

Two-Dimensional Drawings from Three-Dimensional Objects — Grade Six

Ohio Standards Connections

Geometry and Spatial Sense

Benchmark I

Identify and draw three-dimensional objects from different views (top, side, front and perspective).

(Grades 5 - 7)

Indicator 7

Build three-dimensional objects with cubes, and sketch the two-dimensional representations of each side; i.e., projection sets.

(Grade 6)

Mathematical Processes Standard

Benchmark A

Clarify problem-solving situation and identify potential solution processes; e.g., consider different strategies and approaches to a problem, restate problem from various perspectives.

(Grades 5 - 7)

Benchmark C

Use more than one strategy to solve a problem, and recognize there are advantages associated with various methods.

(Grades 5 - 7)

Benchmark G

Relate mathematical ideas to one another and to other content areas; e.g., use area models for adding fractions, interpret graphs in reading, science and social studies.

(Grades 5 - 7)

Benchmark J

Communicate mathematical thinking to others and analyze the mathematical thinking and strategies of others.

(Grades 5 - 7)

Lesson Summary:

Students will be able to identify and draw two-dimensional representations of a three-dimensional object. Students investigate the views of an object and determine that three views are required (front, one side and the top). Students will use these skills to make a presentation of their design of a building and the views that represent the building.

Estimated Duration: 150 minutes

Commentary:

The ability to view objects from different sides is a part of an area of geometry called Spatial Visualization. The skill of visualizing objects spatially is important to many fields of study, including dentistry, architecture, construction, the arts, auto design as well as many other designing and technology fields.

Pre-Assessment:

This pre-assessment is informal and contained within an instructional activity. The students are assessed on their understanding and skills related to spatial visualization as they proceed through the tasks. Provide the pre-assessment form to each student and one additional form for each group. Students will be asked to identify the views of an object built with cubes.

- Create five stations around the classroom. At each station, students build a different object from the pre-assessment form (Blackline Master #1) on a building place mat (Blackline Master #2).

Teacher Tip:

Use the answer key when setting up the objects. The shape, number of cubes and orientation can be determined from the answer key.

- Put students into five groups, one group assigned to each of the objects. Each student will complete Blackline Master #3 by filling in the views (F,R, B, L, T) represented by the diagrams corresponding to the object at the station.
- Students in the groups discuss their individual responses and come to consensus on a group response. Each group records its response on a group pre-assessment form and will present the solution to the rest of the class orally or using an overhead projector.

Optional step: Have each group rotate to each of the five stations. All groups complete the pre-assessment for all five objects. Each group reports to the class the solution for the object at the first station they visited.

- If a group reaches consensus on an incorrect solution, explore that solution with the class until a correct solution is reached.

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- Collect individual and group pre-assessment forms.

Scoring Guidelines:

Use the assessment form to make decisions on how to proceed with the remainder of the lesson. Base these decisions on a review of individual and group pre-assessment forms. Suggested guidelines include:

- A large majority of the students have displayed an understanding of the skills required in the pre-assessment. The class can proceed with the lesson as planned. Many of the groups may also be challenged with the extension to the lesson.
- Many of the students have displayed an understanding of the skills required in the pre-assessment. Provide intervention for those students/groups that may need further development of their understanding of the skills. Allow the other groups to continue with the lesson as planned.
- Many of the students have not demonstrated an understanding of the skills required or were off task during the pre-assessment. Provide further instruction on the skills, and re-assess the students prior to starting the lesson.

Commentary:

The teacher should observe students as they complete the pre-assessment form individually and as they work in groups. This observation may give the teacher insight into possible difficulties in understanding concepts and procedures involved in the tasks and can be helpful in providing assistance to students during the planned lesson.

Post-Assessment:

The post-assessment will be the completion of the project described in the instructional procedures for the lesson. This project will be completed in groups however, individual participation is required.

The project includes three components:

1. Creating a building that meets the following specifications:
 - Contains between 15 and 20 cubes
 - The height of the building must be at least 3 cubes and not more than 6 cubes.
 - The width and depth of the building must also be at least 3 cubes and not more than 6 cubes.
 - Cubes must meet face-to-face.
2. All views are provided and drawn for the model of the building the students will be presenting to the owner.
3. Group presentation

All members of the group are expected to participate in each phase of the project - the design of the building, the drawing of the blueprint, and the presentation to the owner.

Scoring Guidelines:

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A discussion can be held at the beginning of the project to explain the two parts of the evaluation - the building model and the group presentation. Teacher/class - developed rubrics should be used to evaluate the two parts of the project. The rubric for the building model should focus on meeting the specifications for the building and the accuracy of the views drawn for the model. The rubric for the presentation should include criteria such as quality content, audible voice and contributions of group members.

Instructional Procedures:

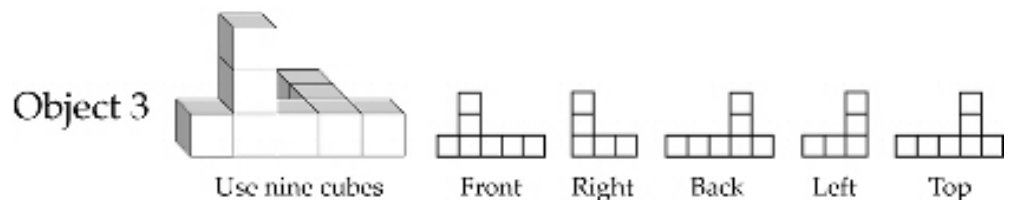
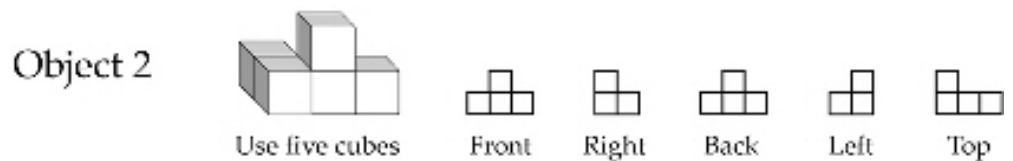
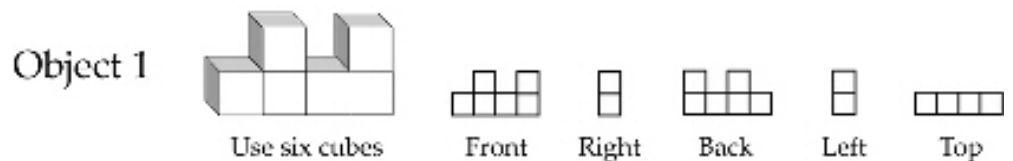
1. Pose the following situation to the students.
 - a . You are part of a company that has been hired to develop the plans and build a model of a new office building. The owner of the new building wants it to be made with cubes.
 - b . You and your team are to design a building to present to the owner.
 - c . Your team will go through a training program for designing buildings in preparation for this project.

Commentary:

Use examples of blueprints to show how designers must be able to show their ideas and concepts to the owners and contractors. Examples could be obtained from housing developers, newspapers, magazines, web sites and industrial technology teachers.

2. Have the students use the Blueprint Worksheet for five views (Blackline Master #1) to draw the following views for each of the objects listed below.

Answers



3. Have the students work in groups to develop solutions for the following questions.
 - a . How are opposite views alike and different? Explain. (Opposite

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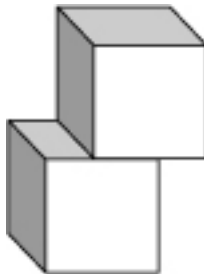
views—front and back, top and bottom, left and right – are always reflections of one another. Sometimes these reflections are the same, e.g., the front and back views are the same.)

- b . Do these views show all the cubes in the building? (Individually the views do not show all the cubes. By using the views in combination, one may be able to see all the cubes. However in more complex objects some cubes cannot be seen in any view, e.g., a 3 x 4 x 3 rectangular solid contains, interior cubes that are not visible in any view.)
 - c . Why do we need the top view? (The top view provides a view that is not the opposite of one of the 4 sides.)
 - d . Are all views needed? Explain? (No, you only need to have one of the opposite views. Remember that each view is a reflection of its opposite.)
 - e . What views are needed to get a good representation of the building? (top, front or back, right or left)
4. Have each group of students build two different buildings, using 6 cubes in each building. For each building, have the students draw the three views front, right and top using Blackline Master #4.
 5. Have each group trade their plans (views) with another group. Have the other group use the plans to build the two buildings. The original group should verify that the building is correct, identifying discrepancies between the plans and the building.

Commentary:

Groups may produce plans that are difficult to read or are interpreted incorrectly by others. This provides students with the opportunity to discuss the necessity of accurate, precise drawings.

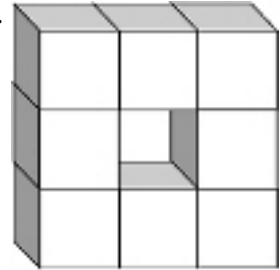
6. Have groups work on their plans for the new building. The building and plans must meet the following requirements:
 - a . The building must contain between 15 and 20 cubes.
 - b . The building must be at least 3 cubes high but not more than 6 cubes high.
 - c . The width and depth of the building must also be at least 3 cubes and not more than 6 cubes.
 - d . Cubes must meet face to face, i.e., no off setting of cubes, as shown below.



- e . The plans must be recorded on the blueprint sheet (Blackline Master #4).
- f . If you have cubes that link, groups may be creative in their design. For example, groups may create a block O. Care must be taken when

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putting something behind the open section as it may make the opening difficult to see in the plans. In such cases, the building will not be accurately constructed according to the plans.



7. Have each group present their plans to the rest of the class. Each plan should meet all the requirements and should represent the building accurately.

Teacher Tip:

If possible have another adult in the classroom during the presentation to act the part of the owner.

Differentiated Instructional Support:

Instruction is differentiated according to learner needs, to help all learners either meet the intent of the specified indicator(s) or, if the indicator is already met, to advance beyond the specified indicator(s).

- Using cubes with a different color on each face, construct an object such that each view (front, back, right, left and top) is a single color. Have students move into a position relative to the object where they are only able to see one color. This will allow students to see only the side needed for the view and not be distracted by the other surfaces.
- Use three-dimensional geometry software to create and rotate representations of the objects made with cubes to aid students in identifying the different views.
- Challenge the students to create buildings where there are cubes hidden from the four side views.

Extension:

These are ideas for all students to continue learning on this topic - in the classroom or outside of the classroom.

- During the project phase of the instruction, students can be asked to also determine the cost of the building. The cost should be based on the number of cubes and exterior walls (visible sides) of the building. For example, each cube can cost \$25,000 and each exterior wall of the final building plan will increase the total by \$3,500.

Materials/Resources Needed:

For the teacher: Blocks or cubes, building place mat, answer keys for pre-assessment, pre-built objects for pre-assessment

For the students: Blocks or cubes, pre-assessment, blueprint worksheet for five views, blueprint worksheet for three views, building place mat.

Interdisciplinary Connections:

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Work with the technology education teachers to show how plans are used to create buildings and objects like tables, chairs and other household objects. In addition to geometry software, architectural drawing software may also be used. Work with English language arts teachers to discuss the components of a quality group presentation.

Key Vocabulary:

- views
- reflection
- width
- depth
- blueprint

Technology Connections:

- The use of presentation software could be used in the creation of the presentation.
- The use of geometry software and architectural drawing software could be used to create the graphics of the buildings and the views.

Attachments:

- Blackline Master #1 (Pre-Assessment)
- Answer Key for Blackline Master #1 (Pre-Assessment)
- Blackline Master #2 (Building Place Mat)
- Blackline Master #3 (5 Views)
- Blackline Master #4 (3 views)
- Student Work A
- Student Work B
- Student Work C
- Student Work D
- Student Work E