

Helping Girls Develop Spatial Skills Through Art

Lynda R. Wiest
University of Nevada, Reno

Tia L. Flores
Coral Academy of Science, Reno, NV

National Council of Teachers of Mathematics
93rd Annual Meeting and Exposition
Boston, April 2015

Contact: Lynda Wiest (wiest@unr.edu)

Spatial Thinking/Reasoning Involves...

- “the locations of objects, their shapes, their relations to each other, and the paths they take as they move” (Newcombe, 2013, p. 28)
- “building and manipulating mental representations of two-and three-dimensional objects and perceiving an object from different perspectives” (NCTM, 2000, p. 41)

Spatial Ability

- Has strong connections to STEM and social studies (predicts STEM performance and participation, relates to STEM innovation and development...).
- Can aid number sense (e.g., picturing dots/objects being divided into equal groups or breaking off some of them for the make/over-ten strategy).
- Is significantly weaker in females than in males, esp. transforming and rotating objects in 3-d space (appears by preschool; can influence math anxiety).
- Can be influenced by parents and teachers.
- Can be improved through appropriate experience inside and outside the classroom.
- Is relatively neglected in K-12 education (teaching, testing).

Relationship of STEM and Art

- STEM and art are connected by spatial ability and creativity.
- Participation in visual arts can improve spatial ability.
- Art/design skills can inspire STEM innovation.



Selected Experiences That Can Influence Spatial Ability

- Computer/video games
- Spatial toys
- Sports
- Spatial chores
- Construction activity (building and repairing things)
- Work with graphic/visual representations (tables, graphs, diagrams, maps, sketches/drawings, reduced/enlarged images of objects...)

Selected STEM Areas Involving Spatial Ability

Geometry, measurement, trigonometry, calculus, algebra, problem solving, physics, chemistry, biology, engineering, technology (e.g., graphics, design)

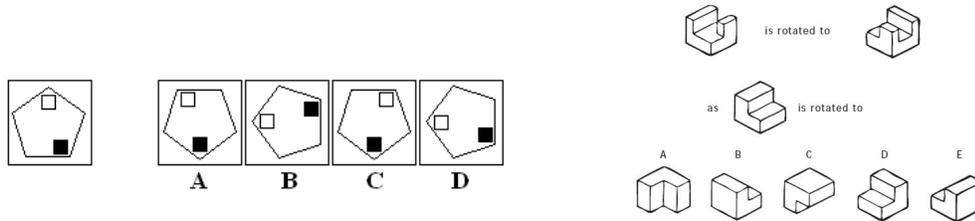
Selected Spatially Oriented Careers

Engineering, architecture, graphic design, cartography, geoscience

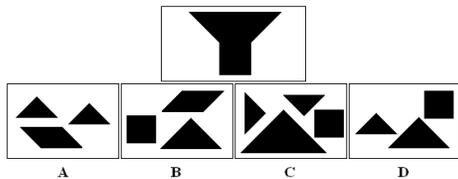
Key Spatial Skills

- Location, orientation, movement, and transformation of objects in space (e.g., mental rotation of 2 & 3-d objects)

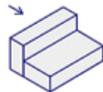
Figure 18. Sample Question from the Purdue Spatial Visualization Test: Rotations (PSVT:R)



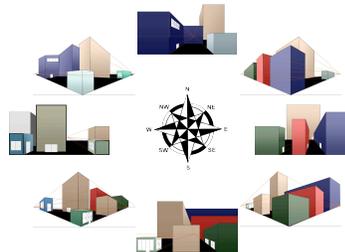
- Spatial relations and perception (among objects and in relation to one's own body)



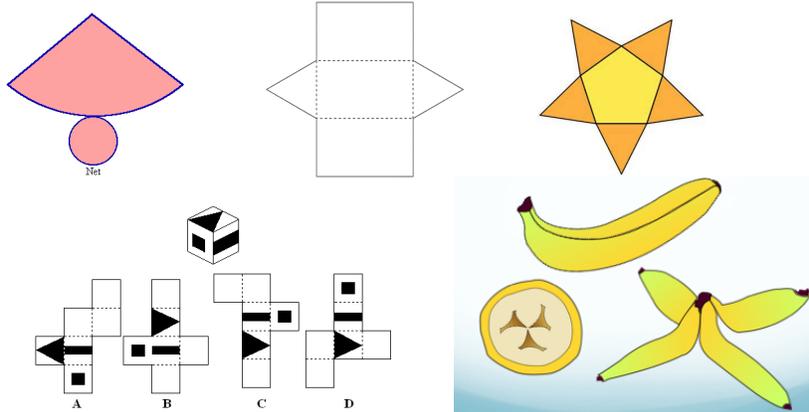
Try to imagine that you are standing behind the building blocks and are looking in the direction the arrow is pointing.



Which of the following pictures shows the figure from the position indicated?

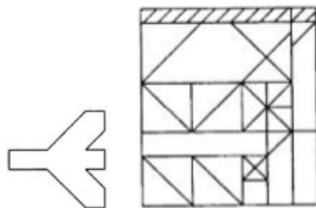


- Relationship between 2- and 3-d objects

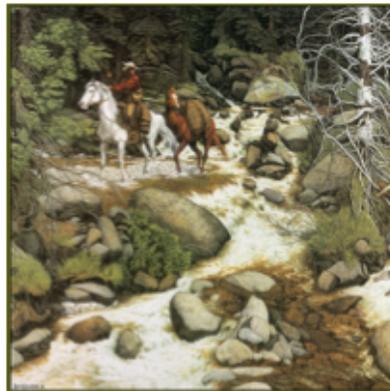
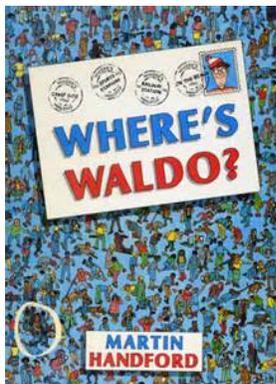


(Also view/examine 3-d figures/structures and draw the 2-d net/plan they would fold down into, and determine the 2-d view from different angles as well as cross sections that could result from intersection with a plane.)

- Hidden/embedded figures



Find the figure on the left within the drawing on the right.



Selected Spatial Actions

Visualize, manipulate (move, cut, fold, rotate), navigate, design, construct, represent, identify, describe, interpret

Selected Strategies for Supporting Spatial Skills

- Tell students that spatial skills are learned, not inborn.
- Provide engaging spatial experiences at home and school, including use of physical and virtual objects and drawing/design activities, such as drafting.
- Use hand-held rather than computer models to help students explore objects.
- Help students understand very small to very large spaces and structures.
- Help students learn spatial language (*rectangle, flat, tall, over, on the right...*).
- “Spatialize” the existing curriculum.
- Improve teachers’ spatial skills and dispositions.

Selected Activities That Promote Spatial Skills

- Play spatial video, computer, and table/board games.
- Create, read, and make sense of graphs, diagrams, construction/design plans, and maps.
- Sketch and visualize objects and scenes (including from different perspectives).
- Construct and take apart things (models, block structures...).
- Program computer animations or robot instructions.
- Assemble jigsaw puzzles.
- Do mental rotation tasks.
- Do hidden shapes/embedded figures tasks.
- Design things, such as games, toys, rooms, buildings, cities, parks, playgrounds, an animal habitat (cat room, dog play area, hamster cage, fish aquarium...), cars, logos, and access to a building for people with disabilities using both hand and technology-assisted drafting.

Art Elements and Design Principles

Space; line; shape; form; value; texture; color; balance; proportion; movement; emphasis; rhythm; contrast; unity

Key Visual Arts Skills for Spatial Reasoning

- Seeing the relationship between positive and negative spaces
- Drawing from observation
- Creating the illusion of depth: light sources; value range/shading; cast shadow

Selected Teacher Resources

- ArtSciMath: Integrated Art Lessons: artscimath.com
- Dewar, G. (2012). *Improving spatial skills in children and teens: Evidence-based activities and tips*. Available on Parenting Science’s website at <http://www.parentingscience.com/spatial-skills.html>
- Newcombe, N. S. (2010). Picture this: Increasing math and science learning by improving spatial thinking. *American Educator*, 34(2), 29-35, 43. Available at aft.org/pdfs/americaneducator/summer2010/Newcombe.pdf [preK-4]
- Newcombe, N. S. (2013). Seeing relationships: Using spatial thinking to teach science, mathematics, and social studies. *American Educator*, 37(1), 26-31, 40. Available at www.aft.org/sites/default/files/periodicals/Newcombe_0.pdf [middle/high school]
- Sousa, D. A., & Pilecki, T. (2013). *From STEM to STEAM: Using brain-compatible strategies to integrate the arts*. Thousand Oaks, CA: Corwin.
- Spatial Intelligence and Learning Center: <http://spatiallearning.org/>

Selected Teacher Resources (continued)

- STEM to STEAM: stemtosteam.org
- WestEd. (2014). *Teaching spatial skills to girls* [video]. Available as part of WestEd's "The Doing What Works Library" at <http://dwwlibrary.wested.org/media/teaching-spatial-skills-to-girls>

References

- National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author. <http://nctm.org/standards/content.aspx?id=16909>
- Newcombe, N. S. (2013). Seeing relationships: Using spatial thinking to teach science, mathematics, and social studies. *American Educator*, 37(1), 26-31, 40.