

# Writing and QR & Reverse Engineering a QR Course

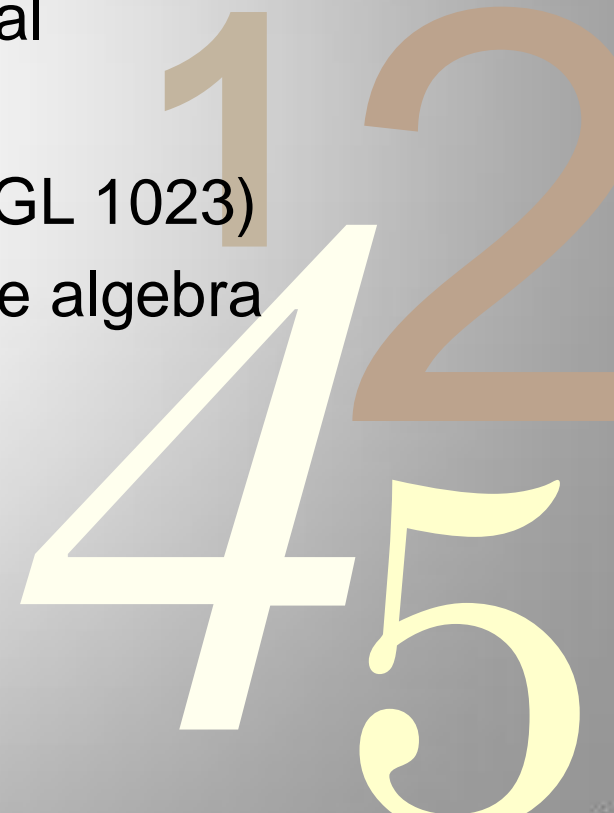
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# The Arkansas QR Course

- Began in 2004 as NewsMath
- Progressed through notes and 3 editions of *Casebook* – now taught to about 600 students/year
- Writing & critical reading always central
- Writing intensive sections
- Failed linking with Composition 2 (ENGL 1023)
- Now proposed as alternative to college algebra
  - Formal writing component
  - A bit more JIT algebra development
  - In State minimum core
  - Alternative to college algebra
  - Expect enrollment to double



**Interpretation** = Ability to glean and explain mathematical information presented in various forms (e.g. equations, graphs, diagrams, tables, words).

**Representation** = Ability to convert information from one mathematical form (e.g. equations, graphs, diagrams, tables, words) into another.

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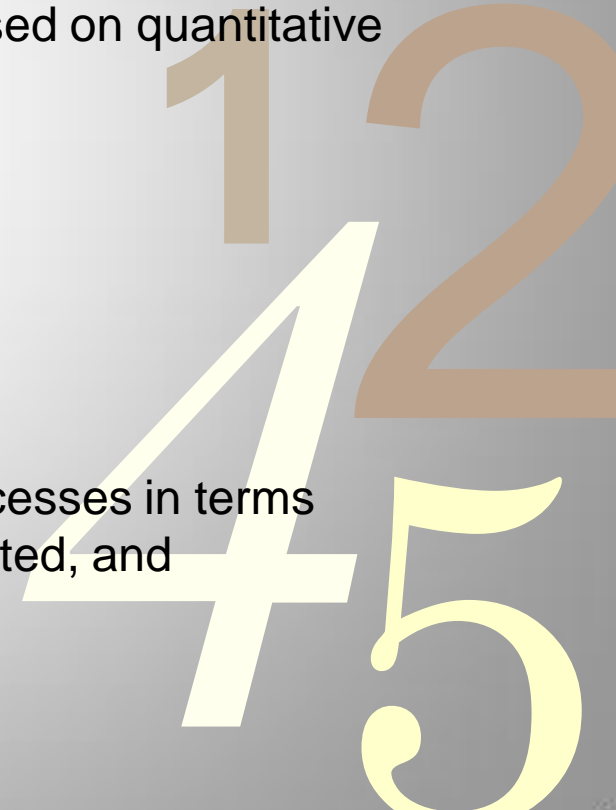
## Six QLAR Core Competencies

**Calculation** = Ability to perform arithmetical and mathematical calculations.

**Analysis/Synthesis** = Ability to make and draw conclusions based on quantitative analysis.

**Assumptions** = Ability to make and evaluate important assumptions in estimation, modeling, and data analysis.

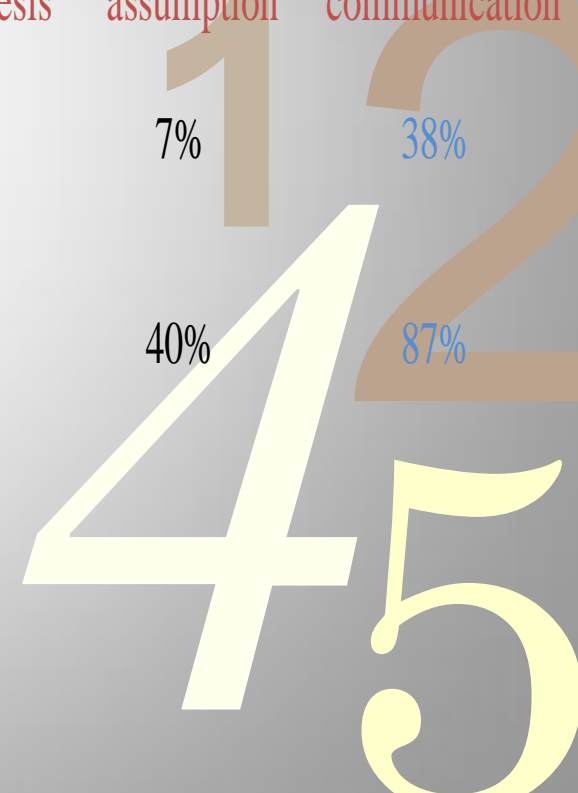
**Communication** = Ability to explain thoughts and processes in terms of what evidence is used, how it is organized, presented, and contextualized.



# Core Competencies and the QR Course Casebook

There are 268 study questions in the 30 case studies in the *Casebook*. Noting that most (1<sup>st</sup> and 2<sup>nd</sup> editions) of the *Casebook* was written before the QL core competencies were articulated, the fractions of the study questions that require each of the six competencies are given in the following table:

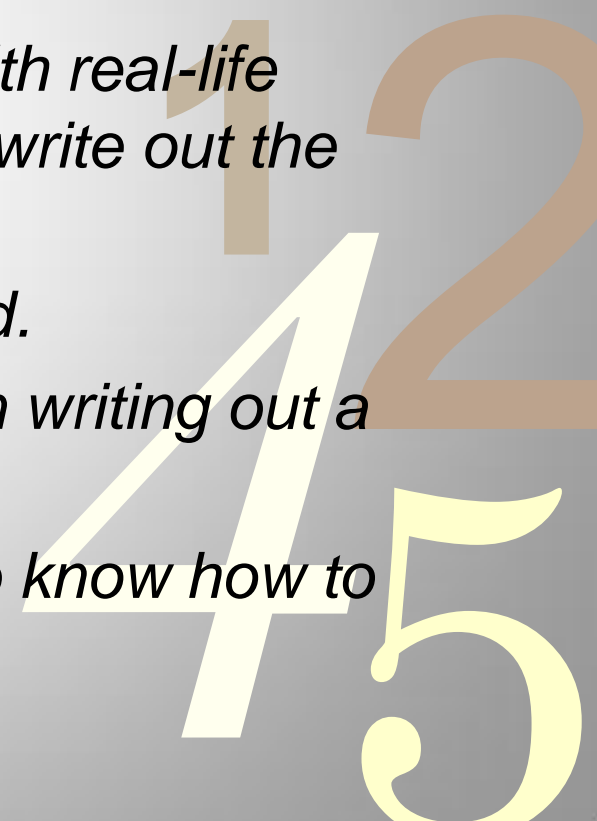
Competency	interpretation	representation	calculation	analysis/synthesis	assumption	communication
% study questions	67%	30%	48%	35%	7%	38%
% case studies	100%	73%	90%	90%	40%	87%



## **Student voices: Connections & Synergistic Learning**

- ... strengths in one subject can be utilized in another.
- ... students lose interest when they fail to see a connection between various subjects.
- ... it connects mathematical issues with real-life application, and it makes the student write out the argument.
- The two subjects are not really related.
- One does not need composition when writing out a mathematical equation.
- I was not good with numbers. But I do know how to write a paper.

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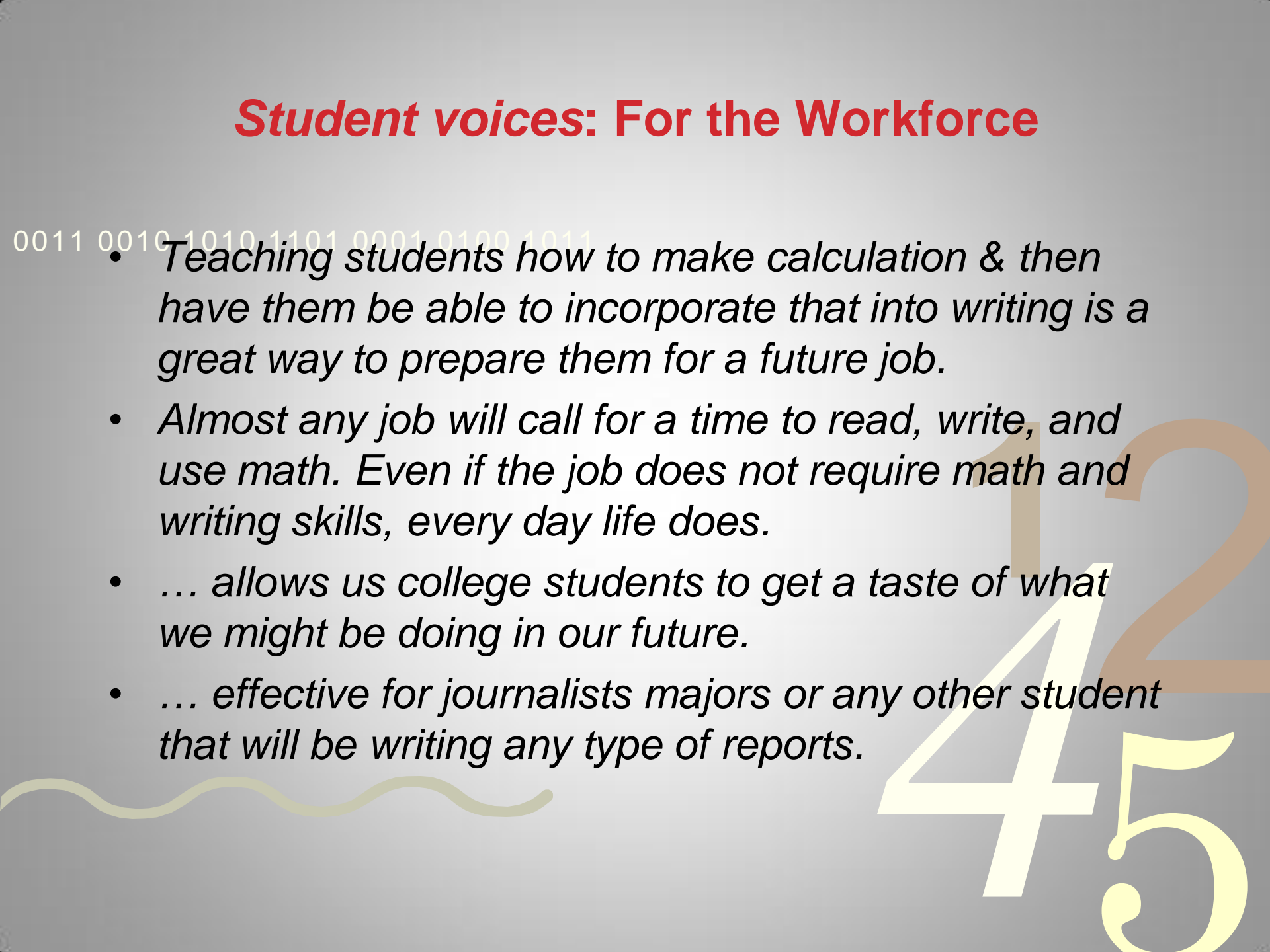
# *Student voices: Deepens Understanding*

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- *... forcing students to fully understand the math concepts discussed by having to write out and explain what the math concepts mean...*
- *When a student has to write and explain their math and to apply it to real world problems, it helps to better understand it.*
- *... requires the student to use two different parts of the brain in one class period.*



## ***Student voices: For the Workforce***

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- *Teaching students how to make calculation & then have them be able to incorporate that into writing is a great way to prepare them for a future job.*
  - *Almost any job will call for a time to read, write, and use math. Even if the job does not require math and writing skills, every day life does.*
  - *... allows us college students to get a taste of what we might be doing in our future.*
  - *... effective for journalists majors or any other student that will be writing any type of reports.*
- 

## ***Student voices: Two Subjects Is Too Much***

- *It is hard in the allotted time to provide equal instruction in math and in writing.*
- *It is very easy to get caught up in either making sure the math is correct or the writing is quality and forget to put enough attention on the other one.*
- *... even though this is a math class, doing poorly on the English part can hurt you grade.*
- *... this class put too much emphasis on the composition part...*
- *... not having enough time in a class period to learn both the math side and the English side.*
- *When I am doing math, the last thing I want to think about is putting it into a paper.*



## *Faculty voices: CITL Participants on Writing*

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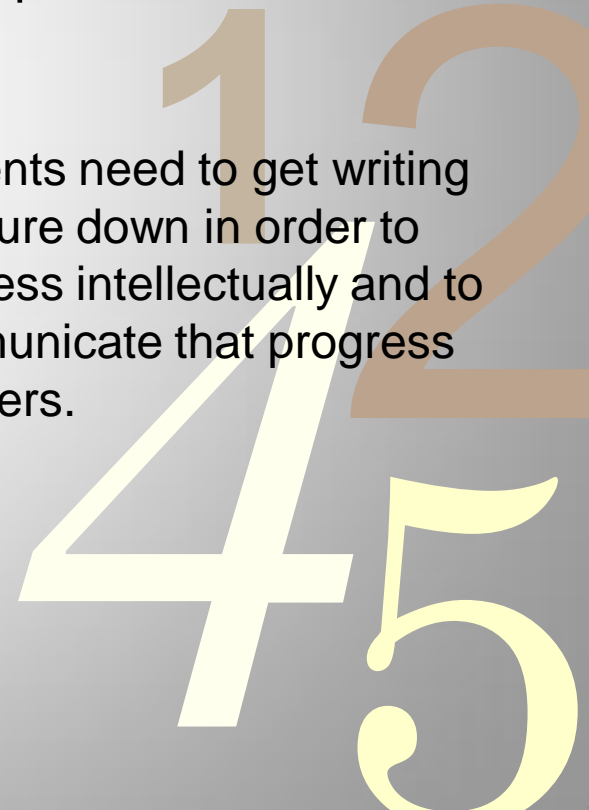
Writing manifests thinking.

Reflective writing can reveal how well students are integrating ideas from different sources or disciplines.

*Writing is nature's way of showing you how sloppy your thinking is.*

Richard Guidon,  
1989 *SF Chronicle*  
cartoon

Students need to get writing structure down in order to progress intellectually and to communicate that progress to others.



No widely accepted  
content

Difficulty in measuring long-  
term retention and transfer  
of learning

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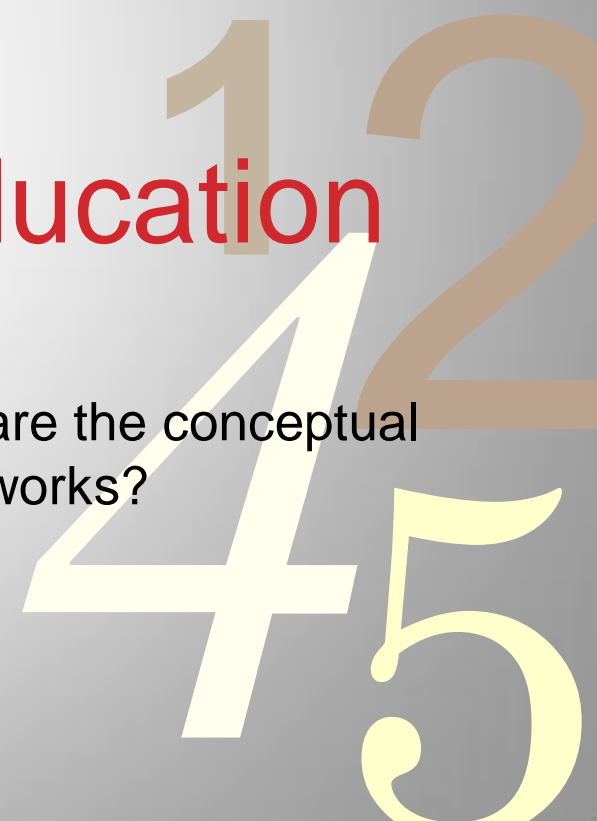
No academic home – none in K-12 and none in 13-16

# Plight of QR education

What to abstract  
and generalize?

What are the conceptual  
frameworks?

Interdisciplinarity



**Conceptual understanding** =  
Comprehension of  
mathematical concepts,  
operations and relations.

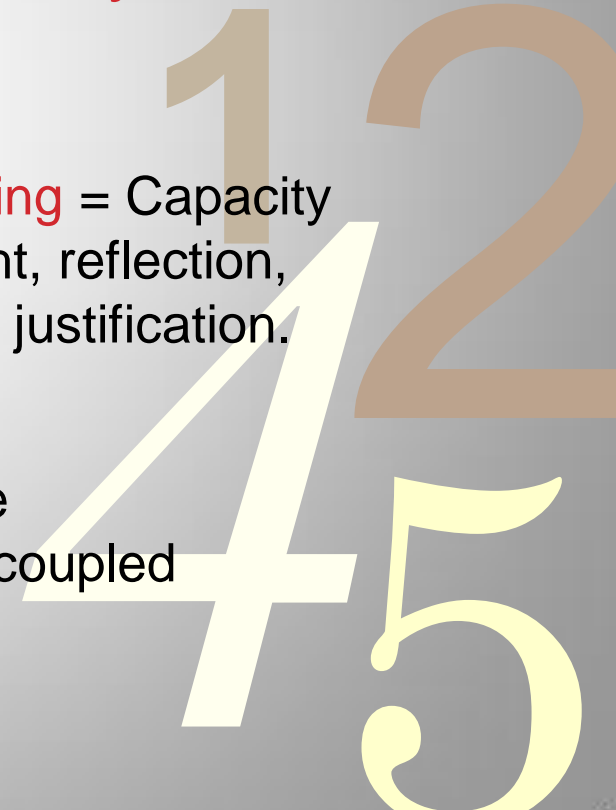
**Procedural fluency** = Skill in  
carrying out procedures  
flexibly, accurately, efficiently,  
and appropriately.

**Strategic competence** =  
Ability to formulate,  
represent, and solve  
mathematical problems.

## Five Strands of Mathematical Proficiency

**Adaptive reasoning** = Capacity  
for logical thought, reflection,  
explanation, and justification.

**Productive disposition** = Habitual inclination to see  
mathematics as sensible, useful, and worthwhile, coupled  
with a belief in diligence in one's own efficacy.



# Eight CCSSM Mathematical Practice Standards

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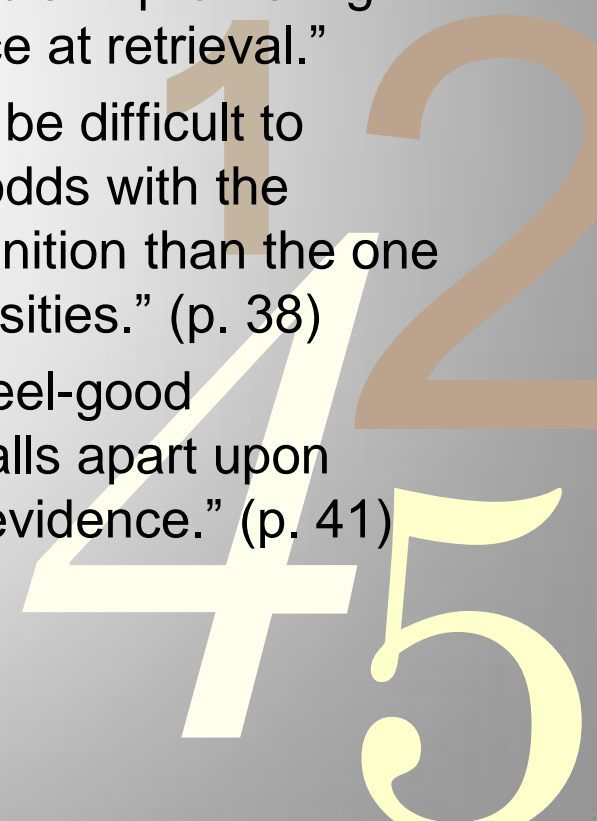
1. **Make sense of problems and persevere in solving them**
2. **Reason abstractly and quantitatively**
3. **Construct viable arguments and critique the reasoning of others**
4. **Model with mathematics**
5. **Use appropriate tools strategically**
6. **Attend to precision**
7. **Look for and make use of structure**
8. **Look for and express regularity in repeated reasoning**



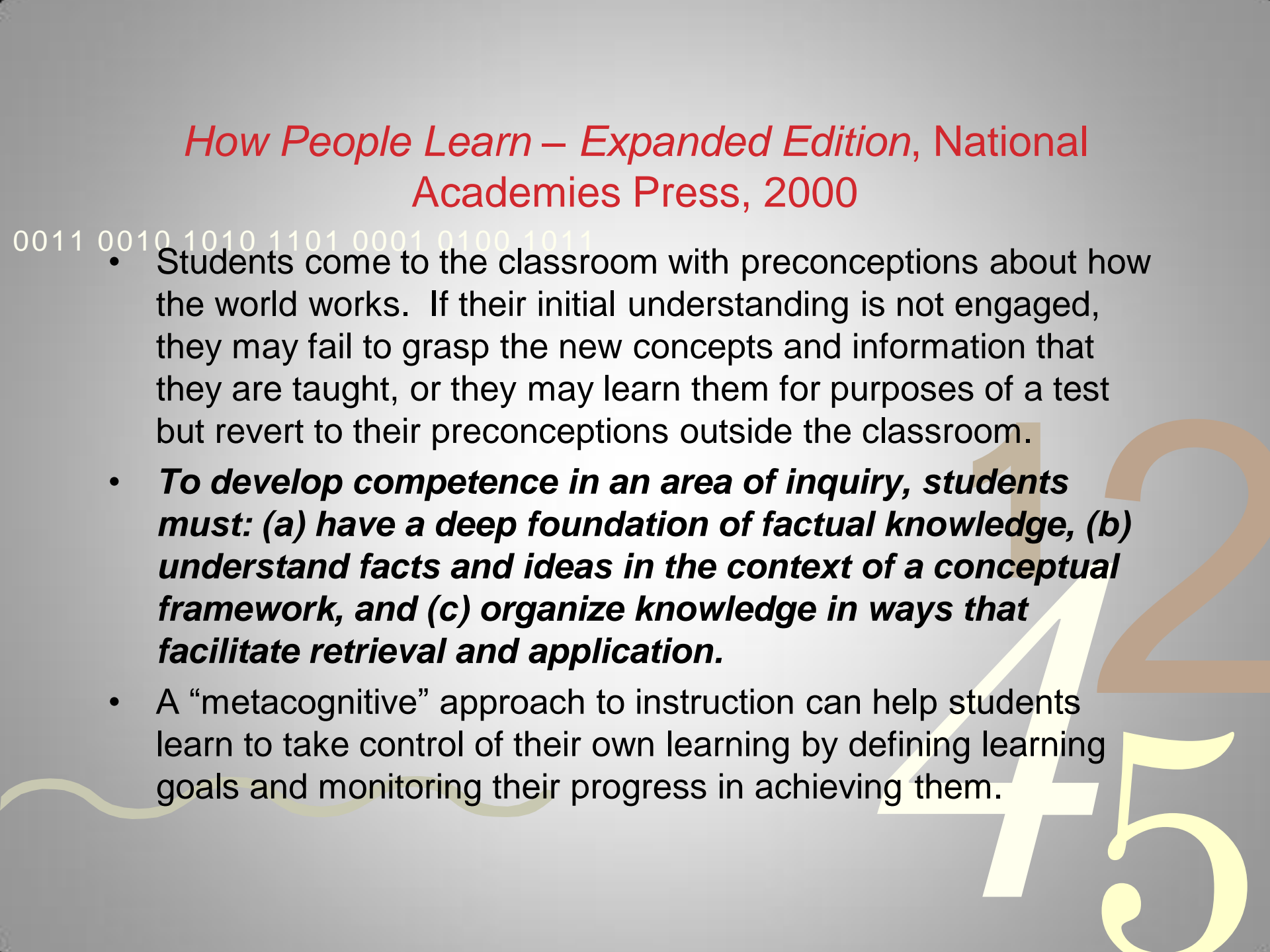
## Diane Halpern & Milton Hakel – Applying the Science of Learning to the University and Beyond – *Change*, 2003

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- Ten basic principles for enhancing long-term retention and transfer of learning (pp. 38-41)
  - Example: The single most important variable in promoting long-term retention and transfer is “practice at retrieval.”
- “But, ironically (and embarrassingly), it would be difficult to design an educational model that is more at odds with the findings of current research about human cognition than the one being used today at most colleges and universities.” (p. 38)
- “There is a large amount of well-intentioned feel-good psychobabble about teaching out there that falls apart upon investigation of the validity of the supporting evidence.” (p. 41)



## *How People Learn – Expanded Edition, National Academies Press, 2000*

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- Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information that they are taught, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom.
  - ***To develop competence in an area of inquiry, students must: (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application.***
  - A “metacognitive” approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them.
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## Edward Burger & Mike Starbird – *The 5 Elements of Effective Thinking*, Princeton University Press 2012

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- **Earth** – Understand deeply. Don't face complex issues head-on; first understand simple ideas deeply. Clear the clutter and expose what is really important.
- **Fire** – Ignite insights by making mistakes. Fail to succeed. Intentionally get it wrong to inevitably get it more right. Mistakes are great teachers – they highlight unforeseen opportunities and holes in your thinking.
- **Air** – Raise questions. Constantly create questions to clarify and extend your understanding. What's the real question? Working on the wrong question can waste a lifetime. Be your own Socrates.
- **Water** – Follow the flow of ideas. Look back to see where ideas came from and then look ahead to see where the ideas may lead. A new idea is a beginning, not an end.

## Design Principles for Arkansas QR Course

- 1.10 *Provide a venue for continued practice beyond the course (and beyond school).*
2. *Keep the material relevant to students' everyday contemporary world.*
3. *Use multiple contexts to practice quantitative reasoning.*
4. *Promote appreciation of arithmetical precision and the power of mathematical concepts and processes.*
5. *Help students to structure their quantitative reasoning in resolving problematic situations, including ample doses of critical reading and writing.*



## Design Principles for Arkansas QR Course - Continued

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6. *Encourage on the fly calculations and estimations.*
7. *Increase students' supplies of quantitative benchmarks.*
8. *Encourage students to use technology to enhance and expedite understanding.*
9. *Allow student interests to emerge.*
10. *Provide interactive classroom environment.*



## Two Unsolved Problems in Arkansas QR Course

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- *What contextual examples should be generalized and abstracted?* The power of mathematics is in abstraction and generalization, and students should not only see this power when it is needed but should combine results of contextual examples with abstractions to increase the long-term retrieval and transfer (Halpern and Hakel, 2003; and Bransford, Brown and Cocking, 2000).
- One of the research findings (Bransford, Brown, and Cocking, 2000, p. 16) about developing competence in an area of inquiry is to “understand facts and ideas in the context of a conceptual framework.” *What are the conceptual frameworks for our QR course, or, more generally, for QR?*