutions are suitable and workable in solving the identified problems.

Key Assessment

Level 3

2. From a given brief, investigate, analyse and write a report on the findings, report to include problem statement and design brief.

Level 3

Generate workable possible solutions to the identified problem in the school environment, example (Indiscriminate littering in the school environment')

SECTION 2: GEOMETRICAL FIGURES

UNIT 1: GRAPHIC COMMUNICATION

Strand: **Graphic Communication**

Sub-Strands:

1. Plane Geometry
2. Solid geometry
3. Fractal geometry.

Learning Outcomes:

1. *Use knowledge of plane geometry to draw plane geometrical shapes and design different artifacts based on plane geometrical figures*
2. *Use knowledge of solid geometry to draw solid geometrical shapes and design different artifacts based on solid geometrical figures*
3. *Use the understanding of fractal geometry to create meaningful designs.*

Content Standards:

1. Apply the concept of plane geometry in designing
2. Apply the concept of solid geometry in designing
3. Demonstrate the knowledge and understanding in fractal geometry in creating meaningful designs.

INTRODUCTION AND SECTION SUMMARY

This section talks about the types, properties and construction of plane, solid and fractal geometrical figures. Learners should have basic knowledge of mathematical principles such as ratio and proportions, trigonometry, and mensuration.

Plane geometry deals with shapes, angles, dimensions and sizes of a variety of things we see in our everyday life and have flat surfaces which include various polygons such as triangles, quadrilaterals and circles. Solid geometry deals with three-dimensional space, that is the kind of space we live in. It is so called because it has a height, width and depth. While fractal geometry is about the combination of solid and plane geometry to create patterns in design.

The section is made up of three sub-strands. In the first sub-strand, learners discuss the types, properties and uses of plane geometrical figures and construct:

1. Enlargement and reduction of plane geometrical figures and its application.
2. Blending circles and lines with arcs and its application.
3. Ellipse and its application.
4. Archimedean spiral and its application

In the second sub strand, learners discuss solid geometrical figures and its applications and construction:

1. Objects in isometric, oblique and perspective.
2. The surface developments of prisms and its truncation

In the third sub strand learners will be introduced to Fractal geometry.

The weeks covered by sub-strand 1 (Apply the concept of plane geometry in designing) are:

***Week 13**: Explain types of plane geometrical figures and give examples*

***Week 14:** Enlargement and reduction of plane geometrical figures*

***Week 15:** Enlargement and reduction of plane geometrical figures (continued)*

***Week 16:** Blending of arcs and circles*

***Week 17:** Blending of arcs and circles(continued)*

***Week 18:** Loci*

SUMMARY OF PEDAGOGICAL EXEMPLARS

This section requires a careful and engaging approach to facilitate the learning process. Teachers need to revise the learner´s previous knowledge on ratios and proportions in Mathematics basic (8 and 9) and plane geometry in Career Technology in basic 9.

Through observation demonstration, illustration and construction pedagogies guide learners to construct plane geometrical figures. Use clear instructions and a series of formative assessments to encourage learners during the learning process in a conducive learning environment where learners can understand the concept and draw expertly.

Teachers should ensure learners respect the views of other learners and ensure gender balance during the learning process. During construction of plane geometrical figures, emphasis should be on the correct use of drawing instruments, constructional lines and outlines and also neat work.

ASSESSMENT SUMMARY

In this section teachers should employ a variety of assessment strategies which involve oral, written presentations, reports and drawings. The assessment should cover **DoK** level 1, 2 and 3.

Assessment should be based on types, properties and applications of:

1. plane geometrical figures and construction of:
2. Enlargement and reduction of plane geometrical figures
3. Blending circles and lines with arcs
4. Ellipse
5. Archimedean spiral

Note: Teachers should give additional support to **AP learners. P learners** should be asked to work within a specific time frame and **HP learners** should be given an expansion of the given task to do.

Week 13

Learning Indicator(s): *Explain plane geometrical figures, state their properties, applications and give examples.*

Theme or Focal Area 1: Plane Geometrical Figures

1. Plane geometrical figures have flat surfaces.
2. They have two dimensions.
3. They do not have thickness.
4. All 2-dimensional shapes are known as polygons.

Table 2. 1.1: Types of polygons and their properties:

Types of polygons	Examples	Properties
Triangles 	• Equilateral • Isosceles • Scalene	Bounded by three straight lines Three internal angles
Quadrilaterals 	• Square • Rectangle • Rhombus • Parallelogram	Bounded by four straight lines Four internal angles
Polygons with more than four sides 	• Pentagon • Hexagon • Heptagon • Octagon	Bounded by more than four straight lines More than four internal angles

Application of plane geometry

1. Folders/envelopes
2. Tabletops
3. Walls
4. Paper
5. Chalkboard/whiteboard
6. TV screens

Learning Tasks

1. Explain the concept of plane geometry and give at least two examples
2. Identify four plane geometrical figures, list their properties and their application in real life

Project:

3. Using the principles of plane geometry, design a warning sign to be placed in the school compound

Pedagogical Exemplars

Environmental observation, collaboration and discussion:

With the aid of relevant pictures, charts and objects in the school environment, draw on learners' previous knowledge on plane geometry from basic 9 in an inclusive whole class discussion to explain plane geometry in their own words.

Collaboration and communication

In mixed-ability groups**,** help learners to identify examples of plane geometrical figures and explain their properties with given examples. Learners present their findings in a whole class discussion. Ensure the AP and P learners participate in the discussions.

Think-pair-share

In mixed-ability group discussions with no more than six members, assist learners to use any plane geometrical figure to design a warning sign that can be placed anywhere in the classroom.

Note: Ensure the groupings consist of AP, P and HP learners

Key Assessment (DoK)

Level 2

Explain the concept of plane geometry and state three examples

Level 2

Identify four plane geometrical figures, list their properties and their application in real life

Level 3

Using the principles of plane geometry, design a warning sign to be placed in the school compound.

Week 14

Learning Indicator(s): *Use ratio to enlarge, reduce or divide plane geometrical figures*

Theme or Focal Area 2: Using Ratio to Enlarge and Reduce Plane Geometrical Figures

A plane geometrical figure can be enlarged/reduced when all its dimensions are changed using the same ratio, without changing the actual shape of the figure. In instances where various sizes of objects are required, for example, small size, medium size and large size, the principles of enlarging and reducing plane geometrical figures are required.

Using ratio to reduce the size of a four-sided polygon

Procedures:

1. Draw the given plane figure.
2. Choose a polar point **O** outside the given figure.
3. Draw lines from the polar point **O** to touch the vertices of the plane figure.
4. Construct the given ratio (using division of lines) on one of the radial lines.
5. Draw lines parallel to the given figure based on the ratio to obtain the reduction or enlargement of the four-sided polygon.

Examples

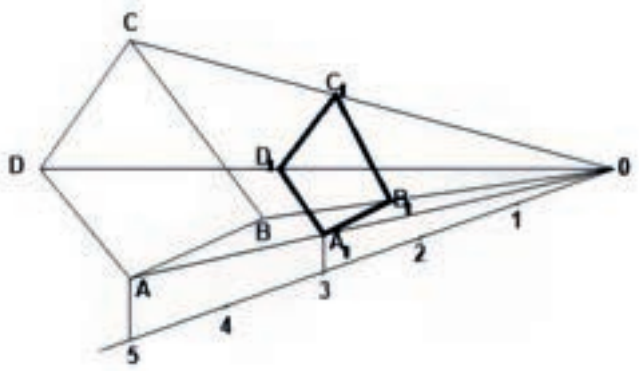


Figure 2.1.1: *Reduction of plane figures*

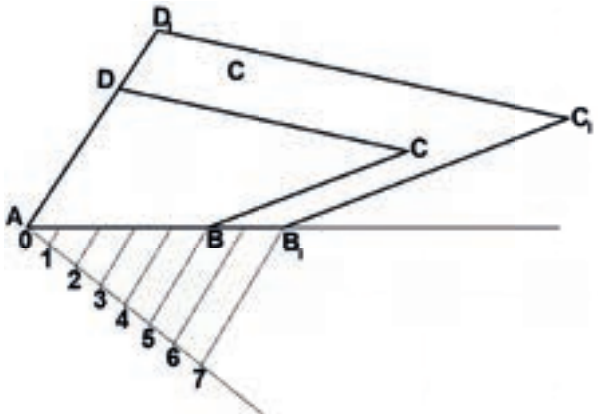


Fig 2.1.2: *Enlargement of plane figures*

Note: Teachers should assist learners to expertly enlarge and reduce different examples of plane geometrical figures.

Construction of plane figures of equal areas

To convert a rectangle to a square of equal area:

1. Draw the given rectangle ABCD.
2. With point D as centre and radius DC, draw an arc to intersect line AD produced at E.
3. Bisect line AE to obtain point F.
4. With point F as centre and radius FE or AF, draw a semi-circle.
5. Produce line DC to intersect the semi-circle at point G. Line DG is one side of the square.
6. With radius DG and D as centre, draw an arc to intersect line AE produced at L.
7. With the same radius as DG and point G and L as enters, draw arcs to intersect at H.
8. Firm in lines DG, GH, HL and LD to obtain the required square.

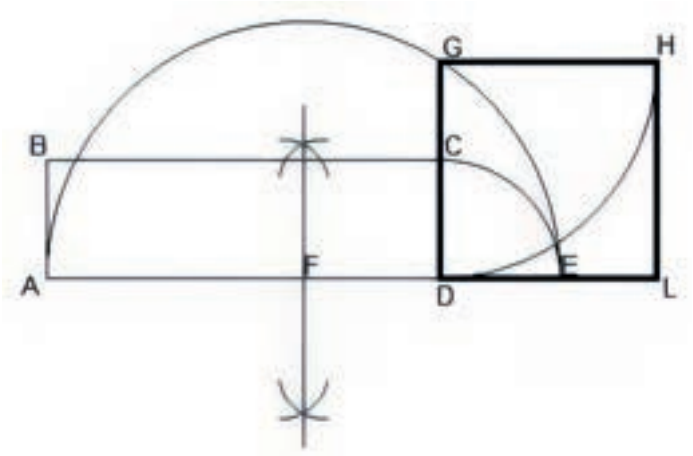


Figure 2.1.3: *Plane figures of equal area*

To convert a triangle to a rectangle of equal area:

1. **Step 1**: Draw the given triangle ABC.
2. **Step 2:** Draw a perpendicular from C to AB to intersect at point Y.
3. **Step 3:** With points C and Y, bisect line CY.
4. **Step 4:** At points A and B, project vertical lines up to intersect the bisector at P and Q, respectively.
5. **Step 5:** Firm in lines AB, BQ, QP and PA to obtain the required rectangle.

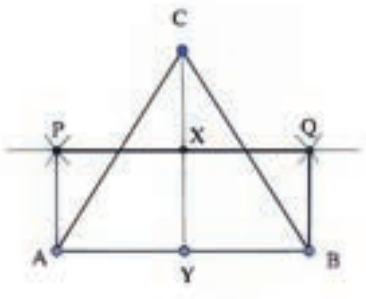


Figure 2.1.4: *Triangle to a rectangle of equal area.*

Note: Teachers should assist learners to convert different examples of plane geometrical figures to other figures of equal area.

Application of reduction and enlargement of plane geometrical figures:

1. Designing of packages
2. Electrical gadgets
3. Varied sizes of canned foods

Example:

A pizza company requests varied sizes of packages (boxes) for their pizza deliveries e.g. small, medium, and large.

Based on your knowledge of enlargement/reduction of plane figures, design three different boxes for the company.

Learning Tasks

1. Construct a plane figure, using the ratio method to enlarge or reduce it in the ratio 8:5 or 5:8.
2. Construct a plane geometrical figure and divide it into two equal parts.
3. Convert a rectangle of given size to a triangle of the same area.
4. A pizza company requests varied sizes of packages (boxes) for their pizza deliveries e.g. small, medium, and large. Use your knowledge in enlargement/reduction of plane geometrical figures, to design three varied sizes of pizza boxes.

Pedagogical Exemplars

Collaboration, communication, critical thinking and research:

With the use of charts, pictures, the internet etc, review learners' previous knowledge on ratios and proportions from basic 7 and 9 mathematics.

Demonstration, activity-based learning, critical thinking

Using board illustration, videos, charts and drawing instruments demonstrate to learners how to use the principles of enlargement, reduction and division of plane figures to enlarge and reduce plane geometrical figures.

Group work, collaboration, communication, critical thinking

With mixed-ability groups each consisting of 3 learners, support groups to expertly enlarge, reduce and divide given plane geometrical figures to given ratios, and present their drawings for a whole class discussion (let learners pin their drawings on the marker board and let group leaders defend their work and allow learners to critique each groups drawings to enhance the understanding of the concept).

Individual learning, critical thinking, innovation

With the use of drawing instruments and board illustrations, support learners to construct plane geometrical figures equal in area to given figures.

Project based learning innovation, creativity, critical thinking

Using the concept acquired in reduction and enlargement of plane geometrical figures, guide learners to design three varied sizes of pizza boxes individually.

Key Assessment (DoK)

Level 2

1. Construct an equilateral triangle of side 60 using the ratio method, enlarge or reduce it to the given ratio 5:3 or 3:5 respectively.
2. Construct a square of side 40 and divide it into 2 equal halves.
3. Convert a rectangle of given size 70 x 40 to a triangle of the same area.

Level 3

Use your knowledge in enlargement/reduction of plane figures, to design three varied sizes of pizza boxes.

Week 15

Learning Indicator(s): *Blend circles and lines with arcs.*

Theme or Focal Area 3: Blend Circles and Lines with Arcs

Blending circles and lines with arcs

A technique used in designing and crafting to create smooth transitions between two curves, surfaces, or lines. It involves the combination of two arcs into a single arc of equal radius or using a blend of arcs between two lines. In real life, incandescent lamps, spanners, and fishing hooks are made based on the principles of blending circles and lines with arcs.

Figure 2.1.5: *Items designed on the principles of blending circles and lines with arcs*

Curves are included in the outlines of components for several reasons. These include:

1. To remove sharp edges
2. To avoid extra machining
3. To improve appearance

Blending circles with arcs is based on three principles. These are:

1. Internal blending of circles with arcs
2. External blending of circles with arcs
3. Internal and external blending

Blending lines with arcs is based on two principles. These are:

1. Blending lines at right angles
2. Blending lines meeting at angles other than 90^0

Blending of lines meeting at right angles/lines meeting at angles other than 90^0 with arcs

Procedure:

To find the centre of an arc of radius T, which blends with two straight lines meeting at right angle.

1. Construct two lines to meet at 90^0 at A.
2. With centre A, and radius T, draw arcs to intersect the constructed lines in B and C.
3. With centre's B and C and radius T, draw two arcs to intersect at O.
4. Use the centre of the arc to blend the two lines.

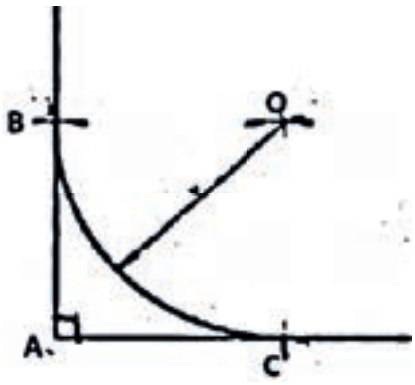


Figure 2.1.6: *Blending of lines meeting at right angles*

To find the centre of an arc of radius r which blends with two straight lines intersecting at any angle:

1. Draw the two lines R and Q to intersect at P any angle, in this case, obtuse.
2. Construct lines M and N parallel to the drawn lines with distance equal to the radius r to intersect at g. g is the centre of the arc required to blend the two lines.

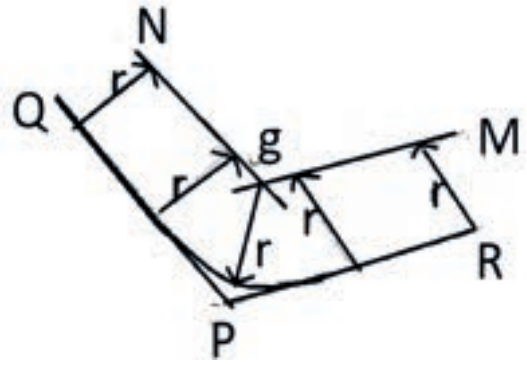


Figure 2.1.6: *Blending of two straight lines intersecting at any angle*

To find the centre of an arc of radius r which blends with a line and passes through a point X:

1. Draw a line AB at any length and a point X.
2. Construct a line CD parallel to line AB which is r away. The centre will be somewhere along this line.
3. With radius r and centre X, draw an arc to intersect with the parallel line at V to give the centre of the arc.

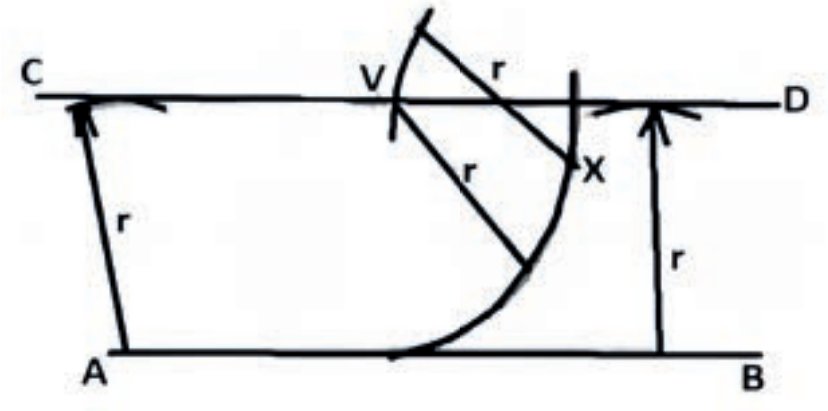


Figure 2.1.7: *Blending of line and an arc that passes through a point X*

To blend two circles U and V of different radii with an arc of radius Y, internally:

1. Draw the two circles with given radii and D apart.
2. Find the centre of the arc by adding the radius of circle U to the radius of the arc, Y. That is Y + radius of circle U.
3. With U as the centre and radius Y + radius of circle U, draw an arc.
4. Again, add the radius of circle V to the radius of the arc, Y.
5. With centre V and radius Y+ radius of circle V, draw another arc to intersect the first arc at O. O is the centre of the arc to blend the circles.
6. With O as centre and radius Y draw the arc to blend the two circles U and V
7. Repeat the processes to obtain the centre O1.
8. With O1 as the centre and radius Y, draw the arc to blend the two circles.

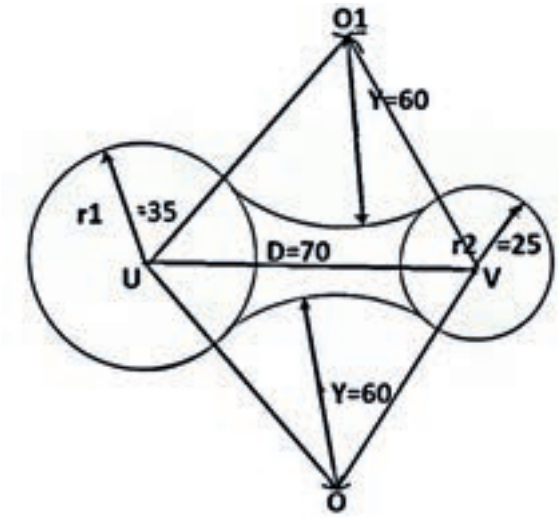


Figure 2.1.8: *Blending of two circles internally.*

Pedagogical Exemplars

Collaboration, critical thinking, and discussion

Place learners into mixed-ability groups. Provide groups with relevant teaching and learning materials such as water bottles, incandescent lamps, pots and Milo or milk tins.

Ask the members in each group to identify the things that are common to the objects they have. The groups present their findings in a whole class discussion.

Support learners to identify other objects that have similar features such as a wine glass, spanner and fishing hook.

Guide learners to explain blending of circles and lines with arcs in a whole class discussion.

With the use of drawing instruments and board illustrations demonstrate:

1. The blending of two lines meeting at right angles
2. The blending of two lines meeting at angles other than 90^0
3. Blending a lime and a point, blending two circles of different radii internally
4. Blending two circles of different radii externally and,
5. Blending two circles of different radii internally and externally

Creativity and innovation

Through mixed gender groupings of four learners, support them with videos and research to demonstrate the use of the principles of blending to design a water bottle.

Guide learners to design a spanner using the appropriate principle of blending circles and straight lines with arcs.

Learning Task

Based on the principles and concept of blending lines and circles with arcs construct a one end open spanner.

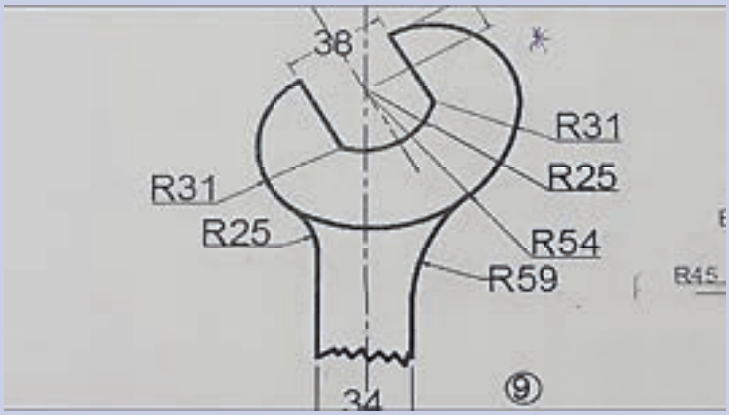


Figure 2.1.9: *Spanner construction*

Key Assessments (DoK)

Level 1

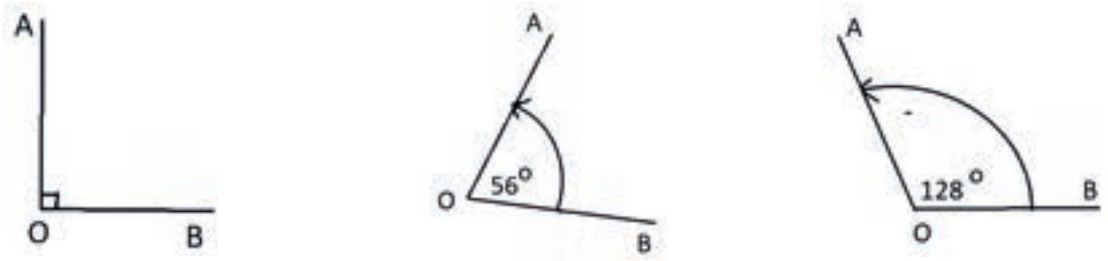
Explain the blending of lines and circles with arcs.

Level 1

Outline the reasons for blending and name three objects that are made from blending.

Level 3

Two lines of length 59 meet at angles shown, use the radius of arc of 47 to blend them.



(i) (ii) (iii)

Figure 2.1.10: *Lines meeting at an angle to be blended with arcs*

Level 3: Two circles have their centres 100 apart, with diameters of 70 and 50 are to be blended with an arc of radius 85. Blend the circles

1. Internally
2. Externally
3. Internally and externally

Week 16

Learning Indicator(s): *Blend circles and lines with arcs* **(continued)**

Theme or Focal Area 4: Blend Circles and Lines With Arcs

Note: Refer to week 15 for pedagogical exemplars

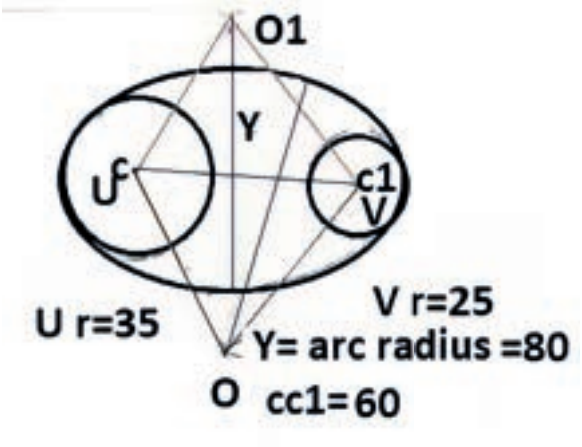


Figure 2.1.11: *Blending of two circles of different radii externally*

To blend two circles, U and V, of different radii with an arc of radius Y externally:

1. Draw the two circles with given radii and P distance apart.
2. Find the centre of the arc by subtracting the radius of circle U from the radius of the arc, Y. That is Y - radius of circle U.
3. With U as centre and radius (Y - radius of circle U), draw an arc.
4. Again, subtract the radius of circle V from the radius of the arc, Y.
5. With centre V and radius (Y - radius of circle V), draw another arc to intersect the first arc at O. O is the centre of the arc to blend the circles.
6. With O as centre and radius Y draw the arc to blend the two circles U and V.
7. Repeat the processes to obtain the centre O1.
8. With O1 as centre and radius Y draw the arc below to blend the two circles.

To blend two circles U and V of different radii with an arc of radius R externally and internally.

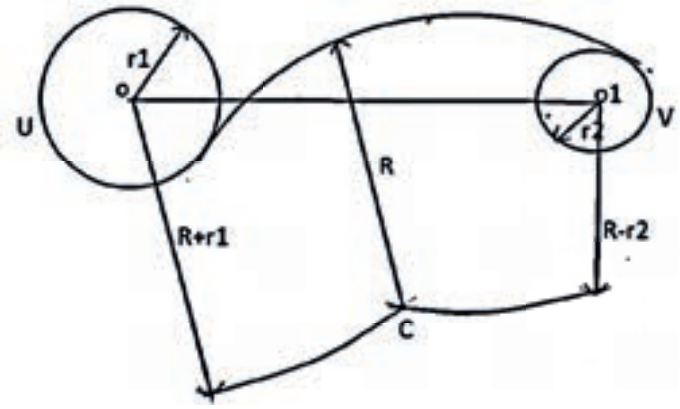


Figure 2.1.12: *Blending of two circles of different radii externally and internally*

1. Draw the two circles with given radii r1 and r2 with P distance apart.
2. Find the centre of the arc by adding the radius of circle U to the radius of the arc, R That is R+r1. With centre O and radius R+r1, draw an arc.
3. Again, subtract the radius of circle V from the radius of the arc, R. That is R-r2, then, with centre O1 and radius R-r2, draw another arc to intersect the first arc at C.
4. From centre C and the arc radius R, draw the arc to blend the two circles U and V externally and internally.

Learning Task:

1. A new water distribution company has given you a contract to design a water bottle for its bottled water department. With your knowledge in blending, design a bottle for the company.

Key assessments (DoK)

Level 4

In pairs, design a water bottle for a bottling company based on the knowledge acquired in designing and blending of lines and circles with arcs.

Note: Teacher should ensure equal participation between learners

Week 17

Learning Indicator(s):

1. *Construct an ellipse as a plane geometrical figure*
2. *Construct an Archimedean spiral as a plane geometrical figure*

Theme or Focal Area 5: Constructing an Ellipse as a Plane Geometrical Figure

Ellipse

An ellipse is the section obtained when a cone is cut at an angle to the base.

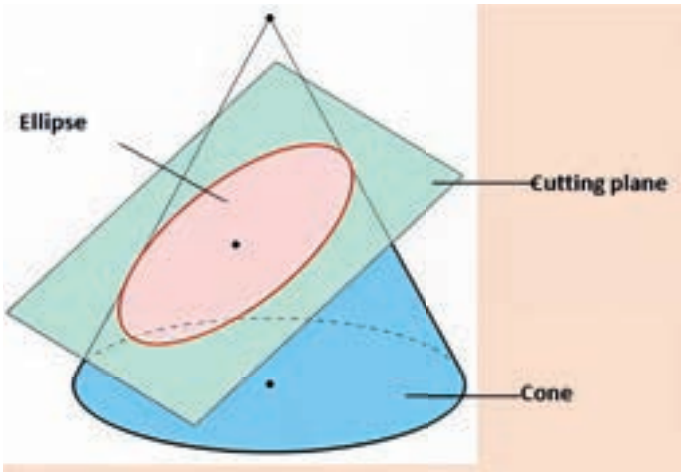


Figure 2.1.13: *ellipse*

It may be defined as the locus of a point which moves so that its distance from a fixed point (called the focus) has a constant ratio which is always less than one (1) to its perpendicular from a straight line (called the directrix).

Figure 2.1.12: *An elliptical faced clock*

Properties of an ellipse: The following are properties of an ellipse:

1. **The major axis:** is the maximum distance measured between its two vertices i.e. vertex A to vertex B on the horizontal axis.
2. **The minor axis:** is the maximum distance measured on the vertical axis.

3. **The Vertex:** is the turning point on a path traced by the locus. An ellipse has two vertices.
4. **The Directrix:** is the perpendicular distance from a straight line which is at right angles with the horizontal axis of the ellipse.
5. **The Focal point (foci):** is the point which moves so that its distance from a fixed point maintains a constant ratio. (Loci is the plural of locus).
6. **The Eccentricity:** is the radial movement of the focal point in relation to its directrix.

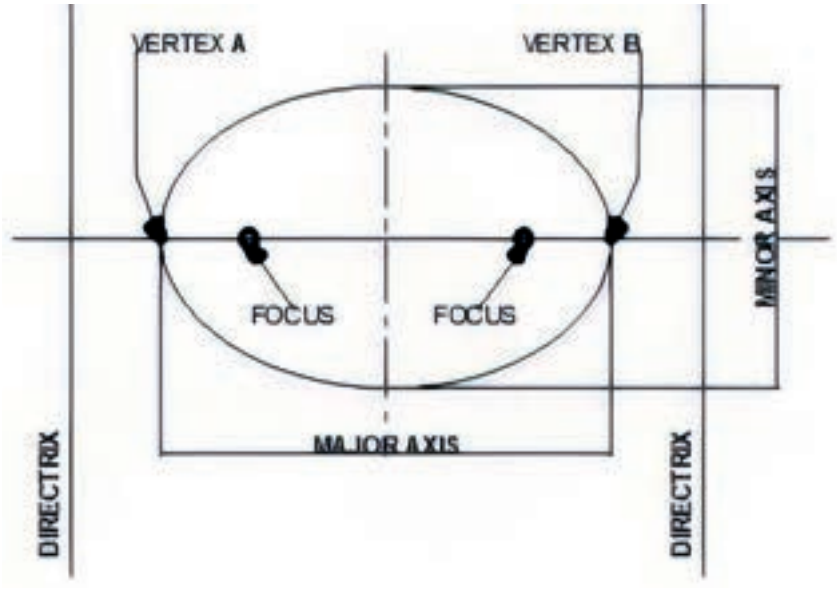


Figure 2.1.14: *Properties of an ellipse*

Application of an ellipse

1. In architecture an ellipse is used to design buildings
2. In woodwork an ellipse is used to design and build table and shelves
3. An ellipse is used to design metal fabrication in metal work and automotive objects.

Methods of construction of an ellipse with major and minor axis:

1. Concentric circles method
2. Rectangular method
3. Trammel method

1. Concentric circles method

To construct an ellipse using concentric circles when the length of the major axis is 120mm and the minor axis 80mm.

a. Draw the major and minor axis AB and CD and then locate the centre O.

b. With centre O and major axis and minor axis as diameters, draw two concentric circles.

c. Divide both the circles into an equal number of parts, say 12 and draw the radial lines.

d. Considering the radial line $0\text{-}1^1\text{-}1$, draw a horizontal line from 1^1 to meet the vertical line from 1 at P_1.

e. Repeat steps 4 and obtain other points P_2, P_3 etc.

f. Join the points by a smooth curve to obtain the required ellipse.

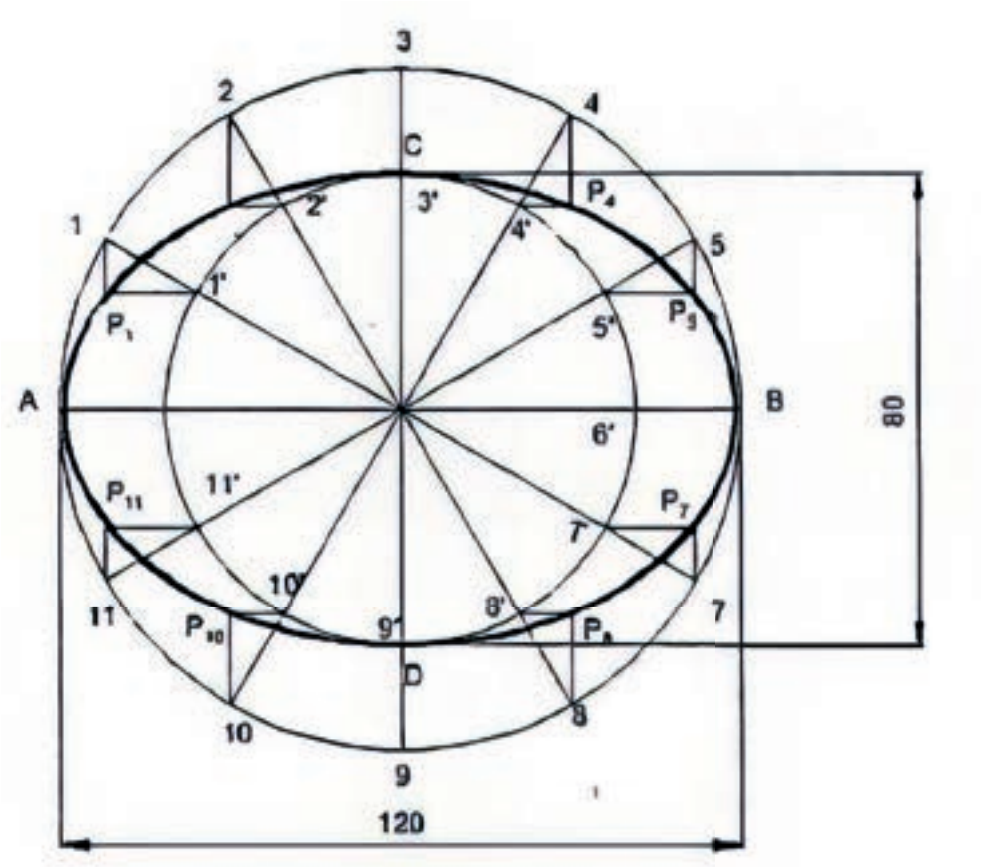


Figure 2.1.15: *Concentric circles method*

Note: Teachers should discuss other methods of constructing ellipse with learners

Learning Task

Based on your knowledge in the construction of an ellipse, design an elliptical object to be used in the home.

Pedagogical Exemplars

Through **environmental observation, videos, charts and in mixed ability groupings** assist learners to identify some elliptical shapes in the environment. Guide learners to present their findings in a whole class discussion. The teacher should ensure AP learners are involved in the discussion.

With the use of, **board illustrations and whole class discussions** let learners express their views on elliptical shapes they saw in their environment in their groups.

With the use of drawing instruments, **board illustrations** and through mixed-ability grouping demonstrate the construction of ellipse using all the three methods mentioned using the minor and major axes. **Note**: Additional support should be given to AP and P learners to be able to construct the ellipse.

With the use of sketches and drawing instruments, guide learners to use the concept of an ellipse construction to design an elliptical object of their choice. **Note:** the AP and P learners should be supported adequately whilst the HP learners should be left alone to explore.

Constructing an Archimedean spiral as a locus

Is the locus of a point moving away from a fixed point with a constant speed along a line that rotates with constant angular velocity.

Archimedean spirals exist in natural forms such as snail shells and coiled millipedes.

Figure 2.1.16: *Coiled millipedes Fig 2.1.17 Snail shell*

And designed objects such as the mosquito coils and spiral stair

Figure 2.1.18: *Mosquito coil Figure 2.1.19 spiral stair*

Construction of an Archimedean spiral

Procedure:

- Start from the point of origin (centre O) and draw a circle using the radius given.
- Divide the circle into 12 equal parts
- Divide the radius into 12 equal parts
- With centre O and radius 1,2, 3…12 draw arcs to intersect the corresponding radii
- Join the intersecting points with a smooth curve to obtain an Archimedean spiral

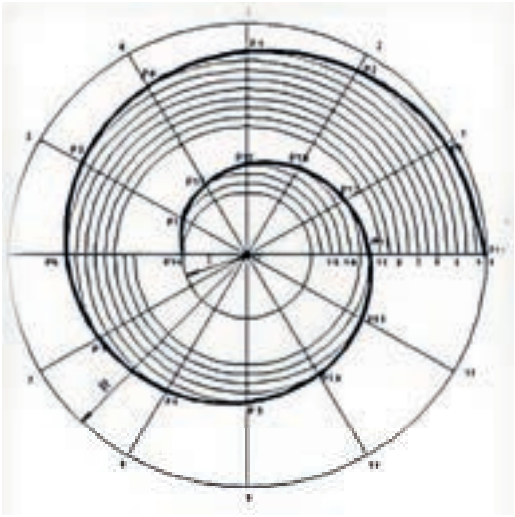


Figure 2.1.20: *Construction of Archimedean spiral*

Application of an Archimedean spiral

An Archimedean spiral is used:

1. In the designing of ships and submarines
2. In hydrometers to determine density of fluids
3. In hydraulic lifts
4. To design the pattern of mosquito coils
5. In designing spiral stairs

Learning Task

1. Based on your knowledge acquired from the construction of an Archimedean spiral and orthographic projection from basic 9. Design a functional spiral stair plan for a two-storey domestic building.

Pedagogical Exemplars

Observation, illustration, demonstration

With the aid of cut shapes, YouTube videos or pictures, show learners different forms of Archimedean spiral that exist naturally and those that are designed.

Group work, Observation/experiential learning communication

In mixed-ability groups, ask learners to observe their immediate environment to identify forms of Archimedean spiral that exist naturally and those that are designed. Guide learners in a whole class discussion to identify some objects they came across during their observation. Ensure AP learners participate in the discussions by asking them leading questions.

Demonstration, illustration, observation, communication

With the use of drawing instruments and board illustration, demonstrate to learners the construction of an Archimedean spiral.

Activity based learning, critical thinking, innovation, creativity

Use the concept of drawing an Archimedean spiral and the knowledge of orthographic projections from basic 9 to design the plan of objects in a spiral form. Support AP learners and P learners in their designing with HP learners working on their own.

Key Assessment (DoK)

Level 1

Name three objects that are made of elliptical shapes that you can find in your environment

Level 2

1. Using any of the three methods, construct an ellipse of major axis 100mm and minor axis 75mm.
2. Construct an Archimedean spiral of radius 75mm.

Level 3

1. Design an elliptical tabletop to be used in the home.
2. Design a plan for a spiral staircase using the principle of spiral construction

Unit 1 Review

This section discussed plane geometrical figures, examples, properties and their construction using drawing instruments.

Learners are expected to expertly construct plane geometrical figures (enlargement, reduction, division and convert plane geometrical figures to other figures of the same area, ellipse, Archimedean spiral and blend circles and lines with arcs). Emphasis should be on neatness of work as well as correct use of constructional lines and outlines.

Additional Reading

Teachers should supplement their knowledge by conducting further reading on plane geometry.

Resources

Models, Charts, drawing instruments, reference books, drawing studio, access to internet, LCD Projector.

References

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2. Asomani J and Dzakpasu R. (2021) Advanced Graphic Communication for Higher Institutions, Landtech Printing Press.
3. Design and Communication Technology Curriculum
4. Rhodes, L. B and Cooks, RS (1982) Engineering Geometrical Drawing, Pitman Publishers.
5. Venkata, K. R, (2008). Textbook of engineering drawing. BS Publications

UNIT 2: SOLID GEOMETRY

Strand: **Graphic Communication**

Sub-Strand(s): Solid geometry

Content Standards: Apply the concept of solid geometry in designing

Learning Outcomes: *Use knowledge of solid geometry to draw solid geometrical shapes and design different artefacts based on solid geometrical figures*

INTRODUCTION AND UNIT SUMMARY

This unit covers the types, properties and construction of solid geometrical figures. Learners who study solid geometry should have basic knowledge in plane geometry.

Solid geometry deals with three-dimensional space, that is the kind of space we live in. Solid geometrical figures have height, width and depth which are seen in our everyday lives. They include everyday shapes such as footballs, pencils, sharpeners, cupboards, cones and pyramids.

Learners are required to explain the types, properties and applications of solid geometrical figures and expertly construct:

1. Objects in isometric, oblique and perspective
2. Develop the surfaces of prisms
3. Develop the surfaces of truncated prisms

The weeks covered by the section are:

Week 18: solid geometrical figures

Week 19: construction of isometric and oblique figures

Week 20: constructing objects in perspectives

Week 21: surface developments of prisms

Week 22: surface developments of truncated prisms

SUMMARY OF PEDAGOGICAL EXEMPLARS

This unit requires attention to detailed processes and some mathematical principles to facilitate the learning process. Teachers need to revise learners' previous knowledge on the construction and measurement of angles.

Through observation, demonstration, illustration and construction pedagogies guide learners to expertly construct solid geometrical figures. Use clear instructions and a series of formative assessments to encourage learners during the learning process in a conducive learning environment where learners can understand the concepts and draw expertly.

Teachers should use board illustrations and instruments and observations of solid geometrical figures around the classroom or school environment. Learners should be able to explain and identify solid geometrical figures and construct them expertly and develop surfaces of prisms.

Teachers should ensure learners respect the views of other learners and ensure gender balance during the learning process. During construction of solid geometrical figures, emphasis should be on correct use of drawing instruments, constructional lines and outlines and neat work.

ASSESSMENT SUMMARY

In this section teachers should employ a variety of assessment strategies which involve oral, written presentations, reports and drawings. The assessment should cover **DoK** levels 1, 2, 3 and 4. Assessment should be based on types, properties and applications of:

1. Solid geometrical figures
2. Fractal geometry

and construction of:

1. Objects in isometric
2. Objects in oblique
3. Objects in perspective
4. Surface developments of prisms
5. Surface developments of truncated prisms

Note: Teachers should give additional support to **AP learners**, **P learners** should be asked to work within a specific time frame. **HP learners** should be given additional tasks to do or be asked to work independently.

Week 18

Learning Indicator(s): *Explain types of solid geometrical figures and give examples*

Theme or Focal Area 6: Solid Geometrical Figures

Solid geometry is a branch of geometry that deals with three-dimensional (3D) space. Solid geometry includes the length, breath, and height of shapes.

Everyday objects such as cupboards, footballs, cardboard tubes, and gas cylinders are examples of solid geometrical shapes.

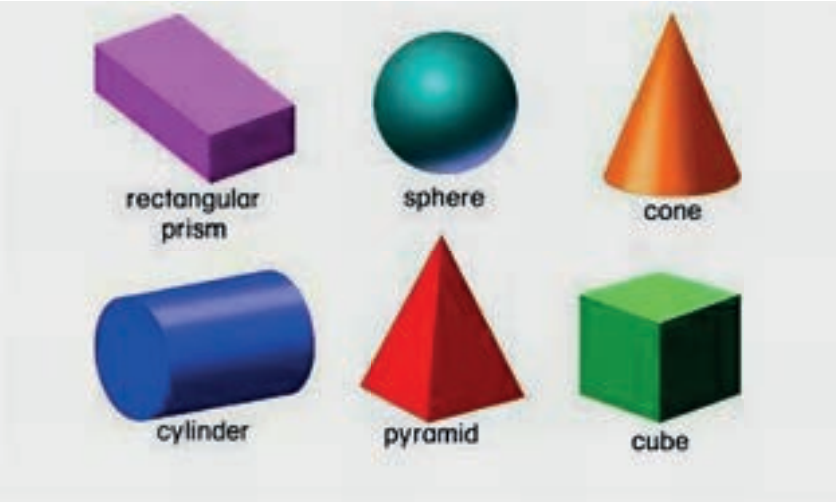

Figure 2.2.1: *Common solid geometrical shapes*

Classifications of solid geometry

1. Prisms
2. Pyramids

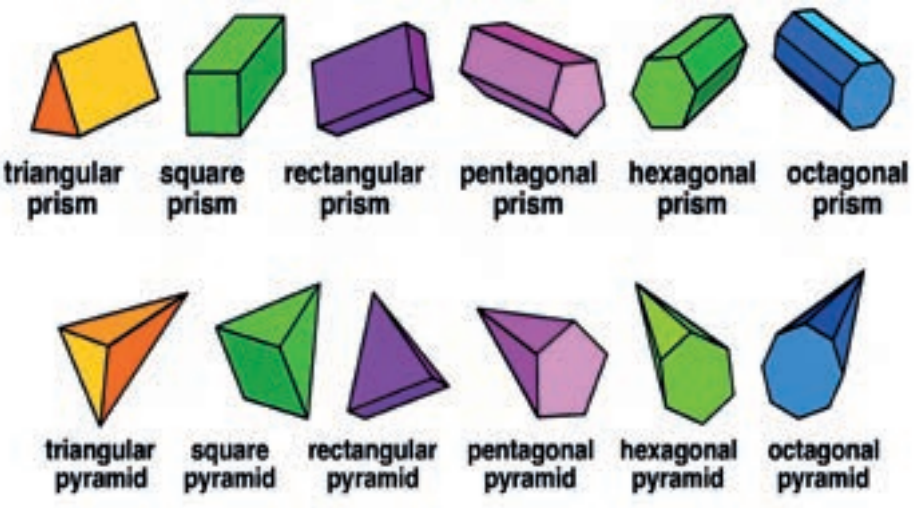

Figure 2.2.2: *Classifications of solid geometry*

Application of solid geometry in real life

1. Construction of structures
2. Art works
3. Interior designing
4. Ship building
5. Vehicle manufacture

Learning Task:

1. Design an envelope that can be used to store your drawing sheets safely based on the knowledge acquired from solid geometry.

Pedagogical Exemplars

Managing talk for learning, observation, communication

With the use of pictures, charts, cardboard shapes and videos engage learners in a whole class discussion to review their knowledge on solid geometry and assist them to explain solid geometry in their own words. Encourage the AP learners to participate in the discussion.

Group work, collaboration, communication, critical thinking

In **mixed gender group discussions,** engage learners to brainstorm on the methods of drawing objects in pictorial form. In a **whole class discussion,** groups present their findings in a polite and orderly manner.

Demonstration, illustration, group work, collaboration, communication, critical thinking

Still in their mixed gender groupings and with the aid of board illustration assist learners to classify solid geometry under prisms and pyramids. Learners should give examples of each and state their properties using a chart.

Collaboration, communication, critical thinking

Guide learners to present their findings in a whole class discussion. AP and P learners should be given support as required.

Project based learning, group work, collaboration, communication

In mixed gender group discussions with not more than six members, assist learners to use any solid geometrical figure to design an envelope to store drawing sheets.

Note: Ensure the groupings consist of AP, P and HP learners.

Key Assessment (DoK)

Level 1

1. Explain solid geometry in your own words
2. In a table, state the two types of solid geometry, list three examples each and state two properties.

Level 3

With the use of neat sketches, design an envelope to store drawing sheets.

Week 19

Learning Indicator(s): *Construct objects in isometric and oblique*

Theme or Focal Area 7: Constructing Objects in Isometric and Oblique

Isometric drawings

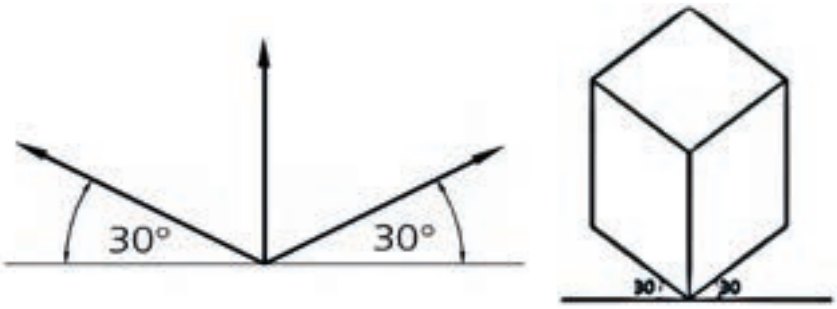

Figure 2.2.3: *Isometric drawing*

1. Vertical lines remain vertical
2. Horizontal lines are inclined at 30 degrees

Used to produced realistic looking 3D views

Oblique drawings

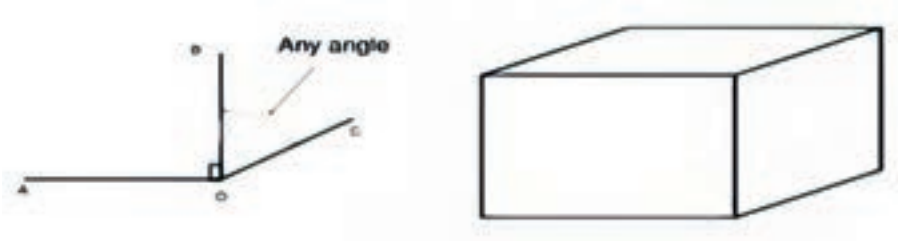

Figure 2.2.4: *Oblique drawing*

Vertical lines remain vertical,

One horizontal line remains horizontal and 90^0 to the vertical.

The other horizontal line should be inclined at an angle less than 90^0.

Learning Task

1. With the knowledge acquired in the construction of solid geometry, design a Dustbin to be used in the classroom.

Pedagogical Exemplars

Research, critical thinking

With the use of sketches, videos, research and pictures help learners to differentiate between isometric and oblique axes, support the AP and P learners to have adequate knowledge in the concept.

Illustration, observation, demonstration, communication

With use of board instruments and illustrations demonstrate to learners how to use isometric axis to construct a simple object in isometric. Provide the AP and P learners with the needed support to draw while the HP learners should be given complex objects to draw in isometric.

With the use of relevant tools, demonstrate to learners how to use the oblique axis to draw simple objects in oblique, again provide the AP and P learners with the needed support to draw while the HP learners should be given complex objects to draw in oblique.

Project based learning, creativity, innovation, critical thinking

With the knowledge in isometric and oblique construction assisting learners in mixed ability groups to design a dustbin to be used in the classroom. AP and P learners should be given additional support.

Key assessments (DoK)

Level 2

Explain the principles used to draw objects in isometric and oblique.

Level 3

Construct the isometric block below with appropriate drawing instruments

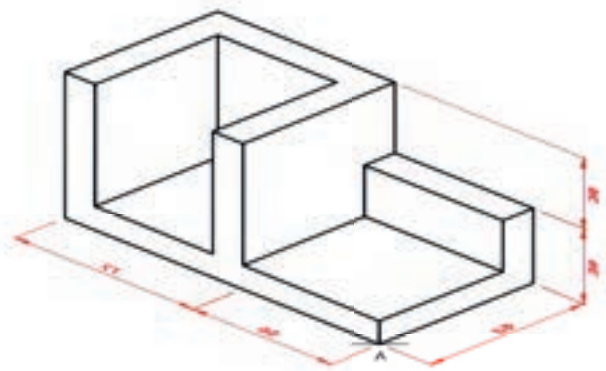

Figure. 2.2.5:*An isometric block*

Level 3 Construct the oblique block below with appropriate drawing instruments

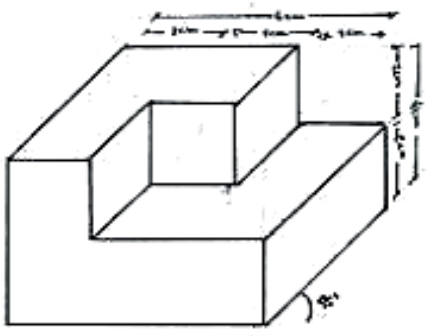

Figure 2.2.6: *An oblique block*

Level 3: Using any of the solid geometrical shapes design a Dustbin to be used in the classroom.

Week 20

Learning Indicator(s): *Construct objects in perspective*

Theme Or Focal Area 8: Perspective Drawing

There are several perspective styles to consider. We'll be covering two of them in this section, namely; *One-point perspective* and *Two-point perspective.*

1. **One-point perspective** is a technique to create **solid geometrical drawings** on a flat surface using a **single vanishing point** on the horizon line.
2. **Two-point perspective** is a technique to create **solid geometrical drawings** on a flat surface using **two vanishing points** on the horizon line.

Eye levels/ horizon

1. Humans eye level (at eye level)
2. Worms eye level (above eye level)
3. Birds eye level (below eye level)

A vanishing point, or point of convergence, in a linear perspective drawing, the vanishing point is the spot on the horizon line to which the receding parallel lines diminish.

1. One-point perspective

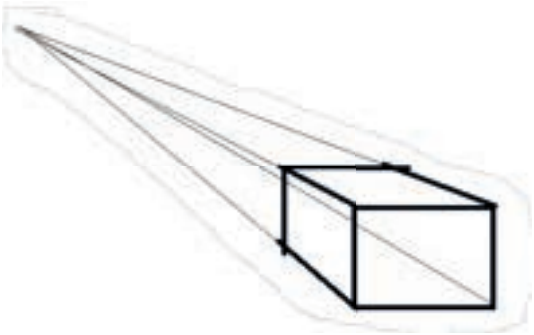

Figure 2.2.7: *One-point perspective at birds eye*

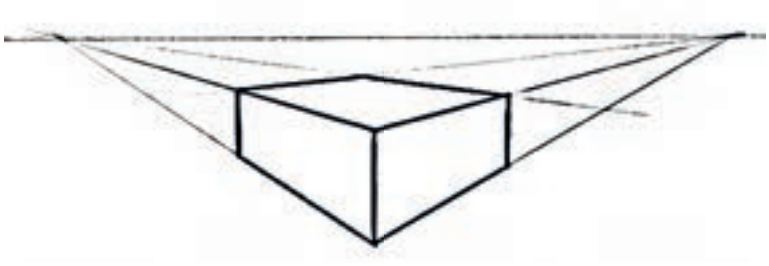

Figure 2.2.8: *Two-point perspective at worms eye view*

Learning Task:

1. Explain the concept of drawing objects in perspective.
2. Construct solid geometrical figures in one-point and two-point perspectives

Pedagogical Exemplars

Observation, talk for learning, collaboration, communication

With relevant pictures and videos show learners how objects appear in perspective. Using think-pair-share let learners observe and present their findings in a whole class discussion. Encourage the AP and P learners to participate in the discussion.

Illustration, observation, demonstration, communication

Using sketches and board illustrations, demonstrate to learners the principles used in drawing objects in one-point perspective at different eye levels. Support the AP and P learners by asking them leading questions.

Illustration, observation, demonstration, communication

Using sketches and board illustrations, demonstrate to learners the principles used in drawing objects in two-point perspective at different eye levels. Support the AP and P learners by asking them leading questions.

Illustration, observation, demonstration, communication

With use of drawing instruments and board illustrations demonstrate to learners how to use the principles in perspective drawing to construct objects.

Activity based learning, manipulative skills

Assist learners to construct objects in perspective with instruments on their drawing sheets.

Note: Include both one point and two-point perspectives and at different eye levels.

Key Assessment (DoK)

Level 2

Explain the principles used in drawing objects in one-point and two-point perspective

Level 3

Construct the isometric blocks below in one-point and two-point perspectives.

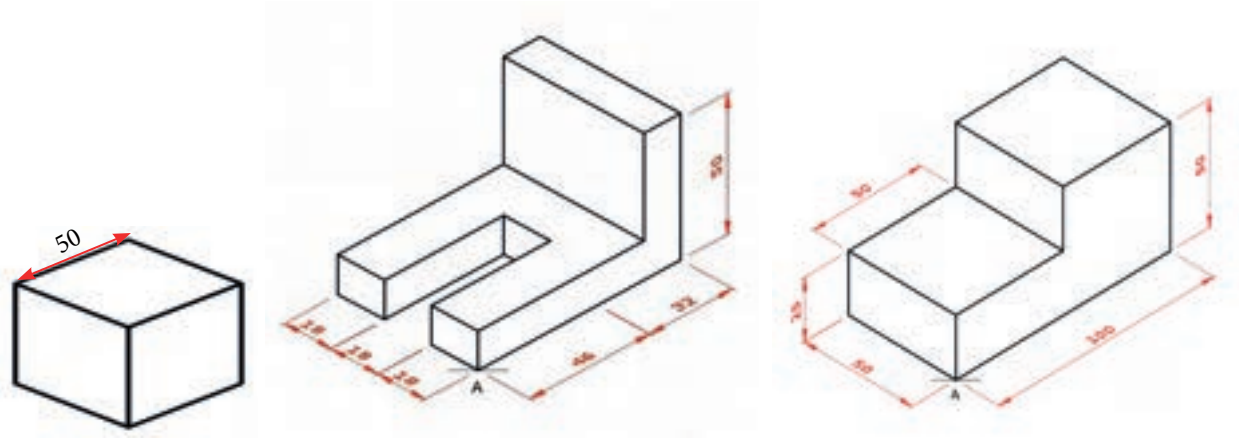

Figure 2.2.9: *Isometric blocks*

Week 21

Learning Indicator(s): *Construct the surface development of prisms*

Theme or Focal Area 9: Surface Development of Prisms

The surface development of an object means the **unfolding of all surfaces that forms the object on a plane**. 'If the surface of a solid is laid out on a plain surface, the shape thus obtained is called the development of that solid.'

When a box is spread out various square shapes are formed this is a typical representation of surface development.

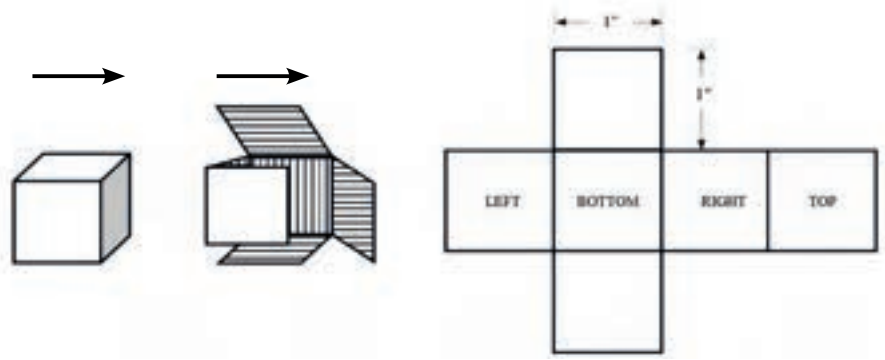

Figure 2.2.10: *Surface development of a cube*

Principles of Surface Development

There are three constructional procedures used in developing the surface of prisms, these procedures involve the use of the:

1. Parallel lines method
2. Radial lines method

NB. The Parallel lines method is used to develop quadrilaterals, prisms and cylinders. The Radial lines method is used for the development of cones and pyramids.

Surface development of a hexagonal prism

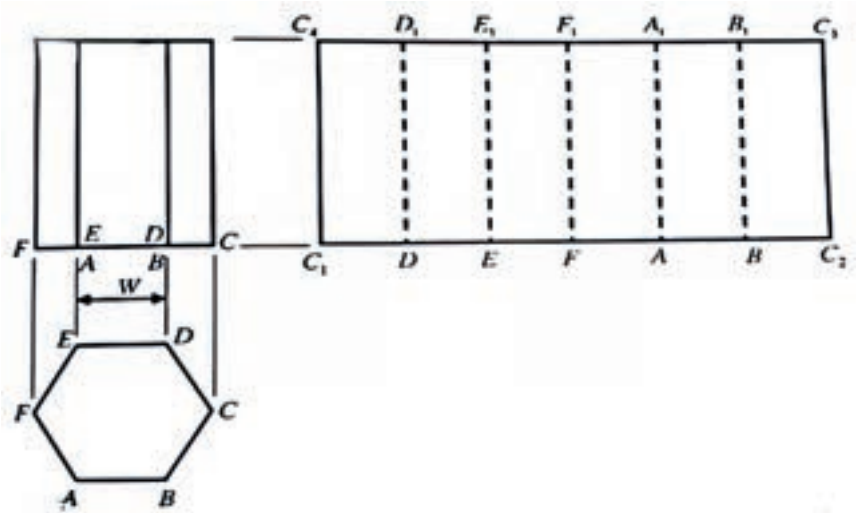

Figure 2.2.11: *Hexagonal prism*

Procedure:

- Draw the plan of the hexagonal prism and letter the corners as A, B, C, D, E, F.
- Project vertical lines to produce the front elevation and label as shown.
- Draw horizontal lines from point C and C' to a convenient distance.
- Draw vertical lines to intersect the horizontal lines at point C1 and C4.
- With radius AB = [one side of the prism] step off six times on the horizontal line.
- Join the last point C2 to C 3 and project broken lines through points.
- Firm in the rectangular shape as the development of the hexagon.

Note: Teachers should assist learners to develop the surfaces of different examples of prisms.

Learning Task:

1. Explain the principles used to develop the surfaces of prisms
2. Construct the surface development of prisms
3. Design and construct, the surface development of a product package for a food company that will come out on 1st January of next year, the product has a height of 150 and width of 50 and length 80 (dimensions are optional).

Pedagogical Exemplars

Communication, critical thinking, discussion and individual learning:

In mixed-ability groupings, ask learners to cut open a water bottle, milk tin, toothpaste box and matches box and spread it out to observe the surfaces formed. Ensure AP and P learners participate in the activity.

Group discussions, collaboration, critical thinking and communication

In their groups, ask learners to sketch the surfaces formed and present their sketches in a whole class discussion. Encourage the AP and P learners to lead the discussion.

Whole class discussions, communication

With the use of models, pictures and charts, guide learners to clearly explain the principles of developing the surfaces of prisms.

Illustration, observation, demonstration, communication

Using board illustration and drawing instruments demonstrate to learners how to use the principles to develop the surfaces of a given prism. Involve the AP and P learners in the demonstration.

Project based learning, innovation, critical thinking, creativity

With the knowledge in developing surfaces of prisms assist learners in mixed-ability groups to design a food package with given dimensions. Provide AP and P learners additional support as required.

Activity based learning, manipulative skills

With the use of drawing instruments and the knowledge acquired in surface development, guide learners to construct the package they have designed.

Key Assessments (DoK)

Level 2

1. Explain the principles of developing surfaces of prisms.

Level 3

1. Construct the surface development of a rectangular prism of sides 30 by 50 and height 80
2. Design and construct the surface development of a product package for a food company.

WEEK 22

Learning Indicator(s): *Construct the surface development of prisms*

Theme or Focal Area 9: Surface Development of Truncated Prisms

This shows how the lateral faces of the truncated prism unfold when flattened out. It helps visualise the shape and layout of the lateral faces. Truncation occurs when a cut is made across the height of a prism at an angle to the base.

The steps to construct the surface development of a truncated prism:

1. **Draw the views**:
   - Draw the front view of the truncated prism, showing both the original base and the truncated top.
   - Label the vertices and edges of the base and the truncated top.
2. **Draw parallel lines**:
   - Draw horizontal lines parallel to the front elevation from the plan of the prism. This line represents the **stretch-out line**.
   - The length of this line should be equal to the **perimeter** of the base of the prism.
3. **Fold lines**:
   - Along the stretch-out line, locate points corresponding to the lengths of the sides of the prism.
   - These points represent the **fold lines** where the lateral faces will be connected.
4. **Surface development**:
   - From each fold line, draw vertical lines perpendicular to the stretch-out line.
   - These vertical lines represent the lateral faces of the truncated prism.
   - Connect the corresponding points on adjacent vertical lines to complete the surface development.

Example

Development of a truncated cylinder.

Procedure

1. Draw the front and the plan views of the cylinder.
2. Divide the plan of the cylinder into a number of equal parts e.g. 12 divisions.
3. Project these lines to intersect line a1 and g1.
4. Extend the base line a1 and g1 of the elevation so a reasonable distance.
5. With a pair of compasses measure 1-12 on the plan.
6. With the same distance step off 12 divisions on the extended line.
7. Draw horizontal lines through the point on line a1 and g1 on the elevation to intersect the projected lines.
8. Draw a smooth line through the intersection to obtain the curve.
9. Firm in the outlines to obtain the development.

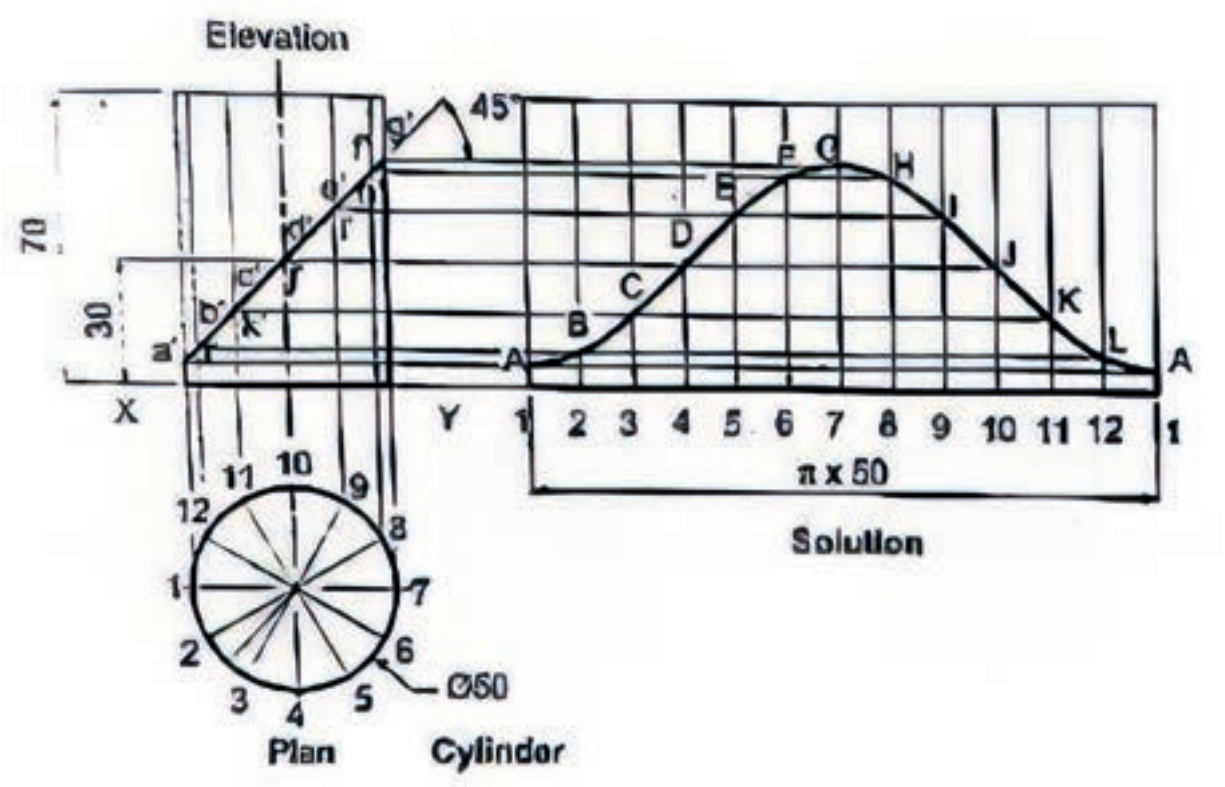

Figure 2.2.12: *Development of a truncated cylinder*

Note: Teachers should assist learners to expertly develop different examples of truncated prisms.

Task:

Develop the surface of a truncated prism

Pedagogical Exemplars

Group work, collaboration, communication, critical thinking

In mixed-ability groupings, ask learners to cut a water bottle, milk tin, toothpaste box and matches box at a given angle to the base and again cut open from the shortest side vertically, spread it out to observe the surfaces formed. Ensure AP and P learners participate in the activity.

Group work, activity-based learning collaboration, communication, critical thinking

In their groups, ask learners to sketch the surfaces formed and present their sketches in a whole class discussion. Encourage AP and P learners to participate in the discussion.

Activity based learning, communication

With the use of models, pictures and charts, guide learners to clearly explain the principles of developing the surfaces of truncated prisms.

illustration, observation, demonstration, communication

Using board illustrations and drawing instruments demonstrate to learners how to use the principles to develop the surfaces of given truncated prisms.

Individual learning, activity-based learning, critical thinking

With the knowledge in developing surfaces of prisms assist learners to individually develop the surface of truncated prisms. Guide AP and P learners to develop the surface of truncated prisms where necessary and extend for HP learners.

Key Assessments (DoK)

Level 3

1. The figure below is a front view of a rectangular prism of height 60mm. Construct the surface development of the prism.

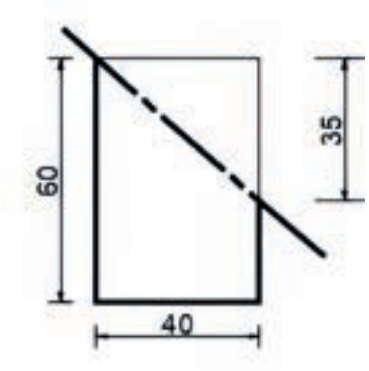

Figure. 2.2.13: *Truncated rectangular prism*

Level 3

2. Construct the surface development of a pentagonal prism of sides 45mm and height 60mm truncated at a height of 18mm to an angle of 30° to the base.

Unit 2 Review

This unit discussed solid geometrical figures, examples, properties and their construction using drawing instruments. Learners are expected to expertly construct solid geometrical figures (isometric, oblique, perspective, surface development), emphasis should be on neatness of work as well as correct use of constructional lines and outlines.

Additional Reading

Teachers should supplement their knowledge by conducting further reading on plane geometry.

Resources

Models, Charts, drawing instruments, reference books, drawing studio, access to internet, LCD Projector.

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UNIT 3: FRACTAL GEOMETRY

Strand: **Graphic Communication**

Sub-Strand(s): Fractal geometry

Content Standards: Demonstrate knowledge and understanding of fractal geometry in creating fractal designs.

Learning Outcomes: Use the understanding of plane and solid geometry to create fractal designs.

INTRODUCTION AND UNIT SUMMARY

This unit introduces fractal design and explores fractal patterns. Learners are introduced to the fascinating world of fractal geometry and its applications.

Through practical demonstration and hands-on project work, learners learn about the concept of fractal geometry.

Fractal geometry exists in natural forms like flowers, tree leaves, scales of some fish and snakes. Artificially some fractal designs are made from solid and plane geometry.

This unit covers:

Introduction to fractal geometry

1. Basic concept of fractal design

Overview of fractal types and classification

2. Exploring fractal patterns
3. Generating fractal patterns geometrically
4. Application of fractal patterns in design.

The weeks covered by the section are:

Week 23: *Introduction to fractal geometry.*

Week 24: *Overview of fractal types and classification.*

Week 23

Learning Indicator(s): *Explain the basic concept of fractal geometry*

Theme or Focal Area 9: Introduction to Fractal Geometry

Explanation of fractal geometry

Fractal geometry is a type of geometrical design created by repeating a geometrical pattern continuously. Fractals are complex geometric shapes that exhibit self-similarity at different scales this means that when a fractal design is zoomed out smaller shapes of the whole structure will be seen repeating itself. These kinds of patterns exist naturally and artificially.

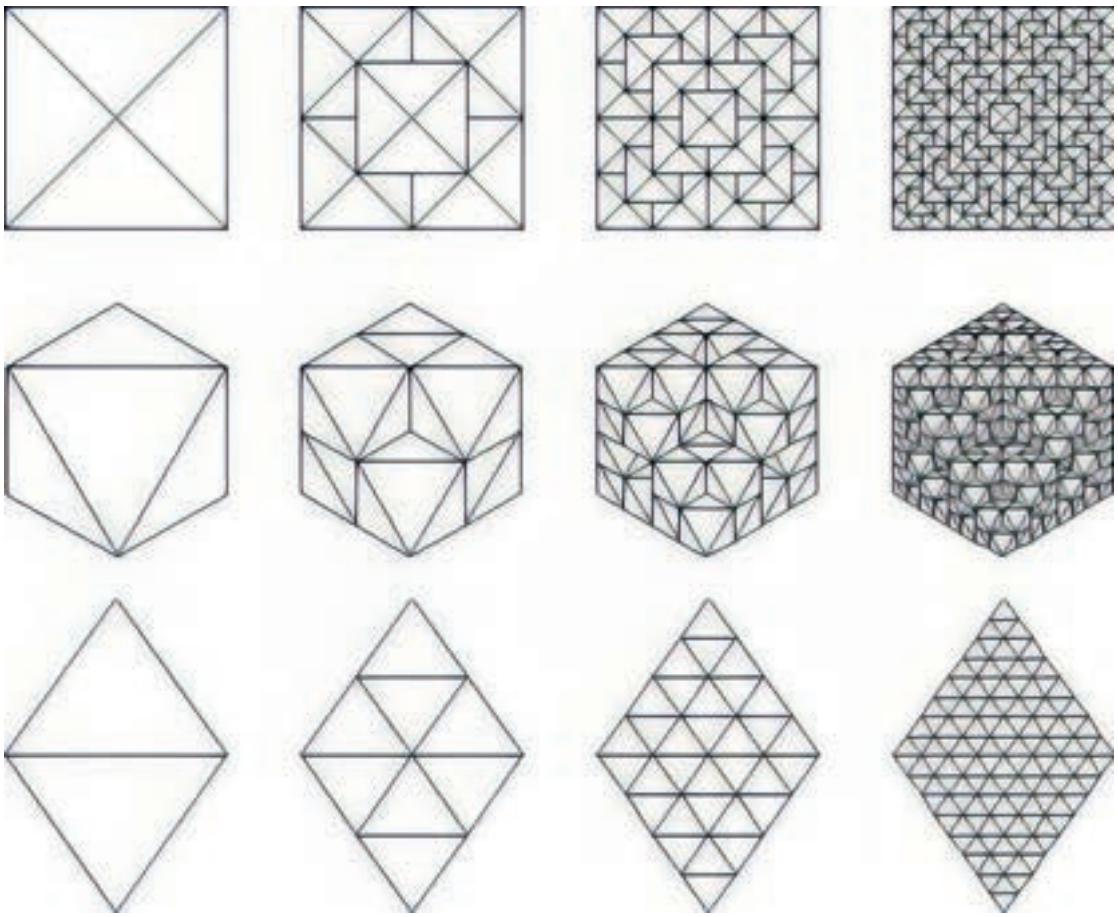
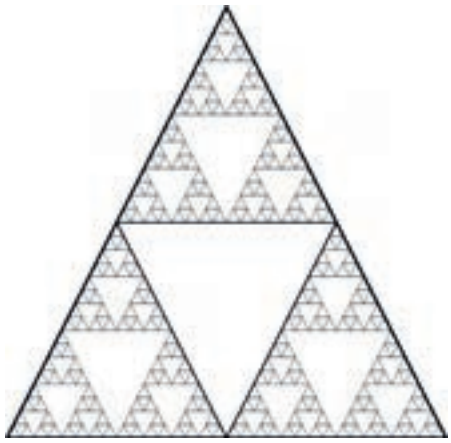


Figure. 2.3.1: *Kepler's fractals*

Types of fractal geometry

Common types of fractals include:

1. **Iterated Function Systems (IFS):** These fractals are generated by repeatedly applying a set of similar shapes to an initial geometric shape. Examples include the Barnsley fern and the Sierpinski triangle.



Sierpinski triangle

Figure 2.3.2: *Sierpinski triangle*

Barnley fern

Figure 2.3.3: *Barnsley fern*

2. **L-systems:** L-systems, or Lindenmayer systems, are a type of formal grammar used to model the growth of biological structures such as plants. They generate fractal-like patterns through the iterative application of production rules.

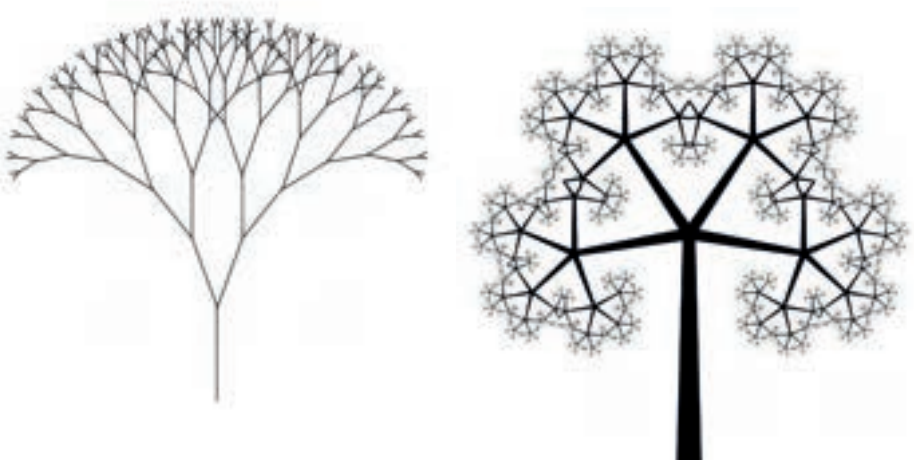


Figure. 2.3.4.: *Fractals in nature (fractal trees)*

3. **Cantor Set:** The Cantor set is an example of a self-similar fractal constructed by iteratively removing middle thirds from a line segment. It has a fractal dimension between 0 and 1, indicating its fractional nature.

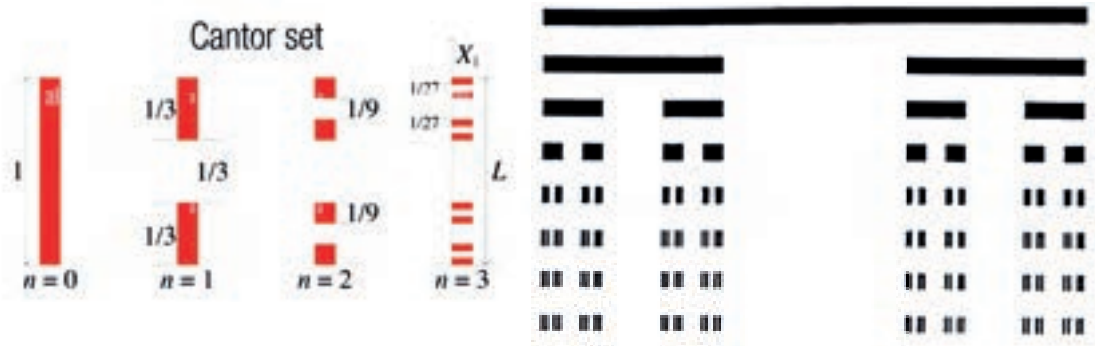


Figure. 2.3.5: *Cantor set*

Characteristics of fractal geometry

1. **Self-similarity:** Portions of the fractal resemble the whole structure, no matter how much you zoom in or out.
2. **Infinite complexity:** Fractals can be incredibly detailed exhibiting intricate patterns at all scales.
3. **Fractal dimensions:** Unlike traditional geometric shapes like lines, square or cubes, fractals can have non integer dimensions, often referred to as fractal dimensions.
4. **Iteration:** Fractals are often created through iterative processes where a simple geometric pattern is repeated and modified at each iteration.

Application of Fractal Geometry

1. **Creation of visual art:** Artists use fractal geometry to create intricate and visually captivating artworks. Fractal patterns can be generated using mathematical algorithms and software programs like Mandelbrot Set or Julia Set, providing artists with a vast canvas of unique shapes and patterns to explore.
2. **Digital art and graphics:** Fractal geometry has revolutionised digital art and graphics by enabling the creation of highly detailed and complex images. Fractal-based software allows artists to generate stunning visual effects, textures, and patterns that mimic natural phenomena or explore abstract concepts.
3. **Fractal music and sound:** Fractal geometry is not limited to visual art; it has also inspired the creation of fractal music and soundscapes. Musical compositions based on fractal patterns exhibit self-similar structures and recursive motifs, providing a rich auditory experience.
4. **Design and architecture:** Fractal geometry has influenced architectural design, offering new possibilities for creating structures with organic, self-similar forms. Architects utilise fractal principles to design buildings, facades, and urban landscapes that harmonise with natural environments and exhibit aesthetically pleasing patterns.
5. **Textile and fashion design:** Fractal geometry has found applications in textile and fashion design, where designers incorporate fractal patterns into fabrics, clothing, and accessories. Fractal-inspired designs add depth, texture, and visual interest to fashion collections, creating unique and memorable pieces.
6. **Generative art and procedural generation:** Fractal geometry is a fundamental tool in generative art, where artists use algorithms to generate artworks autonomously. By harnessing the power of fractal patterns and procedural generation techniques, artists can create endless variations of images, animations, and interactive experiences.
7. **Science:** Fractal geometry has helped explain:
    a. How mammalian brains fold as they grow.
    b. How landscapes fragment in an earthquake.
    c. Model the human lungs, blood vessels and neurological system.
    d. Help to understand the way bacteria grow.

Learning Task

1. Explain the concept of fractal geometry.
2. Identify three types of fractal geometry and how they can be applied in real life situations
3. Explain three applications of fractal geometry.

Pedagogical Exemplars

Observation, group activity, collaboration, communication, critical thinking

With the use of charts, videos, fabrics, flowers, leaves, and in mixed ability groups guide learners to observe the pattern of given materials and identify the common geometrical shape running through the design of the materials given. Guide learners to present their findings in a whole class discussion. Ensure AP and P learners participate in the discussion.

Group activity/talk for learning communication, collaboration

In groups guide learners to explain fractal geometry in their own words. Ensure AP and P learners take part in the explanation.

Research, group activity, collaboration, communication

Using the internet to research, guide learners to identify types of fractal geometry and present their groups findings in a whole class discussion.

Research, group activity, collaboration, communication

Using the internet to research, guide learners to state and explain at least three applications of fractal geometry in their groups and present in a whole class discussion. Ensure AP and P learners take part in the presentation.

Key Assessments (DoK)

Level 2

Explain fractal geometry in relation to designing.

Level 2

1. Identify at least two types of fractal geometry and how they can be applied in real life.
2. List at least two applications of fractal geometry and explain one of them.

Week 24

Learning Indicator(s): *Use the concept of fractal geometry in fractal designs*

Theme or Focal Area 9: Application of Fractal Geometry in Designing

Exploring fractal patterns

Fractal patterns exist in numerous forms which include geometrical patterns. For example, circular and polygon.

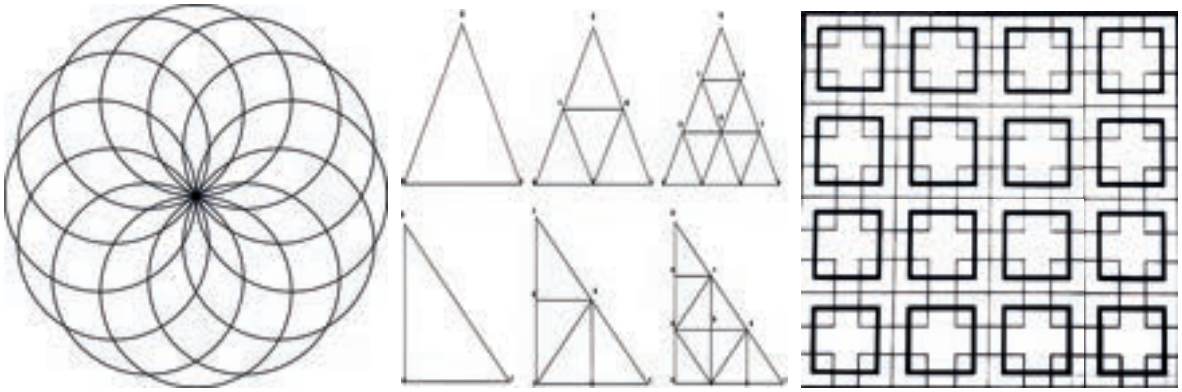


Figure 2.3.6: *Geometrical fractals*

Generating fractal patterns geometrically

The beauty of fractals lies in their simplicity at each level, yet they are complex when viewed as a whole. Fractal pattern can be generated using various drawing instruments or free hand. Computer applications such as Apophysis, Bryce, Chaotica and FractalNow can also be used to generate fascinating fractal designs.

Creating a fractal pattern involves repeating a simple process over and over again, at smaller scales. Fractals are infinitely complex shapes that exhibit self-similarity across different sizes.

Steps to develop your own fractal

1. **Start with a simple shape:**

   Begin with a basic geometric shape or pattern. For instance, you can start with a line segment and then branch off smaller segments from one end.

2. **Iteration and repetition:**
   1. Divide the line segment into smaller segments.
   2. At each iteration, create new branches by repeating the same process.

3. Adjust angles and lengths to achieve the desired fractal structure.

Examples of fractals

1. Sierpinski Triangle: Start with an equilateral triangle and recursively remove smaller triangles from its centre.
2. Mandelbrot Set: Explore the fascinating world of complex numbers and their iterations to create intricate patterns.
3. Space-Filling Curves: Construct curves that fill space densely, such as the Hilbert Curve or Peano Curve.

Application of fractal patterns in design

1. **Architecture:** Fractal patterns are used in architecture to design buildings of self-similarity in the centuries and in recent urban development. Elements like staircases, railings, and decorative mouldings can incorporate fractal-inspired designs. These details create a cohesive and visually engaging environment, enhancing the overall aesthetics.
2. **Textile design:** Textile design is very important in the art world due to their beautiful designs, colour, and infinite details. Fractal patterns can be woven into textiles, creating visually appealing fabrics. These fabrics can be used for clothing, scarves or home decor.
3. **Interior designs:** Fractals play a fascinating role in interior design, infusing spaces with complexity, visual interest, and a sense of natural harmony.

Let's explore how fractals enhance interior environments:

Learning Task:

1. Generate fractal patterns geometrically.
2. Explain at least three applications of fractal pattern in creating designs.
3. Design a fabric pattern for a clothing company in Ghana.

Pedagogical Exemplars

Research, group work, communication, collaborations, critical thinking

Using videos, charts, research and the internet, guide learners to explore varieties of fractal patterns in mixed-ability groups and present their findings in a whole class discussion. Ensure AP and P learners take part in the discussion.

Group work, activity-based learning, creativity, innovation, critical thinking

In mixed-ability groups assist learners to use free hand sketches to create fractal patterns from simple geometrical figures. For example, circle, ellipse and various polygons. Ask learners to share and compare designs with other groups. Ensure AP, and P learners take part in the sketches.

Group work, activity-based learning, creativity, innovation, critical thinking

Guide learners in mixed-ability groups to use drawing instruments to create fractal patterns of their choice and pin their designs on the board for review. Ensure the groups consist of both AP, P, and HP learners.

Managing talk for learning, collaboration, critical thinking

In their groups guide learners to discuss where they think their fractal pattern can be applied in real life.

Group work, activity-based learning, creativity, innovation, critical thinking

In mixed ability groups guide learners to use their knowledge in fractal pattern to create beautiful designs.

Key Assessments (DoK)

Level 2

Generate at least two fractal patterns from simple geometrical figures.

Level 2

Identify at least two applications of fractal patterns in designing.

Level 3

Create a fractal pattern design for a clothing company in Ghana.

Unit 3 Review

This unit brings section two to an end. It discussed the concept, types and application of fractal geometry. Learners are expected to design and generate fractal patterns with simple geometrical figures using freehand sketches and drawing instruments.

Resources

Models, charts, drawing instruments, reference books, drawing studio, access to internet, LCD Projector

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