Expanding Your Reach: Identifying and Serving Spatially Talented Students

College of Education

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Self assessment

- Try this spatial-visualization test:

https://www.123test.com/spatial-reasoning-test/

(Note that they get very challenging as you go!)

Consider:

- Which kinds of questions were most challenging to you?
- Do you notice different kinds of thinking or strategies than you would use on other kinds of test questions?

What is spatial visualization?

- Also known as:
  - Visuospatial skills, spatial reasoning, spatial ability, spatial structuring, spatial thinking
- Ability to visualize objects and mentally manipulate them
- Problem-solving using visual representations
- Visualization processes vary with 2D, 3D, and dynamic visuals

Why are spatial skills important?

- Spatial thinking helps with problem solving.
- Spatial thinking is valuable for scientists and engineers.
- Spatial thinking helps people live and work in a technological world.

Key issues

Engaging students with spatial skills

Often less engaged in school because their skills are not valued

Develop skills for those without them

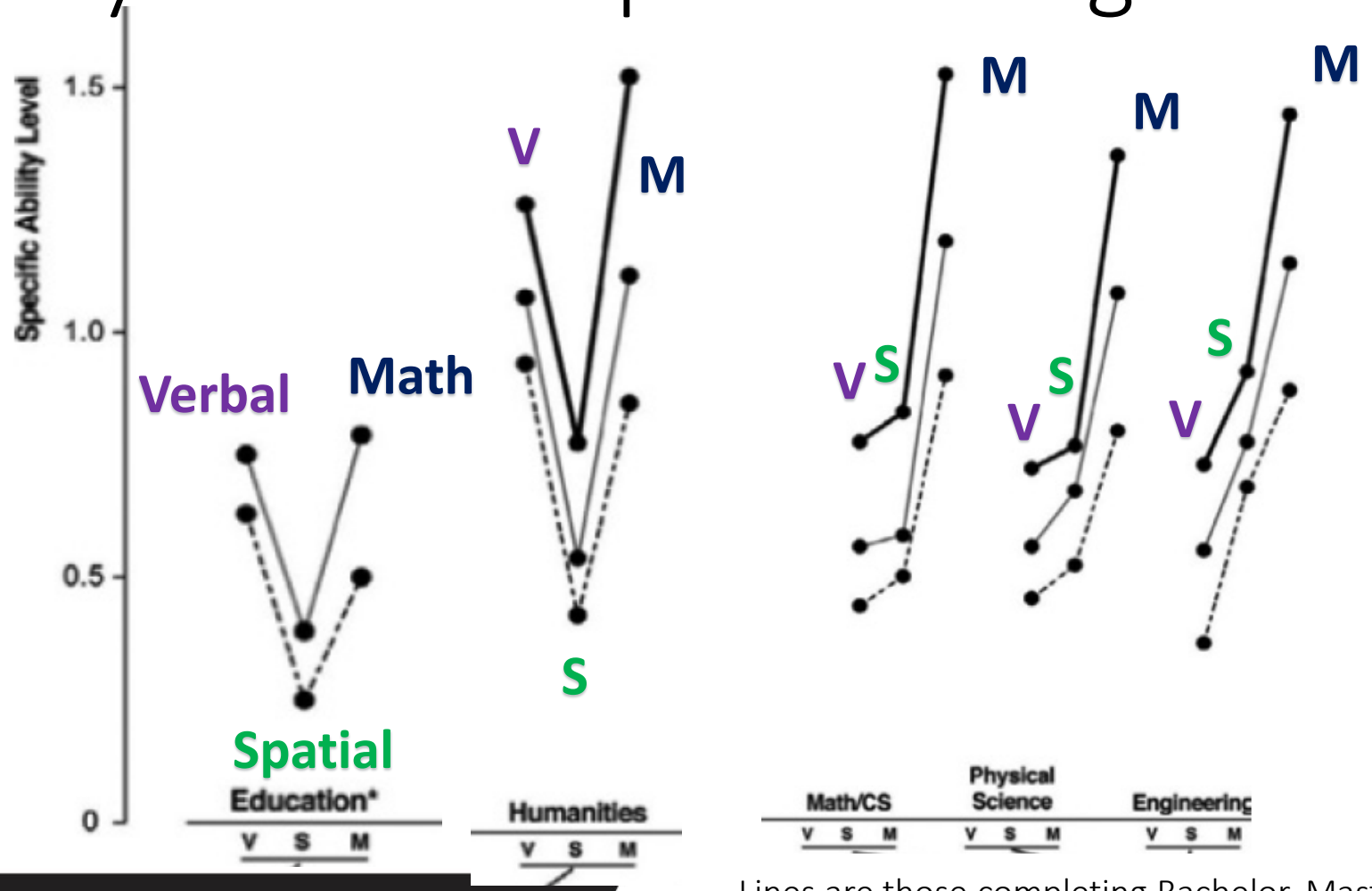
Critical to success in many careers and in everyday tasks

Reading diagrams and figures not always explicitly taught

It is NOT a **"learning style"**

Set of skills and problem-solving strategies everyone needs

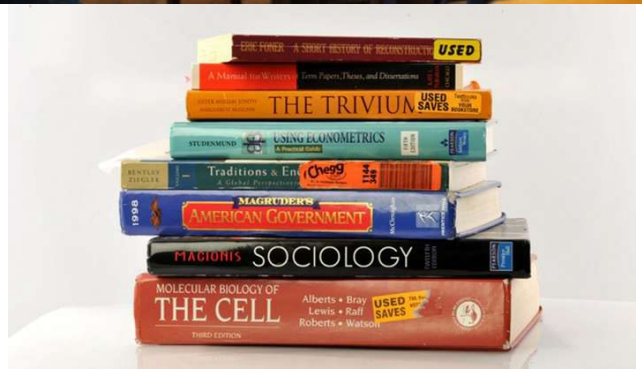
Profile or “tilt” of skills means teachers are less likely to have a spatial strength.



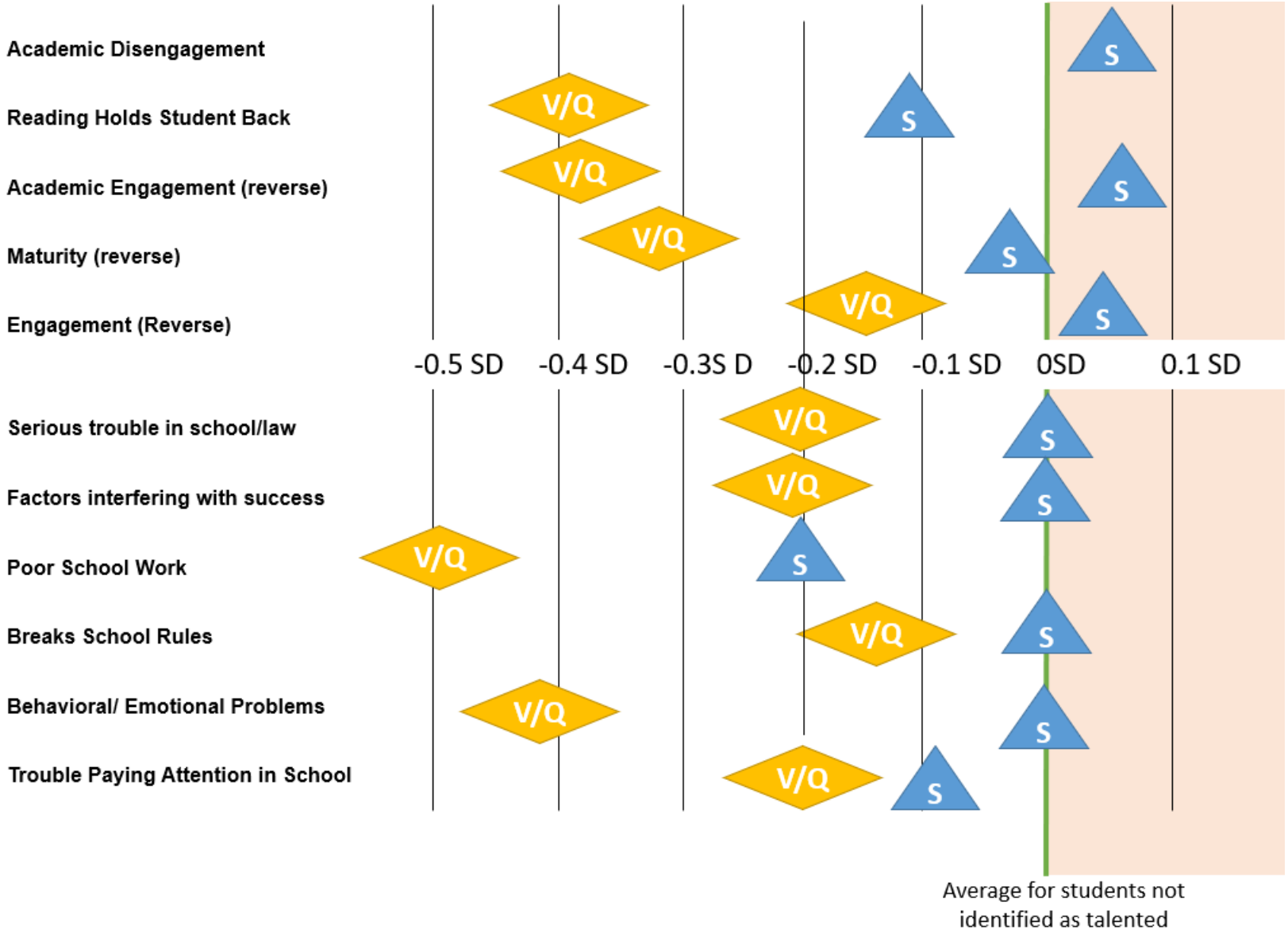
Lines are those completing Bachelor, Masters, Doctorate in field
Wai, Lubinski, & Benbow, 2009

Bored spatially talented kids…

Estimate there are 2-3 million students with spatial strengths but not verbal or quant



Lakin, J. M., & Wai, J. (2020). Spatially gifted, academically inconvenienced: Spatially talented students experience less academic engagement and more behavioural issues than other talented students. *British Journal of Educational Psychology*, *90*(4), 1015-1038.



Negative educational effects

Green vertical line shows the average level of these characteristics for students without a strength at the 95PR+

Negative scores indicate less of these characteristics

Lakin, J. M., & Wai, J. (2020). Spatially gifted, academically inconvenienced: Spatially talented students experience less academic engagement and more behavioural issues than other talented students. *British Journal of Educational Psychology*, *90*(4), 1015-1038.

What happens when talent is ignored?

Individual costs

- Academic struggles, bored kids
- Low degree completion and reduced long-term income

Societal costs

- Behavioral disruptions from bored kids
- Fewer students with talent in STEM fields reach potential
- Continuing gap in STEM workforce needs and current workforce readiness

Providing challenge to spatially talented students

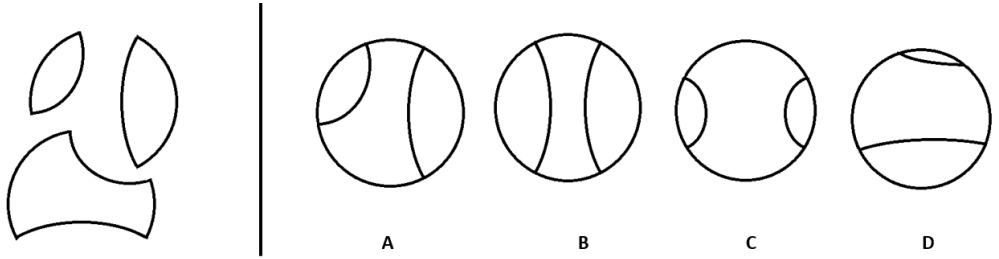
What to do about this?

- Scout for these talented kids
  - Recognition, acceptance
- Serve them however possible within existing services
  - Vocational and engineering courses
  - Opportunities to visually represent learning and use those strategies
  - Encourage them to sketch and draw if they don’t already

Components of spatial visualization with clear links to STEM success

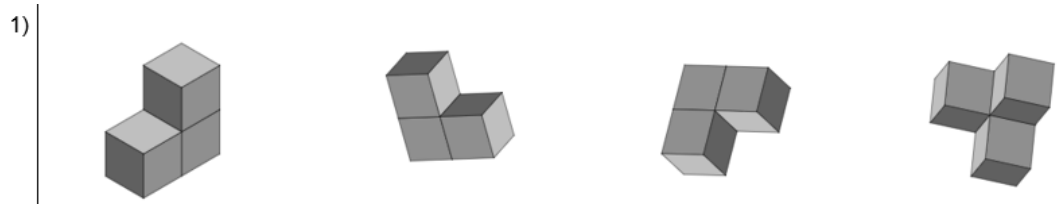
Visualization—perceiving and comparing visual features

Which image of the right can be created from the pieces on the left?



Relations—includes rotations, the ability to mentally manipulate objects (probably includes mechanical reasoning)

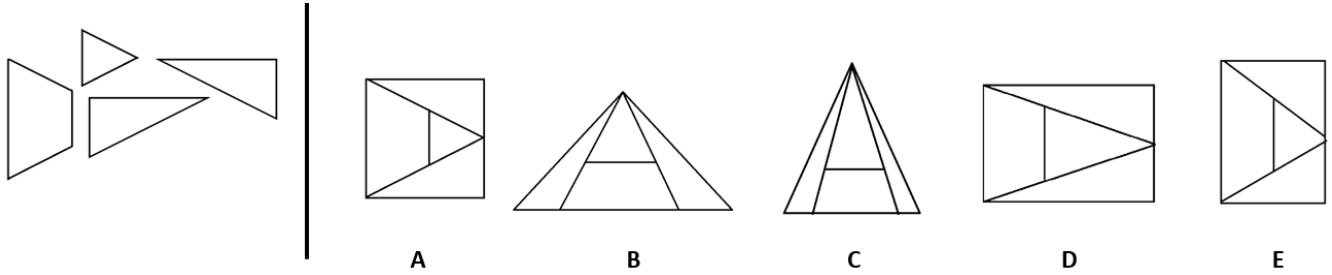
Which object cannot be the same as the other three?



Are these the same as nonverbal/figural formats?

Visualization

Object assembly



Paper folding

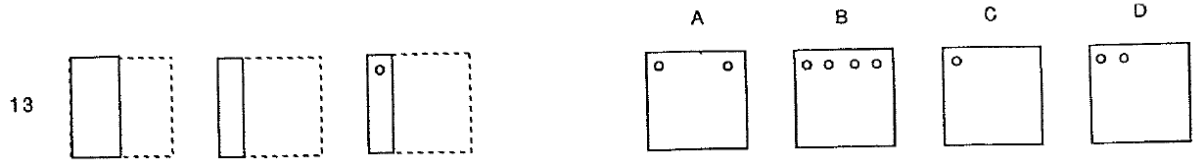
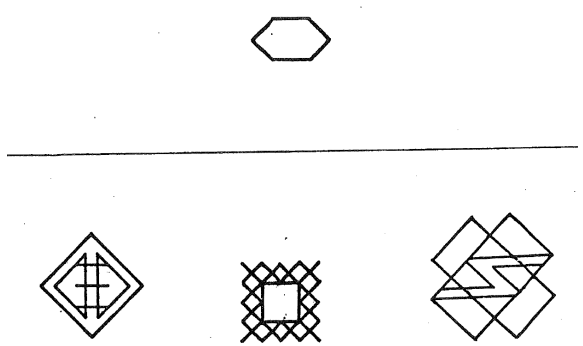
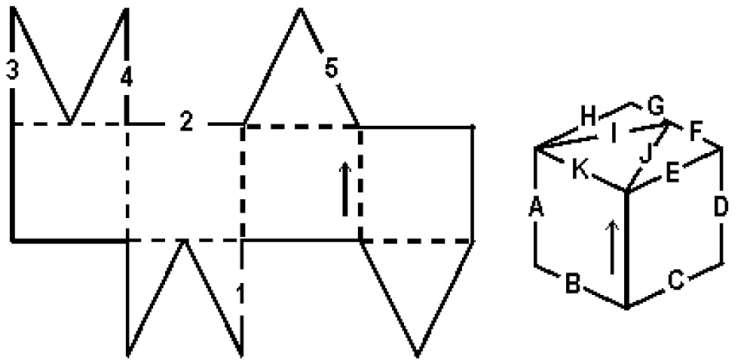


Figure Perception



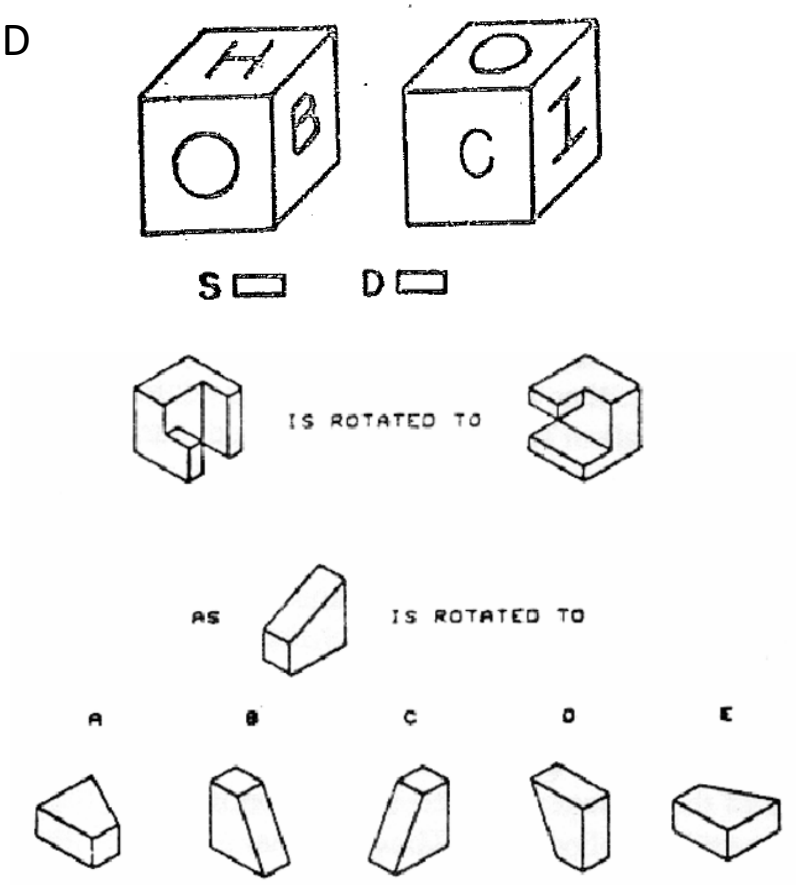
Item 1: Surface Development



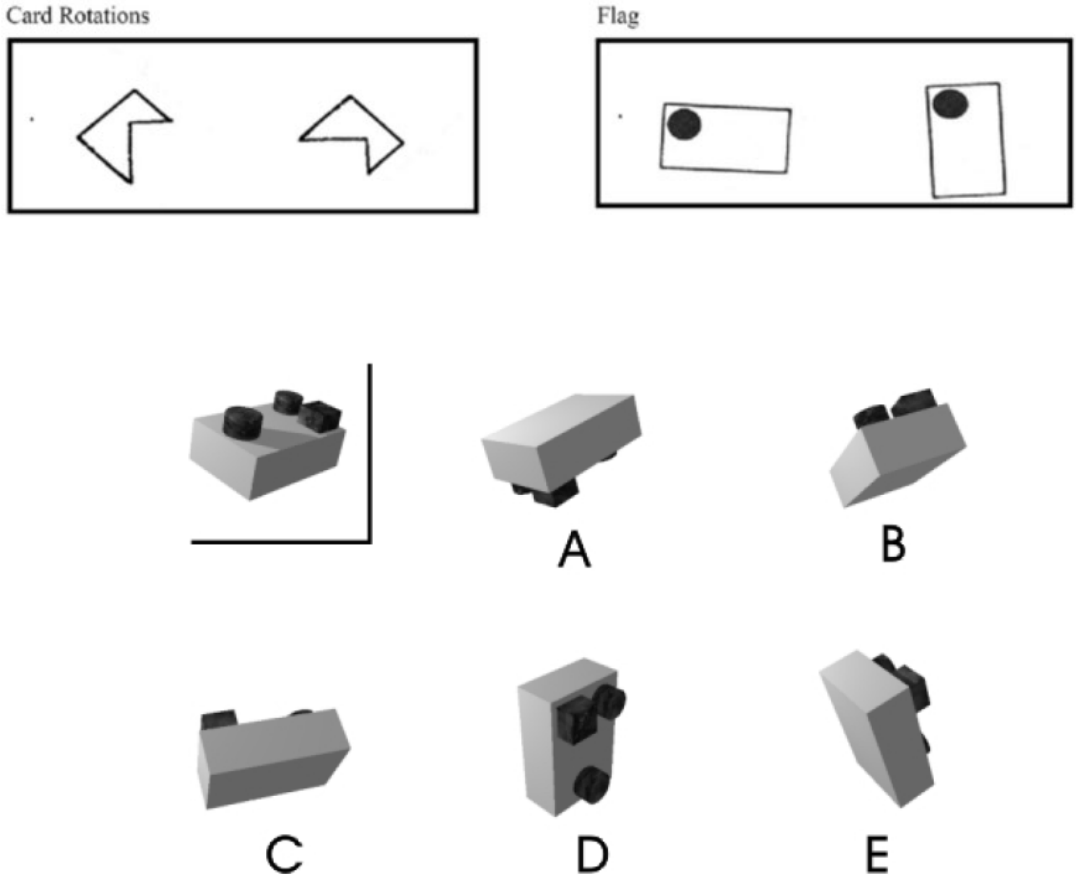
Object assembly

Rotation

3D



2D



Rating scales--UPLUS STAR

DISPLAYS SPATIAL ABILITIES

Has a good sense of direction.
Figures out why and how things work.
Takes objects apart and reassembles with speed and accuracy.
Creates interesting shapes and patterns.
Shows unusual talent in various art forms (including musical, dance, and performance arts).
Invents games.
Creates three-dimensional structures.
Has excellent motor planning and coordination.
Needs movement to connect learning to memory.
Prefers hands-on experiences to learn (uses manipulatives/artifacts).
Brings gadgets, toys, etc. to tinker with at school.
Moves around often (keeps hands and body always busy).

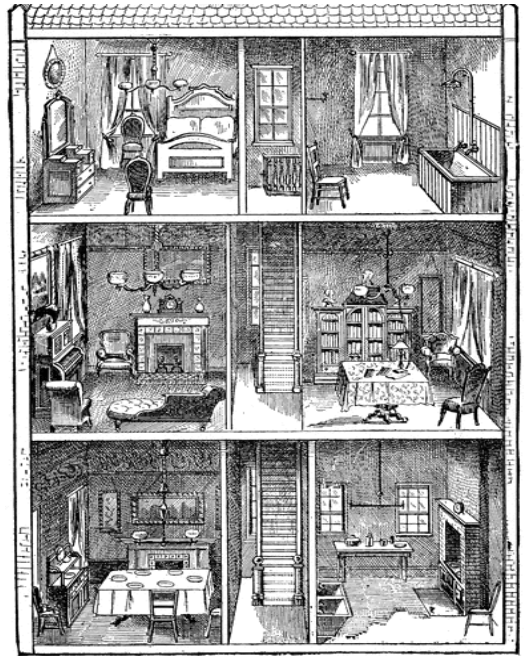
Supporting spatial skill development

Mini-lesson on cross-sections

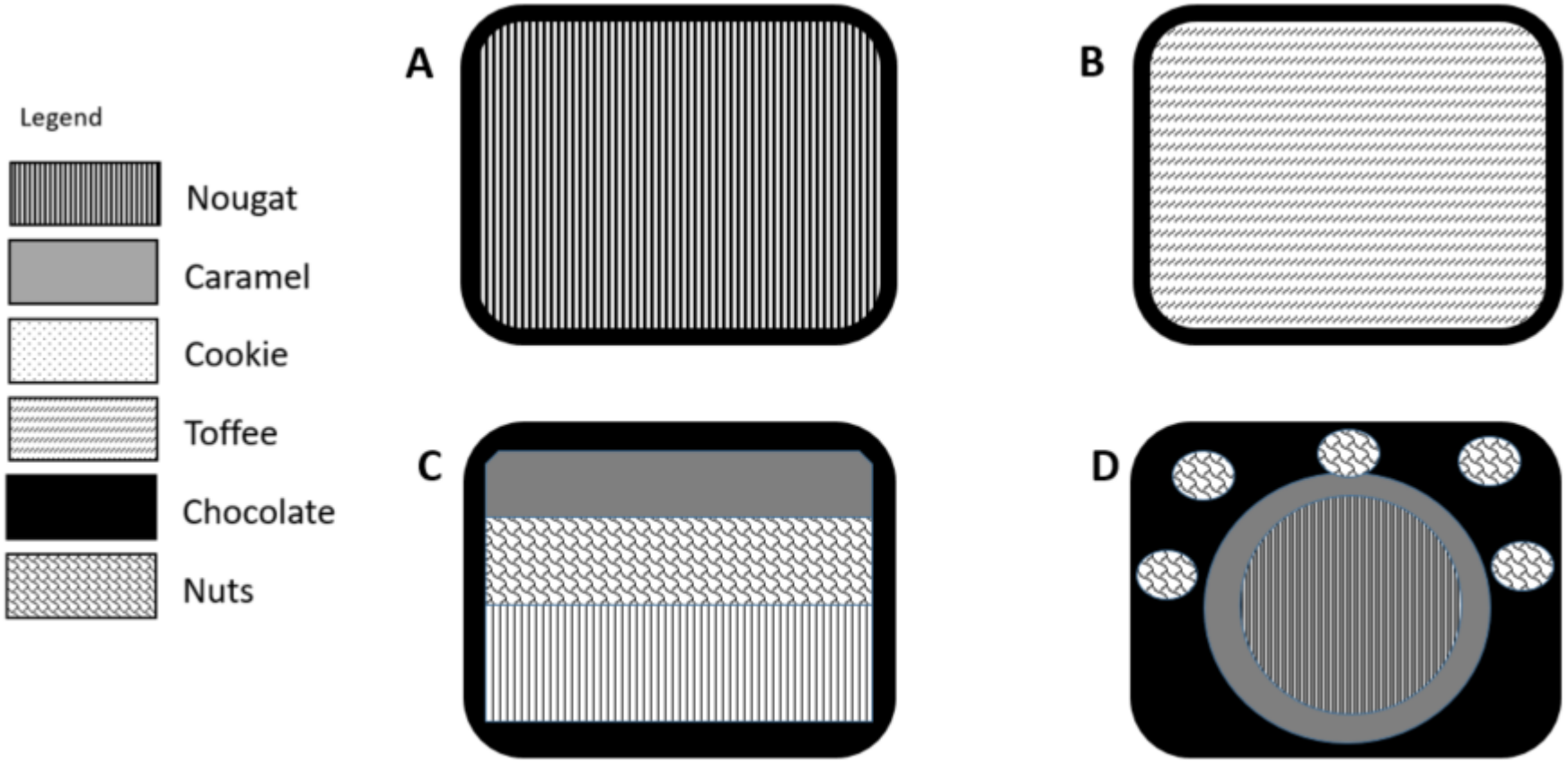
- Introduce students to a new way of looking at objects

What is a cross-section?

A cross-section is a diagram showing what's inside a larger object, like a mountain. It's imagining that you can cut straight through the mountain and see inside. It's helpful for understanding the parts that make up a larger whole.



Identify the candy from its cross-section



Options: Snickers, Milky Way, Twix, Baby Ruth, 100 Grand

Draw your own cross-section!

- **Unwrap your candy and draw the outside of the candy.**
- **Cut the piece of candy in half (down the middle, across, or diagonally…)**
- **Draw a cross-section of your candy. Be sure you include a legend of how you represented different parts of the candy.**

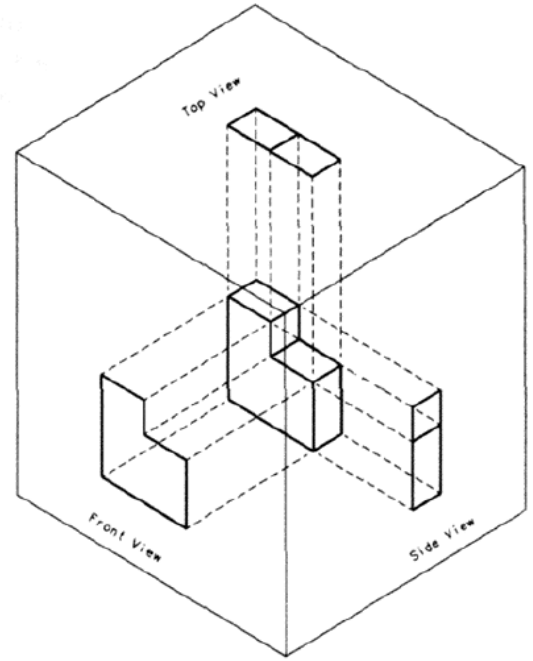
Intro to Engineering Drawing

- Can be done in one 50 minute class, but a bit longer is better
  - Complete slides available
  - Starts with Mystery Object and why visuals are useful
- Could be a lead-in to 3D printing in CAD
- https://www.higheredservices.org/new-resources/ (Sheryl Sorby's resources)

Intro to basic drafting skills

Orthographic Projection

- Imagine an object is surrounded by a glass cube.
- The object's surfaces are projected onto the faces of the glass cube.
  - The projection rays are perpendicular to the panes of glass



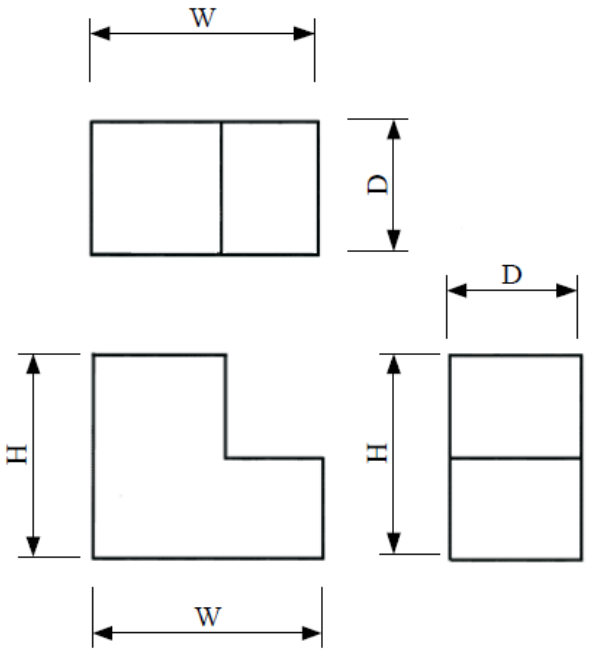
Try building this shape with blocks

Intro to basic drafting skills

Orthographic Projection

When the glass cube is unfolded each view shows two dimensions of the object:

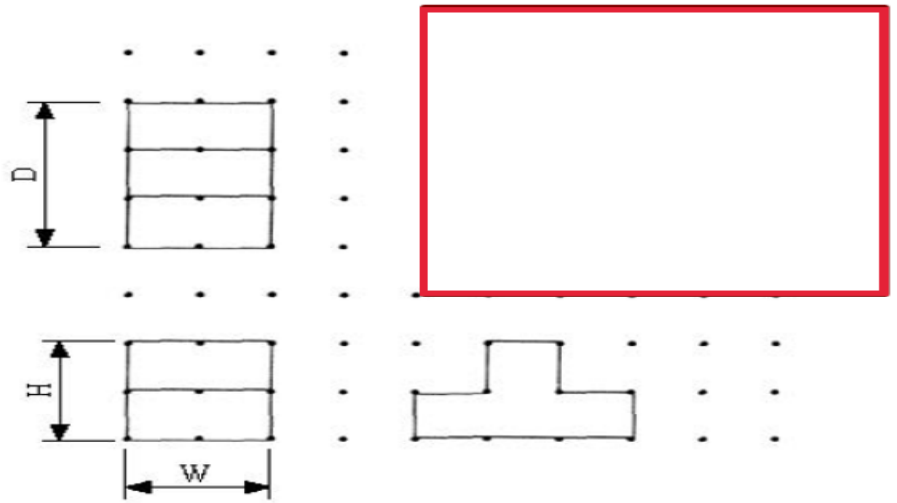
- Front view: Height and Width
- Top view: Width and Depth
- Right view: Depth and Height



Intro to basic drafting skills

Isometric Sketches from Orthographic Views

What will the 3D view of this object look like?

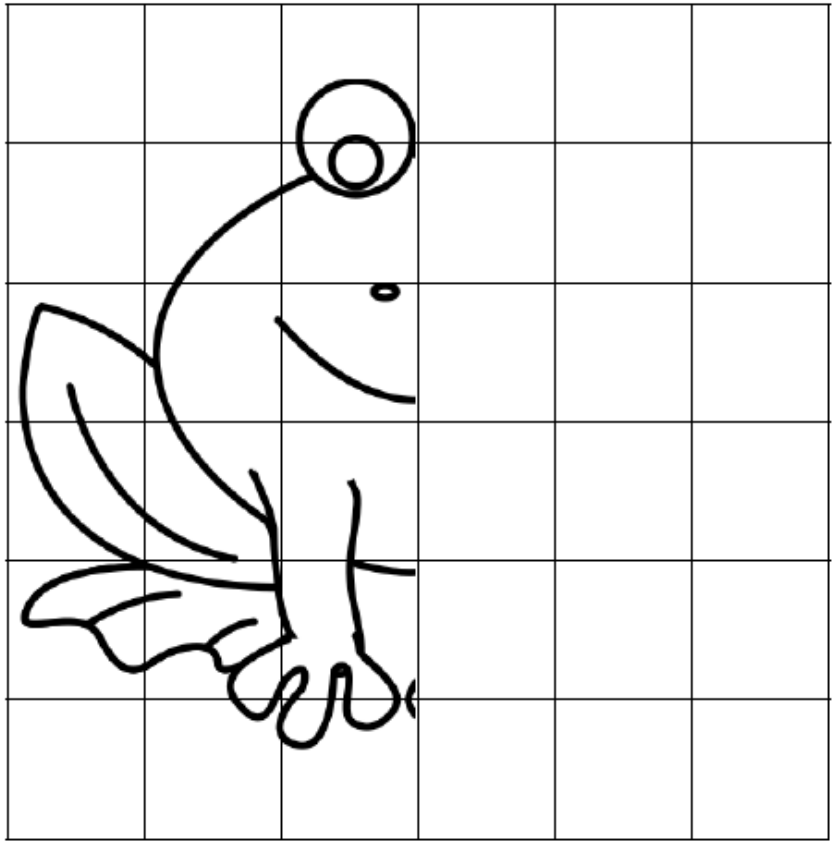


Bellringers

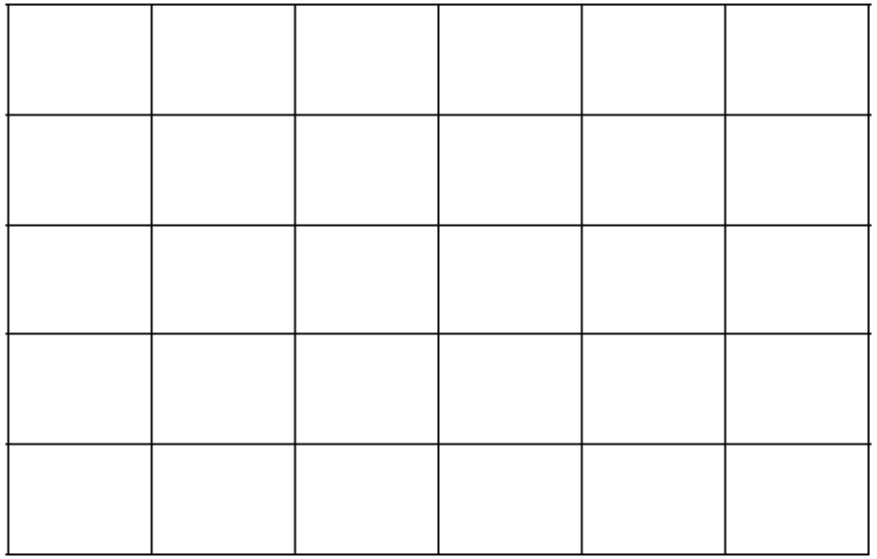
Enrichment challenges

Bellringers

Draw the rest of this picture using the gridlines as a guide.



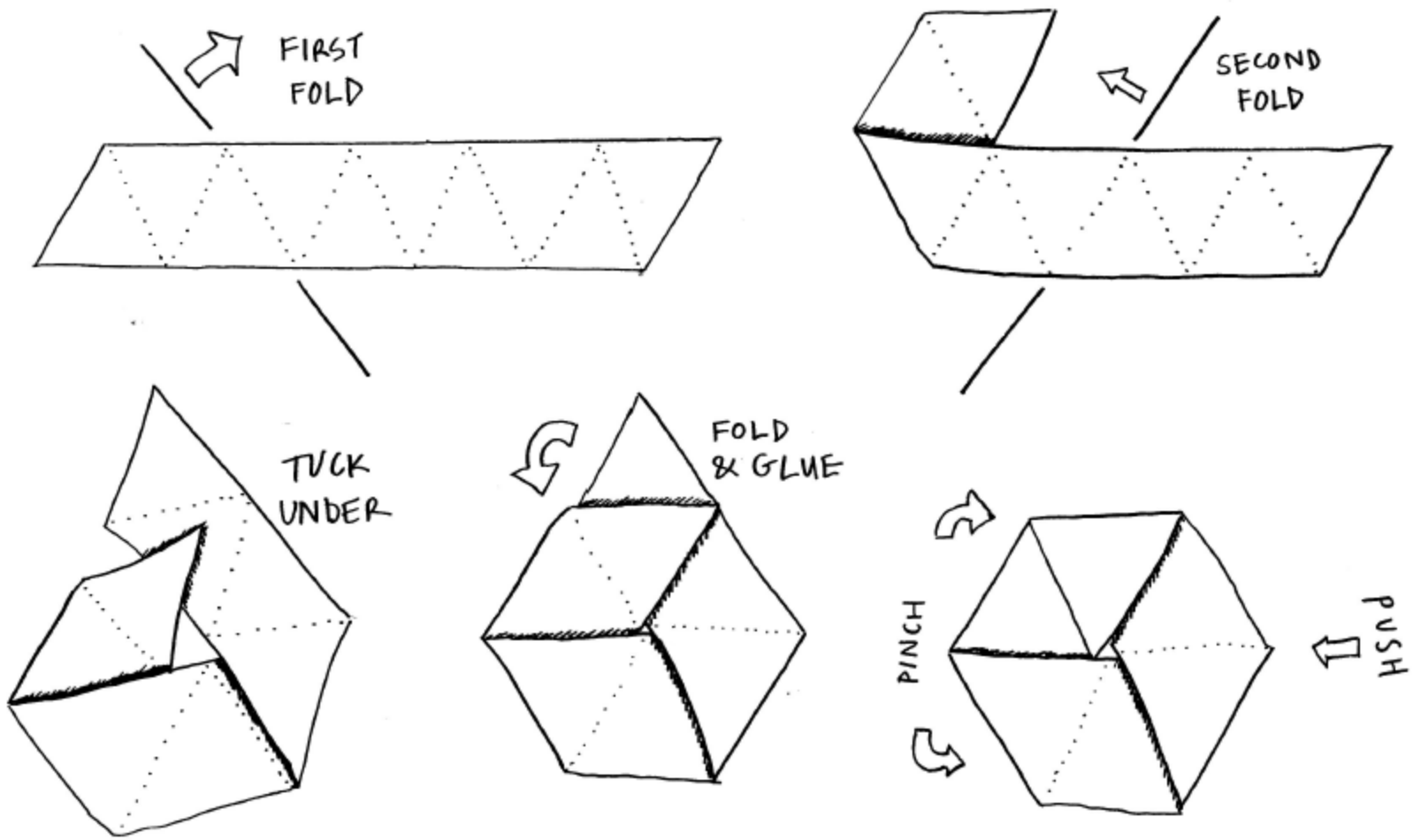
Draw this house using the grid lines as a guide.



Mystery Object Challenge

1. Find a partner. In each box, you will find one MYSTERY object and an assortment of math counting blocks. **Keep your object a secret** from your partner!
2. If you get a box with an even number on it, , you must DRAW your object (no labels) so that your partner can build it.
3. If you get a box with an odd number on it, you must DESCRIBE your object in words only (no diagrams) so your partner can build it.
4. **When you're done, swap instructions**. Use your blocks to build the mystery object from your partner's instructions using the blocks.

Did you build the object correctly? What did you find difficult about this?


FIRST
FOLD
SECOND
FOLD
TUCK
UNDER
FOLD
& GLUE
PINCH
PUSH

Visuospatial tasks are everywhere already

Key is to explicitly draw attention to…

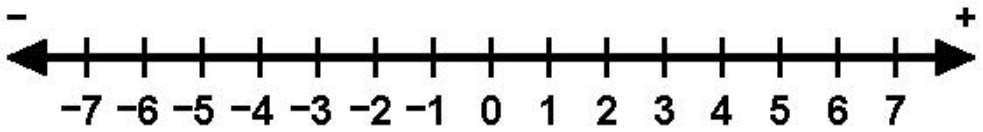
- Spatial vocabulary and visual features
- Strategies
  - Number lines, concept maps
- Basic literacy in graphs, diagrams, and other representations
  - Be sure students know the basic conventions of diagrams (lines for motion, etc.)
  - Be sure students get the unique information provided by their books (often NOT redundant with the text)

Spatial skills across the curriculum

Where spatial talents will be an asset

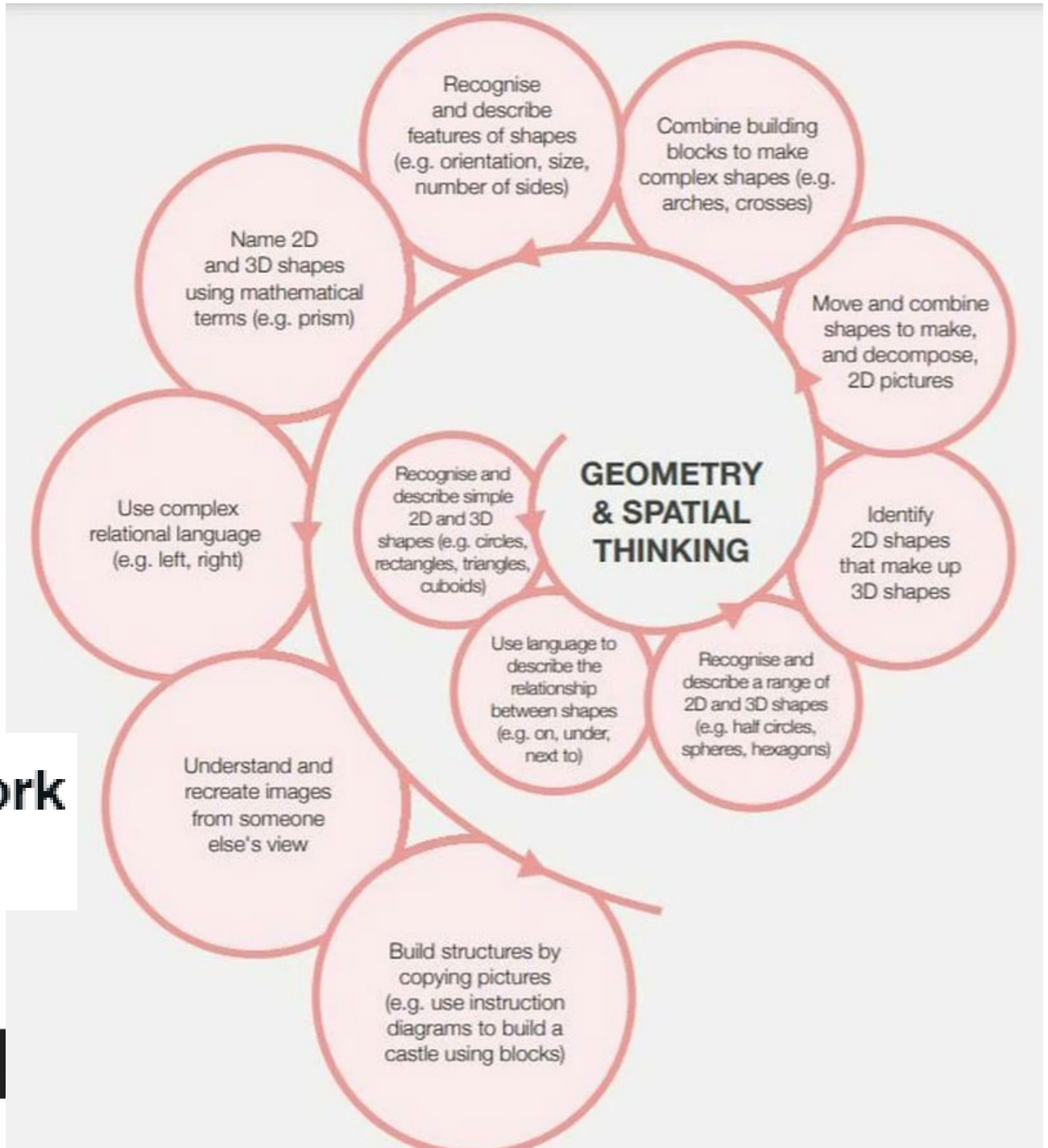
Surprisingly early in math

- buff.ly/3t7XrAE

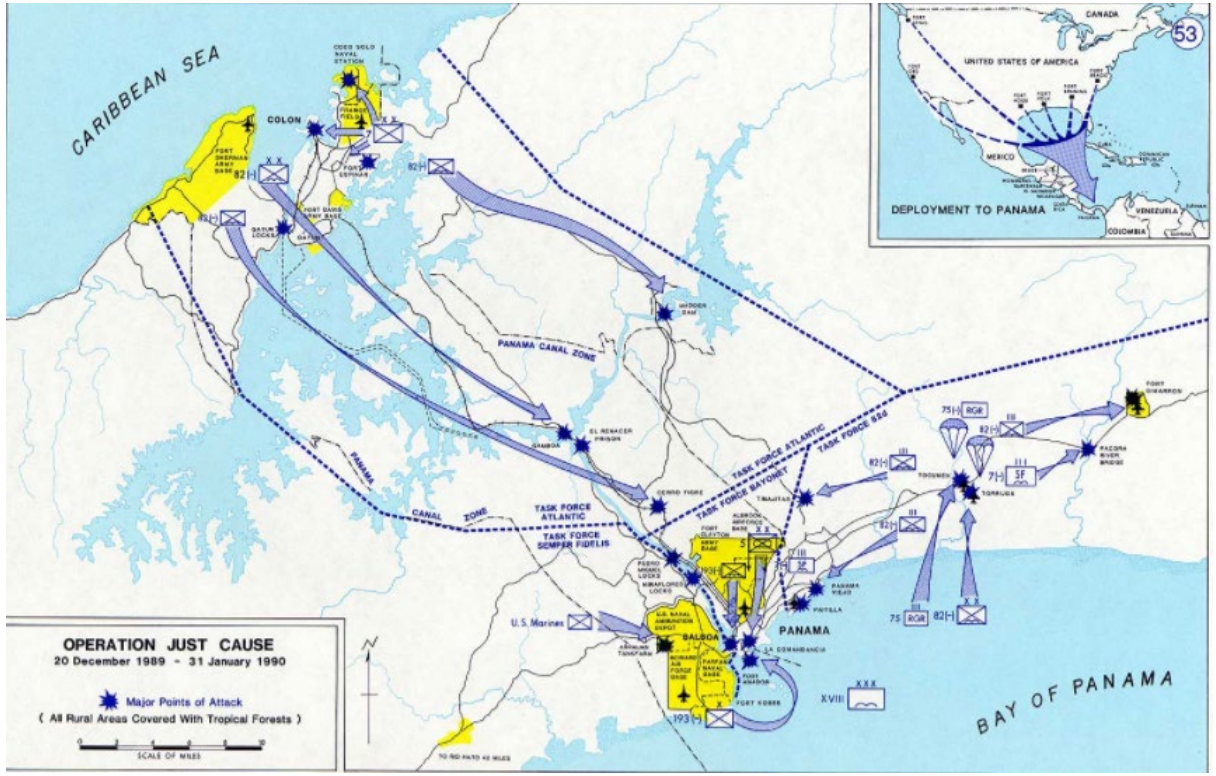


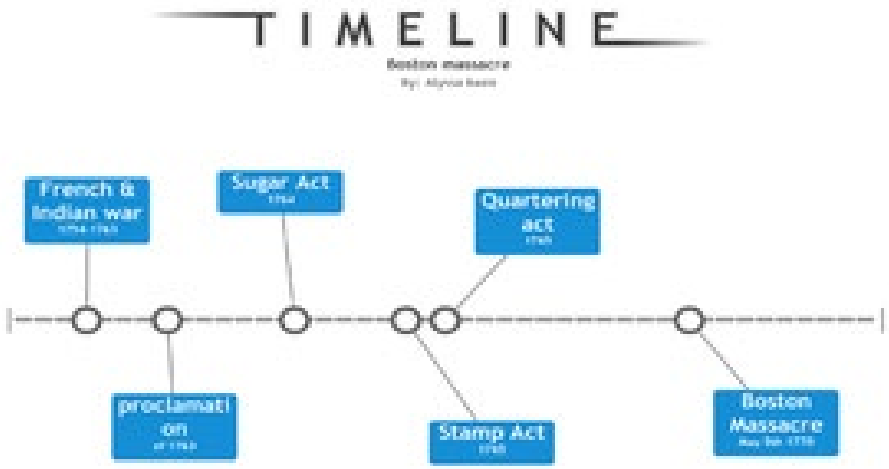
Research Schools Network

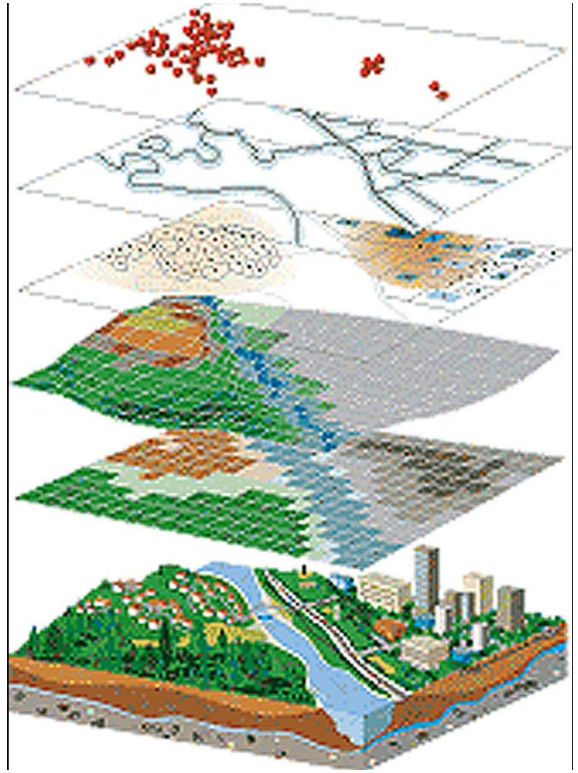
@rs_network



Social Studies

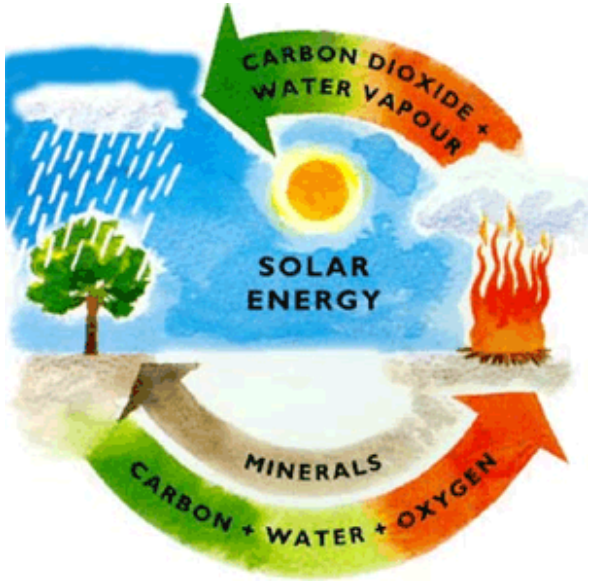


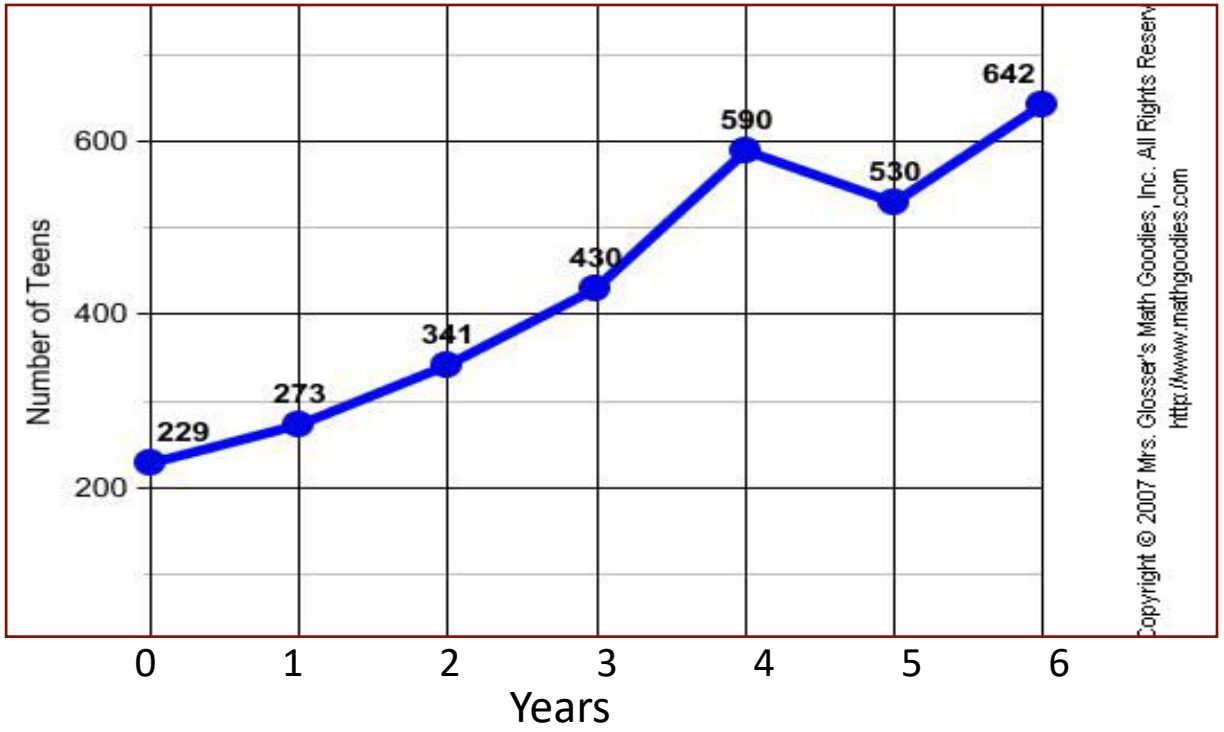




Interpreting graphs

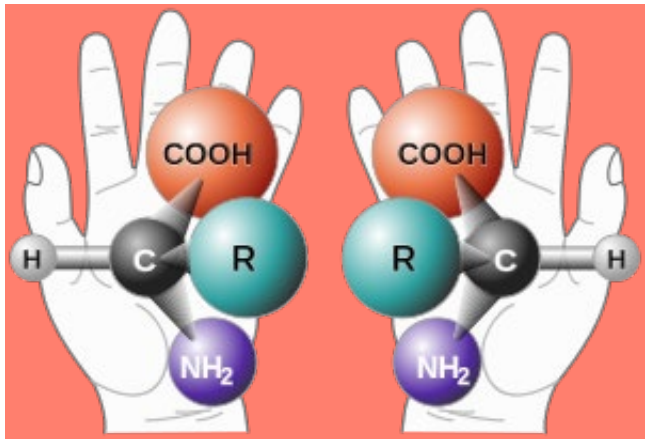
- Being able to draw inferences and make predictions from graphs and diagrams

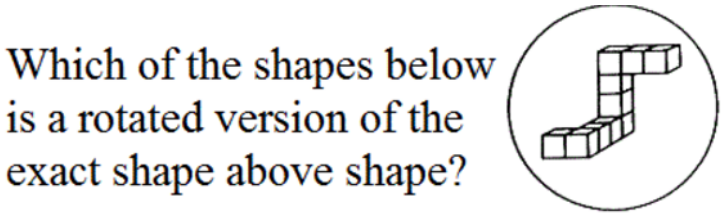


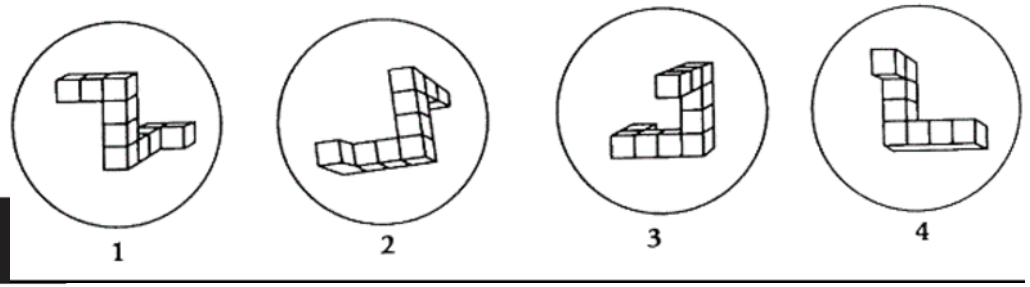


Organic Chemistry

- right- and left-handed molecules bond differently
- Course required for biomedical fields and several fields of engineering.

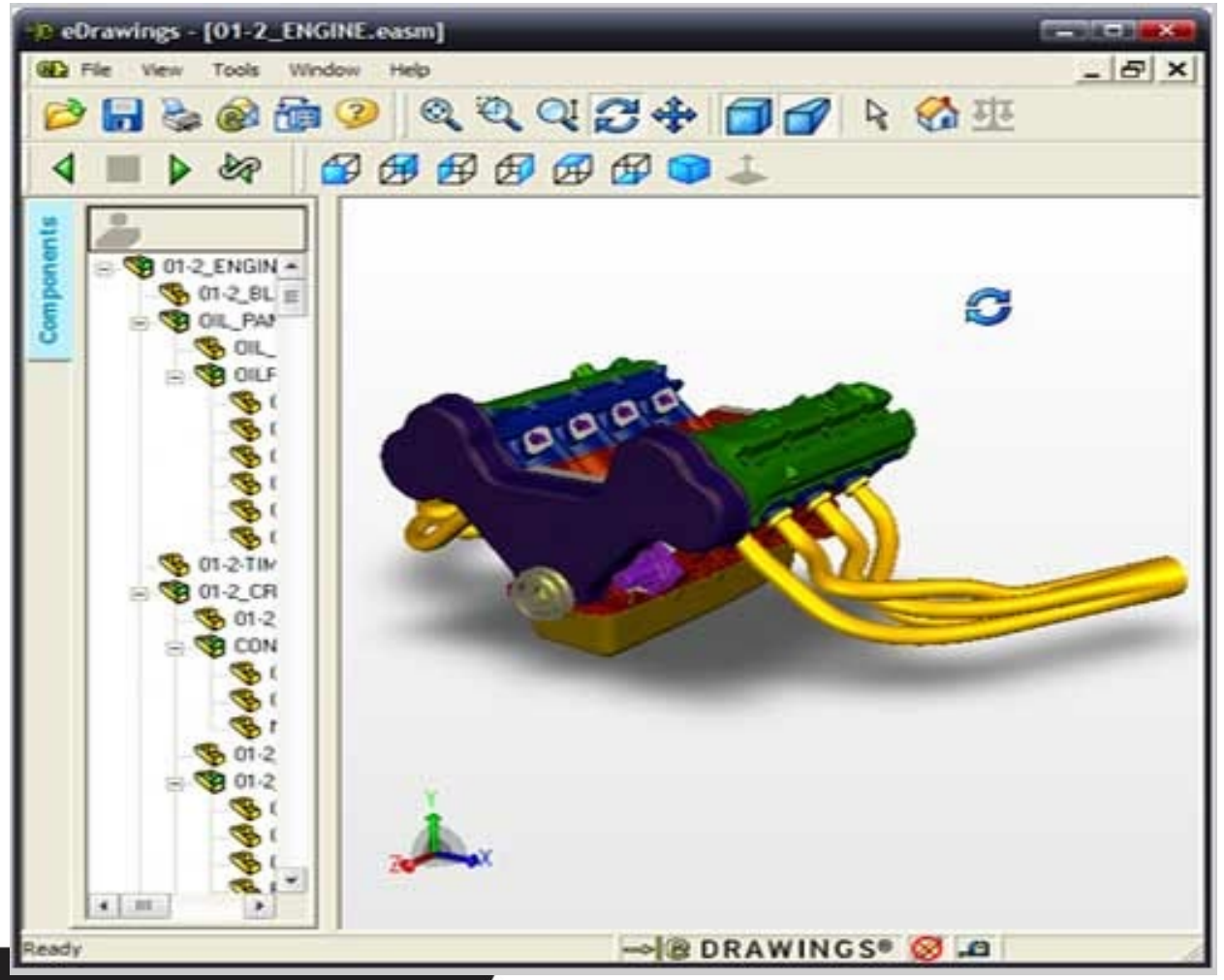






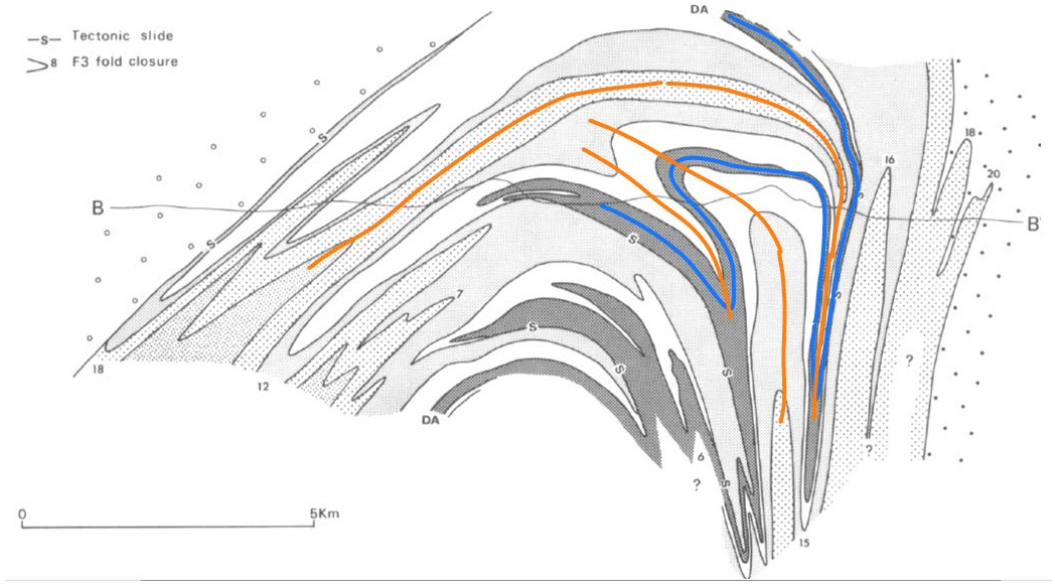
Vandenberg & Kuse, 1978, Mental Rotation Test

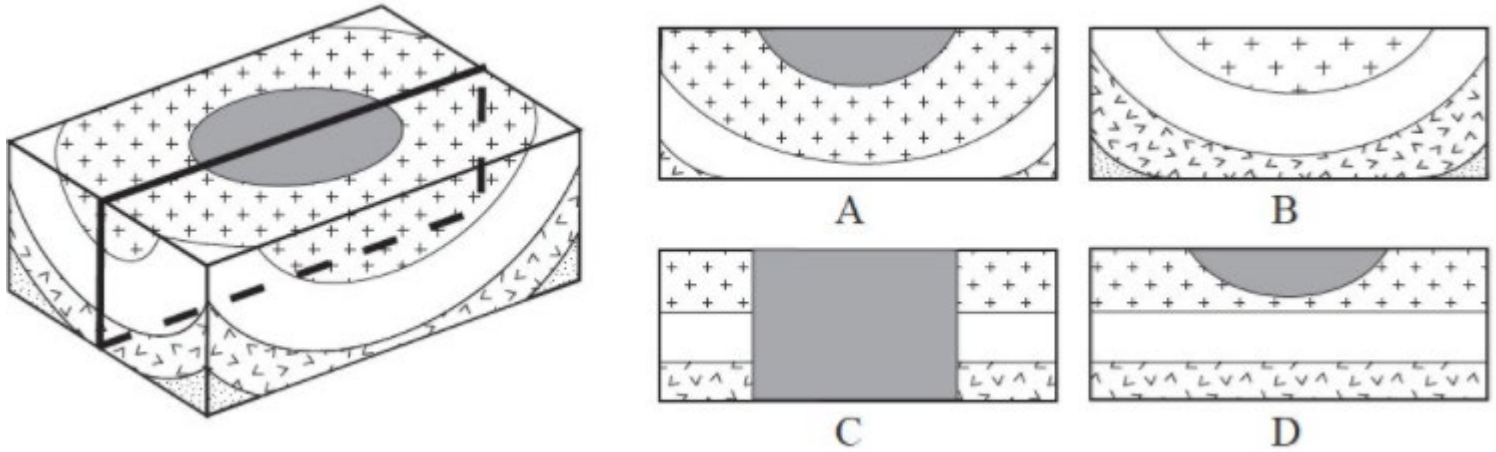
Engineering Drafting, Technicians



Geology, GIS

- Complex diagrams to represent 3D formations and movement





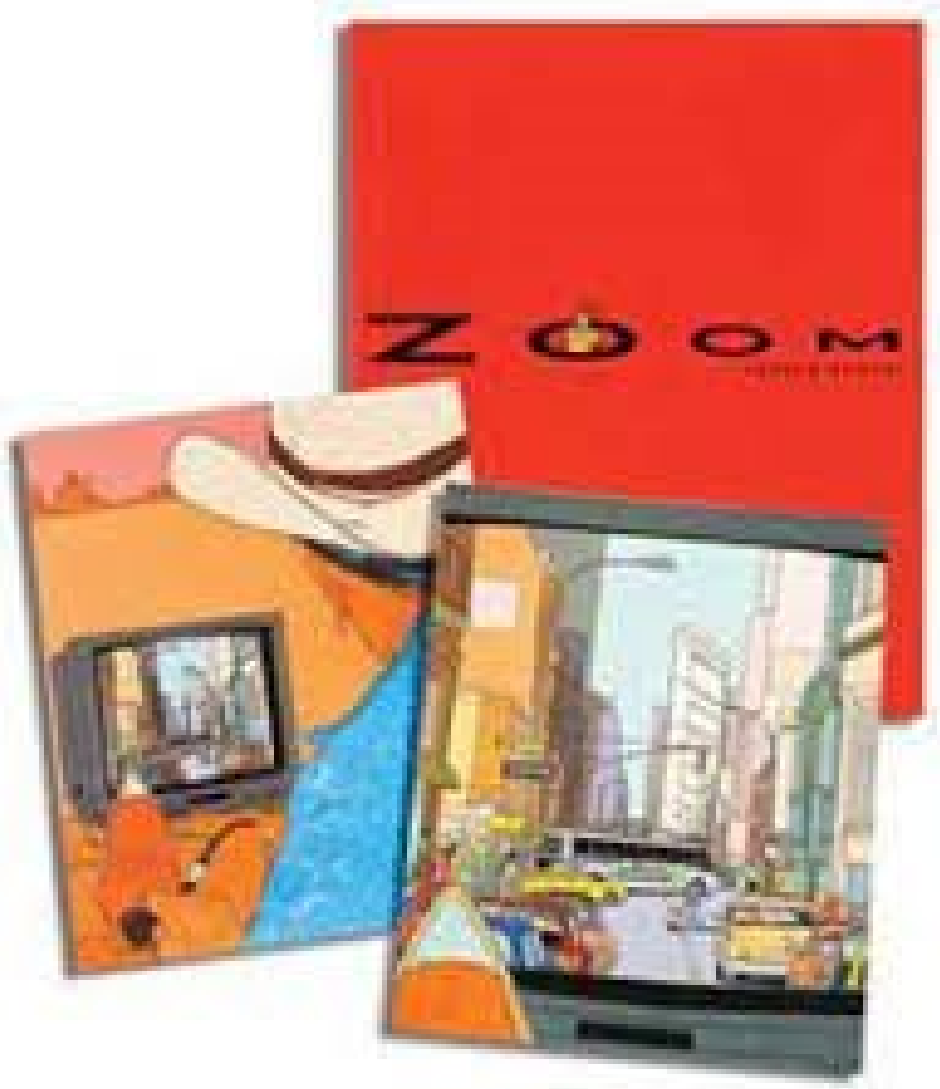
Geologic Block Cross-Sectioning Test
http://www.silccenter.org/index.php/resources/testsainstruments

STEAM

Smartphone microscopes and scale

- Get Creative!
- Upload your best photo to the padlet

https://padlet.com/jonilakin/b0i6h7ncf82e9pl9



Intrigued? Want your district or school to be involved in a validity study of a new measure of spatial thinking for grades 2-8?

Express interest here:
https://tinyurl.com/mr34jhjs

Resources

PAGE
PENNSYLVANIA ASSOCIATION FOR GIFTED EDUCATION

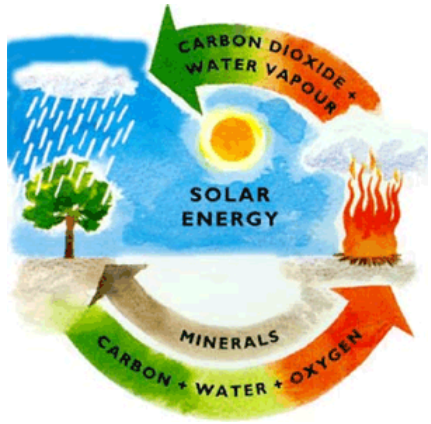
- Spatial Thinking Workbook created with my collaborators
- Spatial teaching toolkit for early childhood: https://earlymaths.org/spatial-reasoning/
- Engineering curriculum on visualization https://www.teachengineering.org/lessons/view/cub_spatviz_lesson01
- Surveys and free tests: https://www.silc.northwestern.edu/resources_2/
  - https://www.engageengineering.org/spatial/takeaction
- Spatial-visualization test: https://www.123test.com/spatial-reasoning-test/ *(Note that they get very challenging as you go!)*

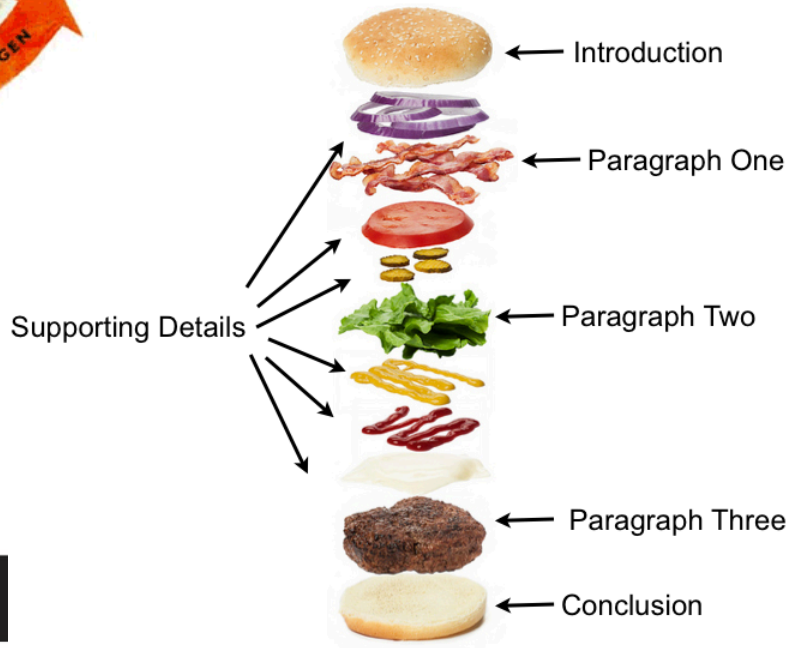
Explicit training on interpreting diagrams

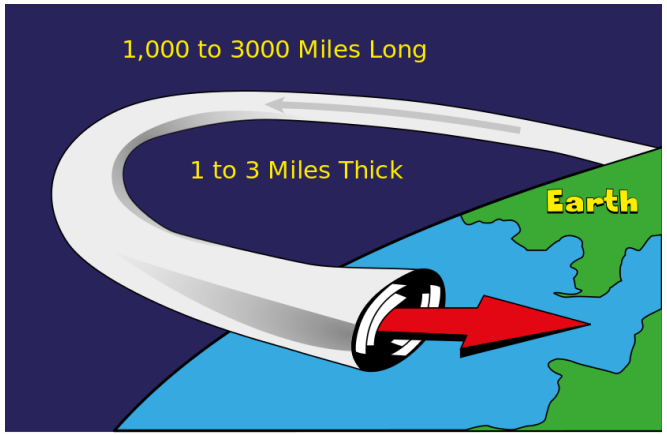
Concept	Definition
Action	Static graphics can be interpreted as dynamic action.
Extension	Some graphics provide additional information that is not present in the written text.
Importance	Some information in a graphic may be more important than other information.
Intentionality	Illustrators (who are sometimes also the authors) choose to create graphics to accomplish a communicative purpose within a larger text.
Partiality	Not everything in written text must be represented in the graphics.
Permanence	Graphics in printed texts are permanent and do not change.
Relevance	Graphics and written text are related.
Representation	Illustrations and photographs represent objects, but do not have the same physical properties as those objects.

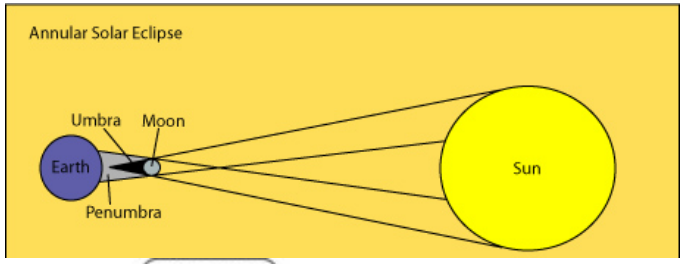
Note: From Duke, N.K., Norman, R.R., Roberts, K.L., Martin, N., Knight, J.A., Morsink, P., et al. (2009, December). Visual literacy development in young children: An investigation with informational texts. Paper presented at the annual meeting of the Literacy Research Association, Albuquerque, NM.

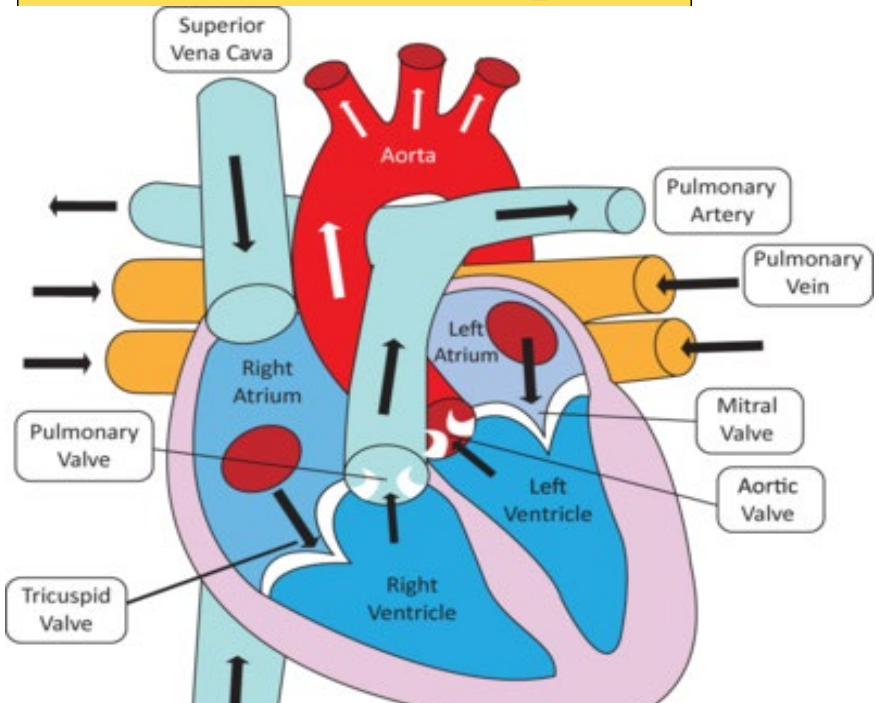
What are some of the conventions seen here?





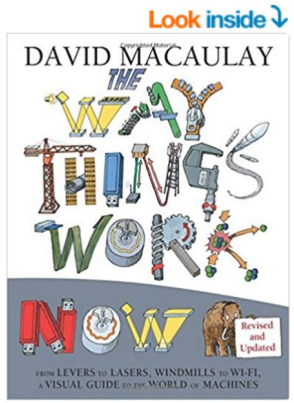




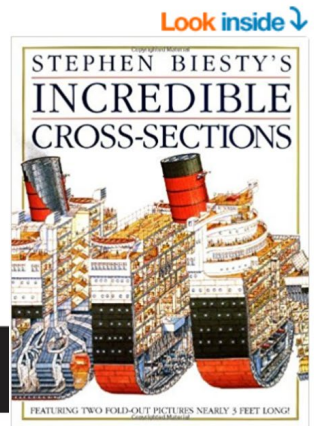


Cross sections

Roberts, Norman, Duke, Morsink, Martin & Knight (September 2013). Diagrams, Timelines, and Tables — Oh, My! Fostering Graphical Literacy. The Reading Teacher, 67(1), 12-24. http://www.readingrockets.org/ article/diagrams-timelines-and-tables



The Way Things Work Now Hardcover
October 4, 2016
by David Macaulay (Author)
58 customer reviews
#1 Best Seller in Teen & Young Adult How Things Work
See all 3 formats and editions
Kindle $19.99
Hardcover $24.87 prime
Read with Our Free App
45 Used from $18.88
33 New from $20.87



Stephen Biesty's Incredible Cross-Sections Hardcover – July 7, 1992
by Richard Platt (Author), Stephen Biesty (Illustrator)
43 customer reviews
See all 11 formats and editions
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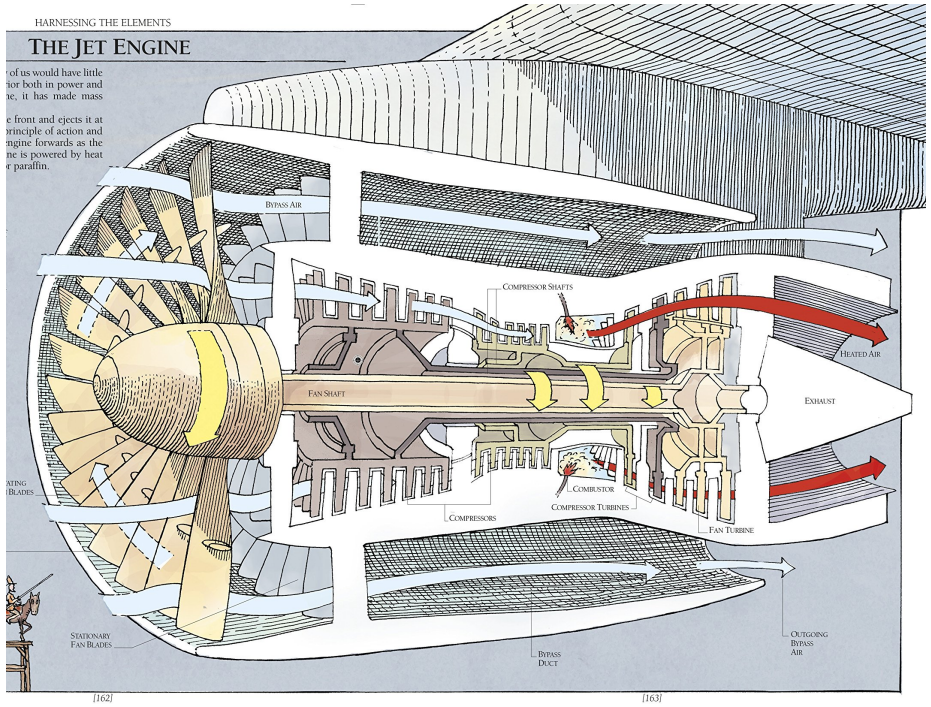
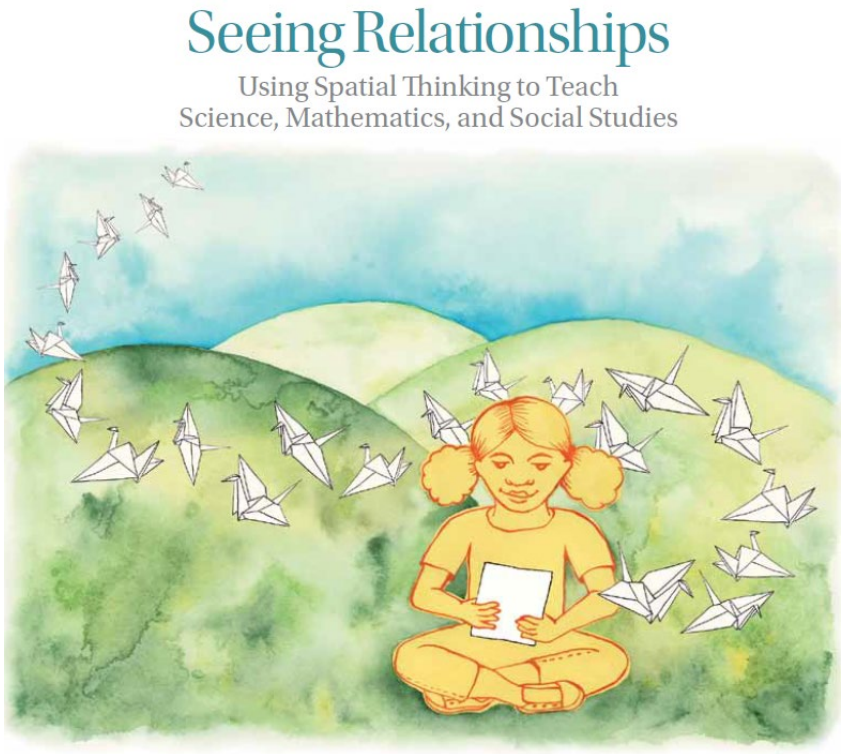
Paperback from $36.72
58 Used from $2.17
5 New from $49.99
3 Collectible from $13.63
4 Used from $36.72
1 New from $114.90



Recommendations from Nora Newcombe

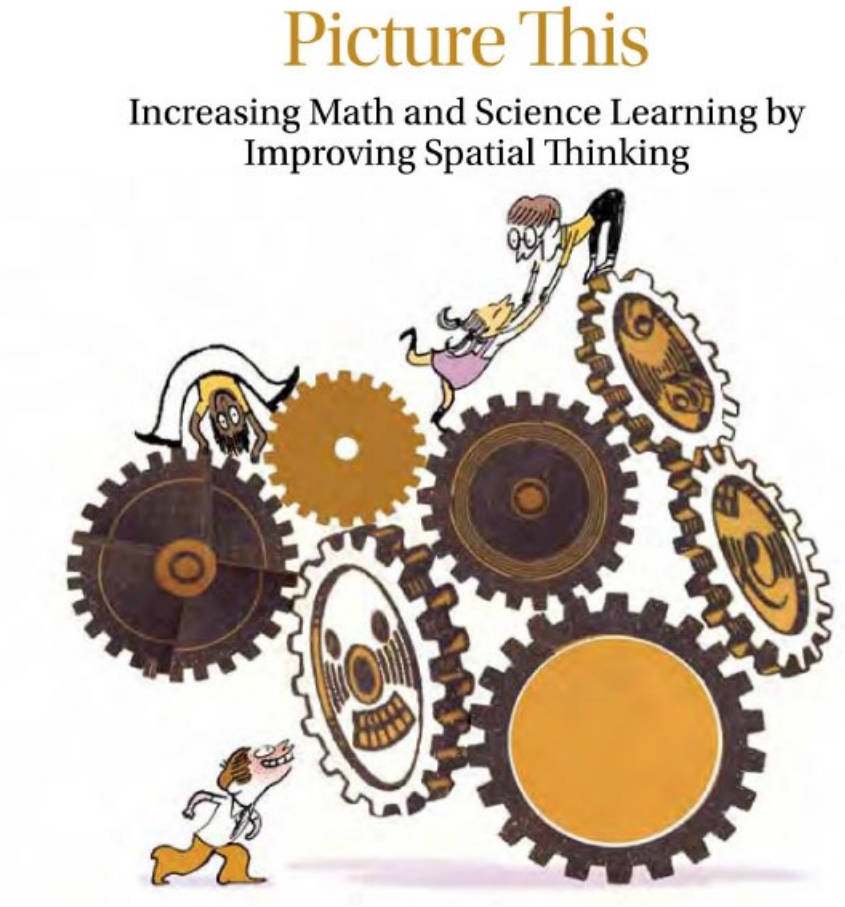


- 1. Teach students how to read (and create) diagrams
- 2. Encourage students to sketch
- 3. Use maps and tools from Geographic Information Systems
- 4. Support students in understanding very large and very small spaces and times
- 5. Teach/use terms related to spatial relationships
- 6. Emphasize that spatial thinking and sketching are SKILLS that are developed with practice

https://www.aft.org/periodical/american-educator/spring-2013/seeing-relationships

More from Newcombe

- “Add mapping skills, when possible, to geography lessons in the upper elementary grades
- “Use well-crafted analogies so that comparisons will highlight essential similarities and differences. For example, students can compare diagrams of animal and plant cells to see similarities and differences.
- “Ask children in upper elementary and middle school to make sketches to elaborate on their understanding of topics such as states of matter, or force and motion. For example, they can be asked to draw water molecules in the form of ice, liquid, or vapor.
- Suggest beneficial recreational activities, such as photography lessons (to develop a sense of shifting viewpoints and changes in scale), origami (to deepen their knowledge and skill in combining shapes) and JavaGami (software for creating polyhedra), and video games like Tetris.”



https://www.aft.org/sites/default/files/periodicals/Newcombe.pdf

Vocabulary

Concept:	Words		
Size or shape	Big Large Little Small Long Short Tall	Wide Narrow Thick Deep Shallow Size Length	Height Width Depth Volume Capacity Measure
Relative location vertically	Under Beneath Below Over Above	Up Down (On) top Bottom	High Low Column Vertical
Features of an object	Side Edge Border	Angle Line	Corner Point
Orientation in space	Horizontal Vertical Diagonal	Parallel Perpendicular	Axis Symmetry
Regularity or patterns in organization	Pattern Design Sequence	Next First Last	Order Before After

https://www.silc.northwestern.edu/spatial-language-coding-manual/

Study strategies

- Concept maps, organizers

Draw.io