My mind to your mind…

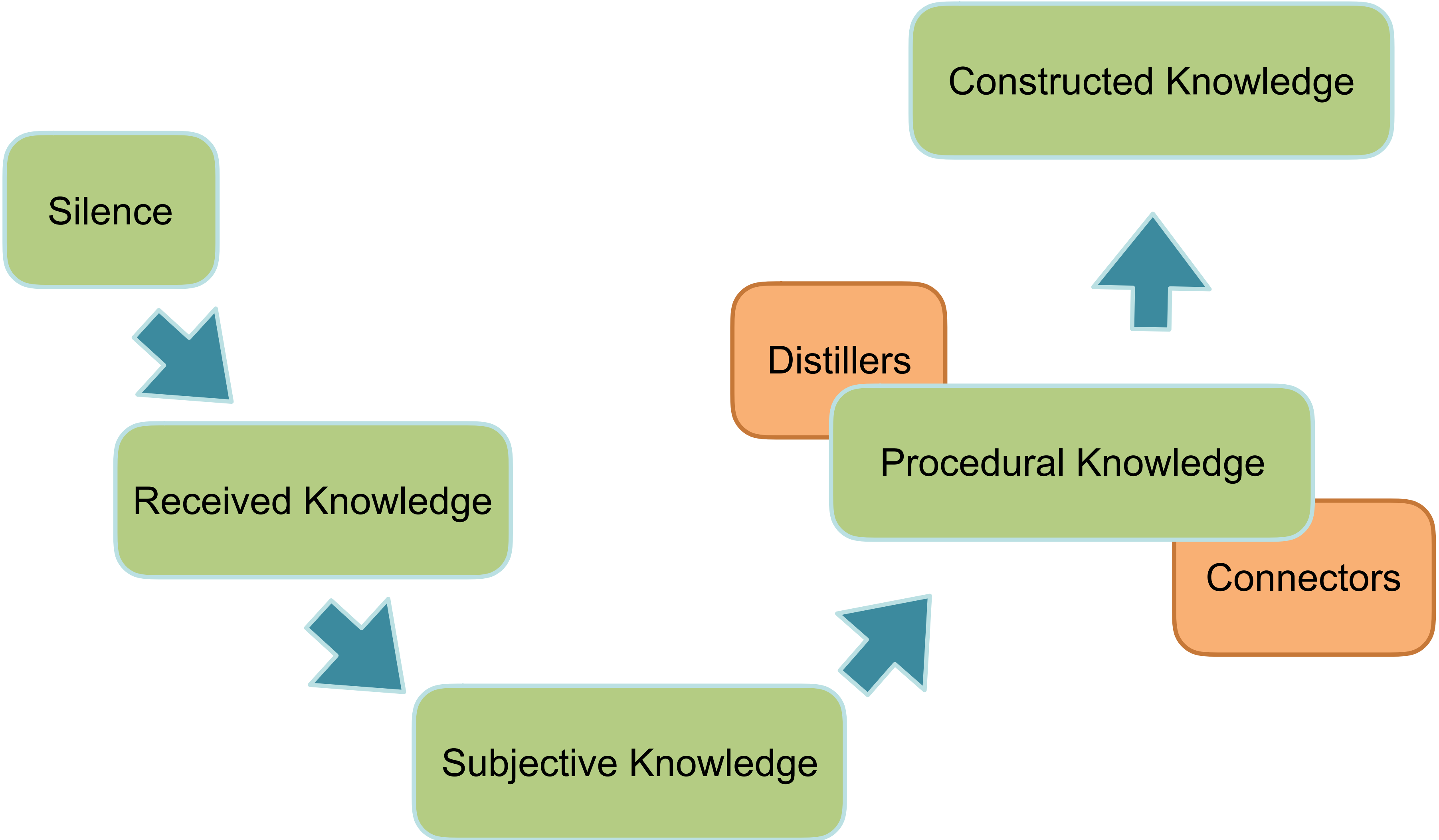
A quick guide to the minds of (many) college-aged students

Teach less so they know more.

What you love decides everything…
Pedro Arrupe SJ

Russell, I. J., Hendricson, W. D., & Herbert, R. J. Effects of lecture information density on medical student achievement. *Journal of Medical Education,* **59**, 881-889 (1984).

Bloom's Taxonomy



Women's Ways of Knowing: The Development of Self, Voice, and Mind (Belenky, Clinchy, Goldberger and Tarule 1986

How people learn

1. Students come with preconceptions. Engagement, understanding are key to developing sustained learning.
2. Competence requires:
   - deep foundation of factual knowledge,
   - a conceptual framework in which to place the facts;
   - organizational schema to allow facts to be retrieved on demand
3. Metacognition. Pull back the curtain, help students see the goals and know how to know what they know.

How People Learn: Brain, Mind, Experience, and School National Academies Press

Backwards design: Start from the student outcome

Traditional instruction
"content-oriented"

What will I teach?

↓

Plan lecture

↓

Give a test.
95% is an A.

Modern instruction
"learning-oriented"

What should students learn?

↓

How will I measure that learning?

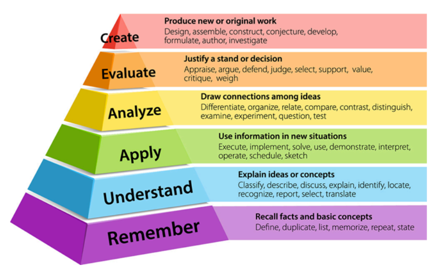
↓

What activities promote that learning?

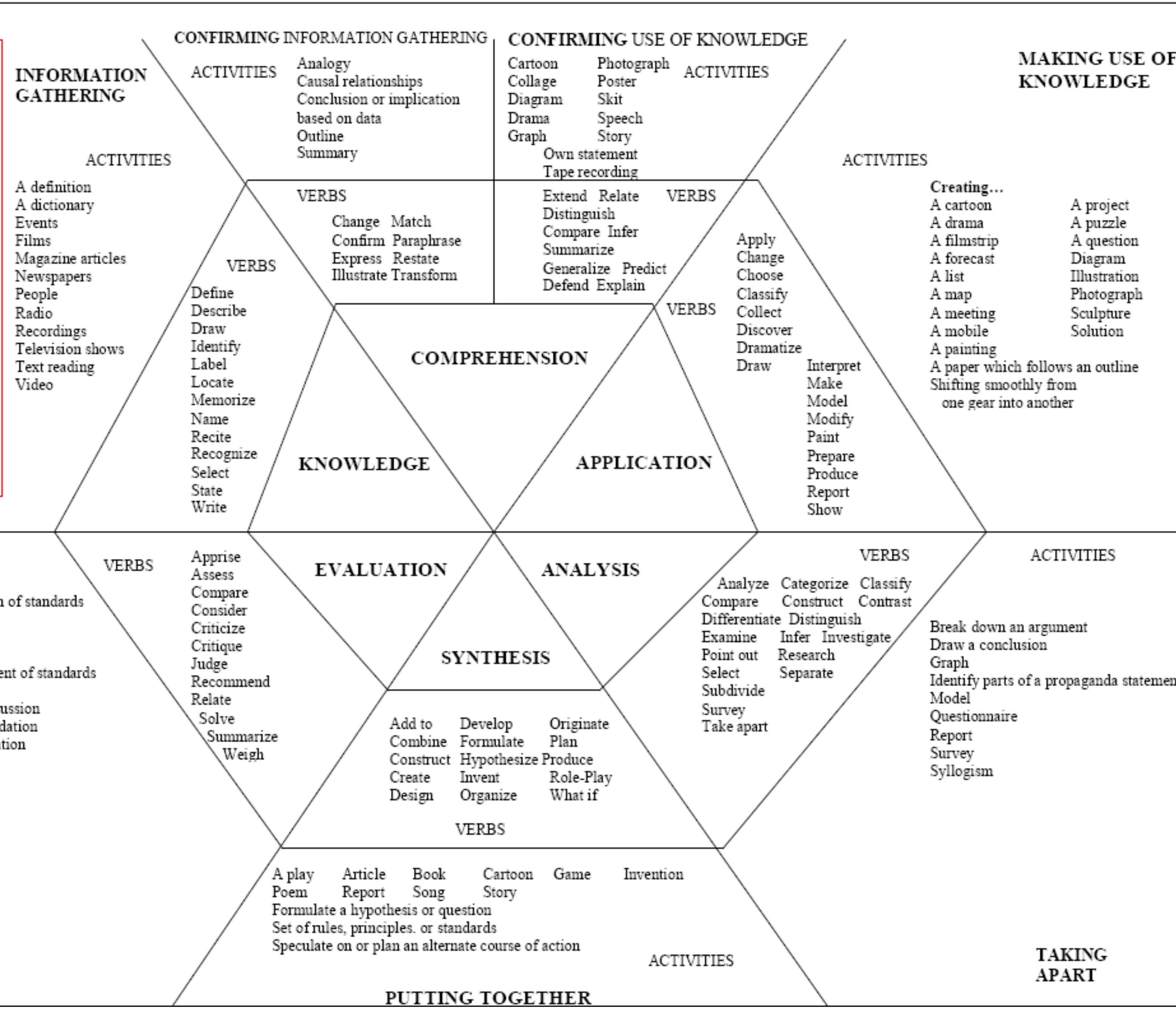
↓

Design instruction and activities

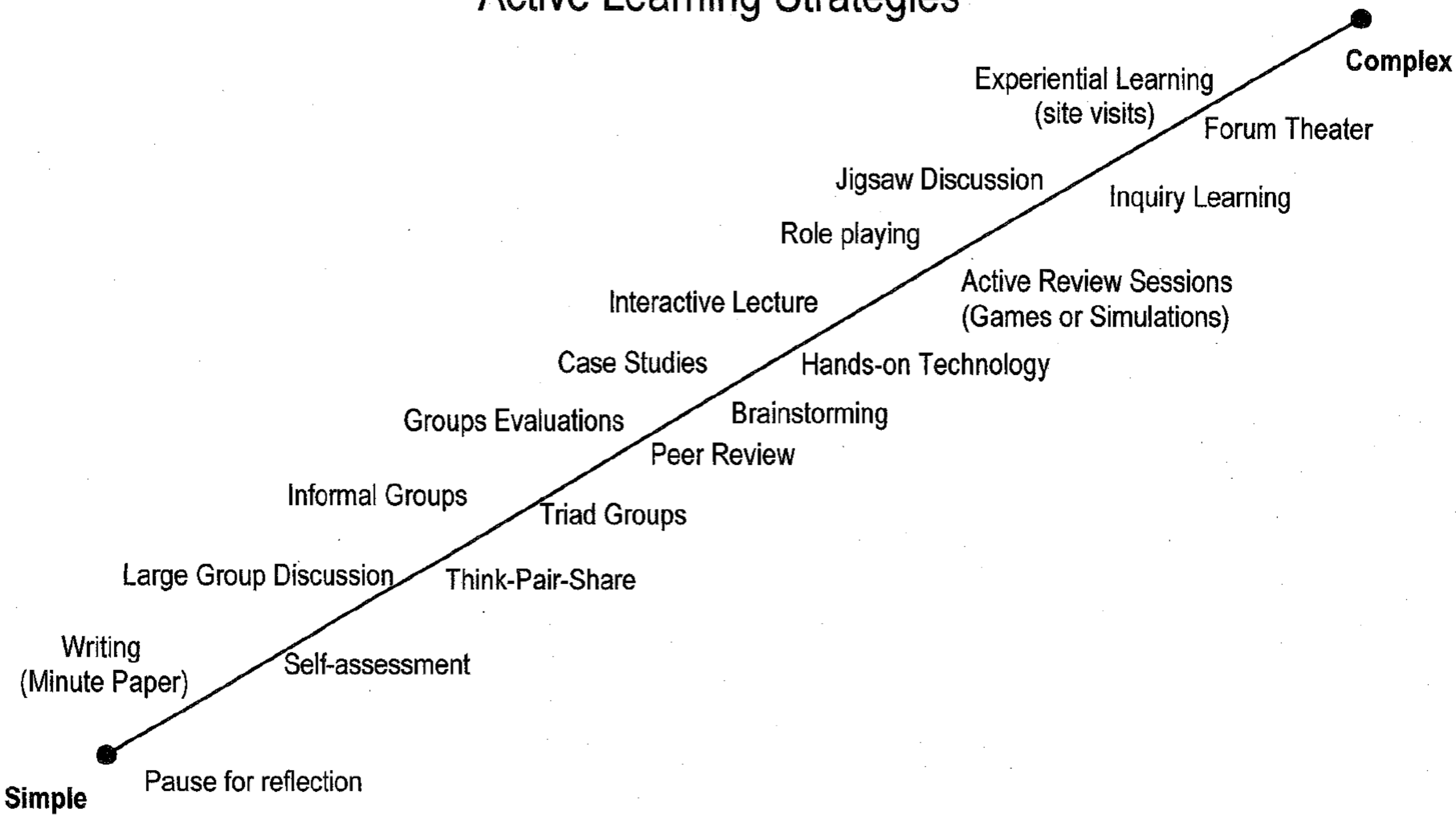
Mapping backward design onto learning taxonomies

Goals	*Create*: Outside the context of this course, students will be able to independently use their learning to…	
	What are the big ideas?	What are the essential questions?
	What content is key?	What skills will be developed?
What does success look like?	What will students do to demonstrate mastery? How will they know and how will I know what their level is? Focussed (homework, quizzes, self-assessments) Integrated (papers, projects, exams)	
What will happen in the classroom?		

Task-Oriented Question Construction Wheel Based on Bloom's Taxonomy



Active Learning Strategies



This is a spectrum of some active learning activities arranged by complexity and classroom time commitment.

Prepared by Chris O'Neal and Tershia Pinder-Grover, Center for Research on Learning and Teaching, University of Michigan

NFW: Learning Taxonomies

Goals	*Create*: Outside the context of this course, participants will be able to independently use their learning to backward design a student experience.	
	Learning is developmental	How can an understanding of students learning drive classroom design?
	Schemas for student learning Types of activities that support different stages	Connect schema to backward design for learning Select activities for different stages
What does success look like?	Faculty will develop a lesson element to take home. Faculty will feel confident in ability to use these schemes to develop as effective teachers and to support student learning. Self-assessment.	
What will happen in the classroom?	Show: some model taxonomies. Understand: Types of questions, where on the maps? Show: Template. Apply: Build an element.	

Example: Solubility rules

Goals

Outside the context of this course, students will be able to independently use their learning to decide whether something will dissolve in a particular solvent

- Molecular structure <-> Molecular function
- Opposites attract
- Proximity

How do we get molecules in contact with each other to react?

- types of IMF
- solvent, solute terminology
- dipoles
- recognize common ions & charges

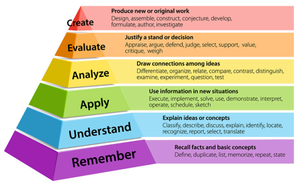
- Drawing Lewis structures.
- Estimating relative strength of Coulombic interactions

What does success look like?

Students can sidestep solubility rules, explain “like dissolves like” and use both to explain chemical phenomena.
Focussed: Homework problems, recitation worksheet
Integrated: Exam question on solvatochromism

What will happen in the classroom?

Watch ChemToddler video of metal ions solubility. Penicillin delivery. Define terminology. One problem, cartooned. Think/Pair/Share. Worksheet in groups.



TL;DR

1. Identify learning **objectives**.
2. What does success look like? Identify **outcomes**.
3. Design **intervention** based on learning models.

Resources

1. Material on Perry’s positions/Belenky’s modifications + practical science inflected advice from William Rapaport SUNY Buffalo. https://cse.buffalo.edu/~rapaport/perry.positions.html
2. *Women's Ways of Knowing: The Development of Self, Voice, and Mind* (Belenky, Clinchy, Goldberger and Tarule 1986
3. *How People Learn* https://www.nap.edu/catalog/9853/how-people-learn-brain-mind-experience-and-school-expanded-edition
4. *Don’t Work Harder Than Your Students*, Robyn R. Jackson
5. Colleagues, students, peers

Workshop: Modeling Benzene using the Particles in a Two-Dimensional Box

Physical Chemistry I
M. Francl

1. Benzene is an iconic molecule for organic chemists. The π molecular orbital diagram is well known. A mnemonic for the pattern of the pi energy levels is the Frost circle (see http://chemistry.umeche.maine.edu/CHY556/Frost.html, or the original paper: A. A. Frost [J. Chem. Phys., **1953**, *21*, 572]). Sketch the energy levels for benzene based on the Frost circle.

2. Now let's model the wave functions for the pi electrons in benzene assuming it is a square. Given that the CC bond length in benzene is 1.40 Å, what should the edge length of the square be? There are several ways to estimate this. It might be useful to recall that the distance from the center of a regular hexagon to the vertices is the same as the edge length. What simplifications are we making here?

3. Following the same logic we did for the particle in a 3-dimensional box, what is the wave function for a particle confined to a square two dimensional box?

4. Write an expression for the energy for the square box. How many independent quantum numbers are there?

5. Now, using the box size you choose above, compute the energies of the first 6 states of your benzene-sized box. Predict the HOMO-LUMO transition energy. What wavelength of light does this correspond to? Where does this fall in the spectrum?

6. Experimentally, the HOMO-LUMO transition in benzene falls at about 200 nm, how does this compare with your prediction? Would making the box bigger or smaller improve the agreement? Can you ustify changing the box size in this way? What might be a better model than a square box?

The Culture of Chemistry

Kathleen Lonsdale Dame Kathleen Lonsdale was an Irish crystallographer who showed that benzene had a regular hexagonal structure. She was the first woman to be elected to the Royal Society. Bryn Mawr trivia: Prof. Lonsdale was a good friend of Prof. Donnay's mother (Gai Donnay, another eminent woman crystallographer), and was godmother to Prof. Donnay's brother, Albert.

Map the exercise onto Bloom's taxonomy. Assess overall on scale of 1 (weakly maps onto the taxonomy) to 3 (strongly maps onto the taxonomy).

Bloom's taxonomy

Remember: recall facts

Understand: explain ideas or concepts

Apply: Use information in new situations

Analyze: Draw connections among ideas

Evaluate: Justify a stand or decision

Create: Produce new or original work