ENGINEERING DRAWING

Module 1: Seeing and Showing 3D Objects

Teacher Facilitation Guide

Grade: 6th–8th

Duration: ~1 Week (4 Class Periods)

Module Overview

How do we show a 3D object on a flat piece of paper — and how do we know if our drawing gives enough information? In this module, students explore those questions through observation sketching and vocabulary building. By the end of the module, students understand the relationship between 2D drawings and 3D objects, and they have experienced firsthand why engineers need a shared drawing language.

This module is designed to stand alone as a spatial reasoning and communication unit. It also serves as the foundation for Modules 2, 3, and 4, all of which build directly on the vocabulary and concepts introduced here.

BY THE END OF THIS MODULE, STUDENTS WILL BE ABLE TO:

- Identify and label the faces, edges, and vertices of a cube structure
- Evaluate a drawing for communicative completeness — does it give enough information to reconstruct the object?
- Explain why engineers need a shared drawing language

MATERIALS

- 8 Large (4") cardboard cubes, pre-assembled
- Small (1") wooden cubes — 4 to 6 per student
- Graph paper and blank paper
- Pencils and small rulers
- Tape or magnets to hang student drawings

MODULE STRUCTURE

- Activity 1 — Why Drawing? The Communication Problem (Day 1)
- Activity 2 — What Do You See? Observation Sketching (Day 2)
- Activity 3 — Sketching to Communicate: Partner Challenge (Day 3)
- Activity 4 — Pulling It Together: Annotated Sketches (Day 4)

Standards and Learning Dimensions

Standard	Details
Georgia Standards of Excellence	Grade 6: EET-1, EET-7 | Grade 7: II-3, II-7 | Grade 8: TS-2, TS-7
NGSS Standard	MS-ETS1: Engineering Design https://www.nextgenscience.org/dci-arrangement/ms-ets1-engineering-design
Performance Expectation MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
Performance Expectation MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Learning Dimension	Classroom Connections
Science and Engineering Practice *Constructing Explanations and Designing Solutions* Students investigate the relationship between 2D representations and 3D objects, exploring how flat drawings can encode information about three-dimensional shapes. They evaluate different drawing approaches for communicating 3D information and construct explanations for why some drawings communicate more completely than others.	In Activities 1 and 2, students begin by attempting to draw a cube structure without instruction, then analyze what information is and is not communicated by different drawings. In Activities 3 and 4, students put their observational skills to the test by sketching structures and evaluating whether their drawings communicate enough information to reconstruct the original — setting up the face-counting work in Module 4.
Disciplinary Core Idea *MS-ETS1-1: Defining and Delimiting Engineering Problems* The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. A shared drawing language is a constraint that makes engineering communication reliable and precise.	Students discover through the gallery exercise and partner sketching activities that drawings without a shared convention cannot reliably communicate 3D information. This motivates the need for a standardized approach — the problem Module 3 solves. Students experience the insufficiency of informal drawing as a design constraint, not just an abstract concept.
Crosscutting Concept *Structure and Function* The structure of a net — which faces are included and how they are connected — determines its function	In Activity 3 (Partner Challenge), students put the principle of completeness to the test: a drawing that does not show all sides of a structure cannot reliably be reconstructed. This mirrors the structure-function relationship — a drawing’s structure (which views are shown) determines whether it functions as a complete representation. The idea of

as a representation of a 3D object. Different nets of the same object have different structures but fold into the same 3D form. *Scale, Proportion, and Quantity* A net drawn to scale preserves the proportions of each face of the 3D object. Students draw nets on graph paper and verify that the dimensions of each face match the corresponding dimension of the physical cube structure.	completeness carries into Module 3 (all views must be shown) and Module 4 (all faces must be counted for surface area).

Engineering Skill Learning Goals

- Students observe and sketch 3D objects with increasing accuracy, focusing on communicating shape rather than artistic technique.
- Students build vocabulary for describing 3D objects — face, edge, vertex, net — and use that vocabulary to discuss their drawings.
- Students evaluate their own and classmates' drawings for communicative completeness: does this drawing give enough information to reconstruct the object?
- Students articulate why a shared drawing language matters in engineering — setting up the conventions introduced in Module 3.

Key Vocabulary

These terms are used throughout Module 1 and carry forward into Modules 2, 3, and 4. Introduce each one when it comes up naturally in the activities.

Term	What It Means
3D (Three-Dimensional)	An object that has length, width, and height — like a real cube or box. You can pick it up and look at it from different angles.
2D (Two-Dimensional)	A flat shape that has length and width but no height — like a drawing on paper or a shadow on a wall.
Face	A flat surface on the outside of a 3D shape. A cube has 6 faces — each one is a square.
Edge	The straight line where two faces meet. A cube has 12 edges.
Vertex (Vertices)	A corner point where three or more edges meet. A cube has 8 vertices.
View	What an object looks like when seen from one direction — for example, looking from above (top view) or from the front (front view).
Sketch	A quick, informal drawing. Engineering sketches don't need to be perfect — they need to communicate an idea clearly.

ACTIVITY 1

Why Drawing? The Communication Problem

Essential Question: Why do engineers need a shared drawing language?

TIME
~45 min

TEACHER NOTES

Setup: Before class, assemble a structure of 4–6 large cubes visible from anywhere in the room. Have blank paper (not graph paper) and tape or magnets for hanging drawings ready.

Part 1 — Draw It Your Way (10 minutes)

Give each student a blank sheet of paper. Tell them: "*Draw what you see. You have 10 minutes. Don't worry about doing it the 'right' way — just draw it as best you can.*"

Walk around and observe different approaches. Do not comment on technique yet — the variety is the point.

Part 2 — Gallery Walk (10 minutes)

Collect the drawings and hang them around the room. Give students a few minutes to walk around and look at all of them. When they return, draw their attention to the variety:

- Some drawings show the structure from the side, some from above, some from an angle
- Some show all the cubes clearly; others only show the front face
- Some look very different from each other even though everyone was drawing the same object

Part 3 — Class Discussion (15 minutes)

DISCUSSION QUESTIONS

- If you had to rebuild this cube structure using only one of these drawings, which would you choose? Why?
- Is there any single drawing here that gives you enough information to rebuild the structure exactly? What's missing?
- Why do you think the drawings look so different if everyone was drawing the same thing?
- Can you think of a situation where it would really matter that someone else could understand your drawing exactly?

TEACHER NOTES

Wrap up with the big idea: "*Right now, every drawing in this room uses a different language. If I sent one of these to an engineer across the country and asked them to build this structure, they probably couldn't — not because the drawings are bad, but because there's no shared agreement about what things mean. In this unit, we're going to figure out what a shared drawing language needs to include.*"

Part 4 — Introducing 3D Vocabulary (10 minutes)

Use a single cube to introduce the key vocabulary students will use throughout all three modules. Hold up the cube and point to each feature as you name it.

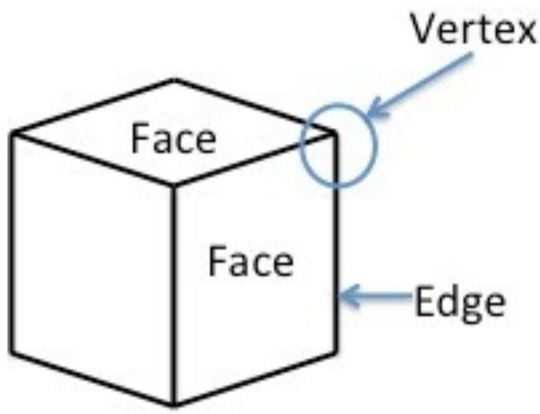

Figure 1. Single cube with face, edge, and vertex

Face: Each flat surface of the cube. How many faces does a cube have? (6)

Edge: The line where two faces meet. How many edges? (12)

Vertex: A corner point where three edges meet. How many vertices? (8)

Have students count the faces, edges, and vertices on their own small cube and record the numbers in their journals. Then ask: "*If you drew just one face of this cube, what shape would it be?*" (A square.) "*Does that square tell you everything about the cube?*" (No — it only shows one face.)

✏️ **JOURNAL PROMPT**

In your own words:

- Why do engineers need a shared drawing language? Give one example of what could go wrong if two engineers were using different drawing conventions.

ACTIVITY 2

What Do You See? Observation Sketching

Essential Question: What information does a drawing communicate — and what does it leave out?

TIME
~45 min

Students practice careful observation sketching with cube structures of increasing complexity. The goal is not technical drawing skill — it is building the habit of asking: "*Does my drawing give enough information to understand what I drew?*"

TEACHER NOTES

Framing for students: "*An engineering sketch doesn't have to be beautiful. It has to be clear. As you draw today, keep asking yourself: if I showed this sketch to someone who couldn't see the real object, would they be able to describe it back to me?*"

Part 1 — Single Cube (10 minutes)

Give each student one small cube. Ask them to place it on their desk and sketch it from where they are sitting. Then have them pick it up, rotate it, and sketch it from a different angle.

- Compare the two sketches: "*Does the cube look like the same object? What changed? What stayed the same?*"
- Ask: "*Which sketch gives more information about the cube?*"

Part 2 — Two and Three Cubes (20 minutes)

Have students build a structure of 2 cubes side by side, then sketch it. Then add a third cube on top of one of them and sketch again. After each sketch, ask:

- "If you only had this drawing, would you know how many cubes were in the structure?"
- "Would you know where each cube was — in front, behind, on top?"
- "What would you add to your drawing to make it clearer?"

TEACHER NOTES

What to watch for: Students will naturally start to want to show multiple sides of the structure. Encourage this without prescribing how. The insight that one view is never enough should emerge from the activity, not from instruction.

Scaffolding for struggling students: Prompt students to trace the outline of the cube's shadow on paper using a light source, then sketch the rest. This helps them see the relationship between the 3D object and its 2D silhouette.

Part 3 — Peer Review (15 minutes)

Students exchange sketches with a partner. Without looking at the original structure, the partner tries to answer:

- How many cubes are in this structure?
- Describe where each cube is positioned.
- Is there anything about the structure you can't tell from this drawing?

Partners share their answers, then compare to the actual structure. Debrief as a class: what kinds of information were most often missing or unclear?

✏️ **JOURNAL PROMPT**

Draw your 3-cube structure in your journal. Then write: (1) what information your drawing communicates clearly, and (2) what a reader would NOT be able to figure out from your drawing alone.

ACTIVITY 3

Sketching to Communicate: Partner Challenge

Essential Question: Can your drawing give someone else enough information to reconstruct what you built?

TIME
~45 min

This activity applies everything from the week. One student builds a cube structure; their partner tries to reconstruct it using only a drawing. This tests whether the drawing communicates enough — and surfaces exactly what is missing when it does not.

TEACHER NOTES

Framing: *"An engineer who designs something may never meet the person who builds it. The only thing connecting them is documentation — drawings, specifications, measurements. Today, your drawing is the only thing your partner has to work from. Make it count."*

Part 1 — Build and Draw (20 minutes)

Each student independently builds a structure using 4–6 small cubes. The structure should have at least two levels or an interesting shape — not just a flat row.

Students then sketch their structure on graph paper. They may draw as many views as they want, from any angles, and may add labels or written descriptions. The only rule: no showing your partner the actual structure until they are done rebuilding.

Part 2 — Reconstruct from the Drawing (10 minutes)

Students exchange drawings (but not structures) with their partner. Using only the drawing, partners attempt to rebuild the structure.

Part 3 — Compare and Debrief (15 minutes)

Students reveal their original structures and compare. For each pair, discuss:

- Did the reconstructed structure match? If not, what was different?
- What information in the drawing was most helpful?
- What information was missing or unclear?

As a class, compile a list on the board: "*What would you need to include in a drawing to make reconstruction reliable?*" This list will typically converge on: show all sides, use consistent scale, indicate depth somehow. Leave this question intentionally open — it is what Module 3 answers.

THE CLIFFHANGER

Close with: *"No matter how hard you tried, most of you probably found that a single drawing from one angle wasn't enough. Engineers solved this problem a long time ago — they invented a standard system for showing a 3D object from exactly the right set of views so that the drawing is complete and unambiguous. That's what we'll learn in Module 3."*

ACTIVITY 4

Pulling It Together: Annotated Sketches

Essential Question: How do words and labels make a drawing more complete?

TIME
~45 min

Students build and sketch one final cube structure, this time adding annotations — labels, measurements, and written notes — to make their drawing as complete as possible. This bridges observation sketching and the more formal engineering drawing work of Modules 2 and 3.

Part 1 — Build a Structure (5 minutes)

Each student builds a structure of 4–6 cubes. Encourage more complex configurations — something with at least one stacked cube and one change in depth.

Part 2 — Annotated Sketch (25 minutes)

Students sketch their structure from at least two different angles and annotate their drawings with:

Vocabulary labels: point to at least one face, one edge, and one vertex and label them.

Dimension notes: add measurements where you can (each cube is 1 inch, so a 3-cube row is 3 inches long).

Written notes: add short phrases describing things the sketch alone doesn't show — e.g., "this cube is behind the tall stack" or "there are 2 cubes on the bottom that you can't see from this angle."

Face count: write the total number of exposed faces on your drawing (This will be verified in Module 4).

> **TEACHER NOTES**
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> **Why annotations matter:** This activity plants the seed for two things: (1) engineering notation in Module 3, which is a standardized way of annotating drawings so that written notes are no longer necessary; and (2) surface area in Module 4, where the face count students write here will become a systematic calculation.

Part 3 — Gallery and Reflection (15 minutes)

Post the annotated sketches around the room. Students do a brief gallery walk and note: which drawing would be easiest to reconstruct from? What made it better than others?

> ✏️ **JOURNAL PROMPT**
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> **Answer both:**
>
> - What is the hardest thing to communicate in a sketch of a 3D object? Why?
> - What questions do you still have about how engineers draw 3D objects?

Looking Ahead — Module 2

In this module, students discovered that informal sketching — even with multiple views and written annotations — cannot reliably communicate a 3D design. Module 2 deepens that discovery by exploring nets: 2D shapes that unfold from (and fold back into) 3D objects. Students will build and draw nets of cube structures, investigate why a net must include all exposed faces, and connect that idea to surface area.

The vocabulary (face, edge, vertex) and spatial reasoning habits from Module 1 carry directly into Module 2. Students who can identify the faces of a cube structure and understand why each face matters will find the nets work intuitive — and will be prepared for the 3-view drawing conventions that follow in Module 3.

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