Using Problem-Based Learning to Foster Discipline-Specific Habits of Mind

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Outline of Presentation

1. Habits of Mind
2. Problem-Based Learning
3. An Example
4. Open Discussion

What are Habits of Mind?

"They are the characteristics of what intelligent people do when they are confronted with problems, the resolutions to which are not immediately apparent."

(Costa, 2000, p. 21)

"They are productive patterns of intellectual behaviors"

What are the Attributes of Habits of Mind?

Value: Choosing to employ a pattern of intellectual behaviors rather than other, less productive patterns.

Inclination: Feeling the tendency to employ a pattern of intellectual behaviors.

Sensitivity: Perceiving opportunities for, and appropriateness of, employing the pattern of behaviors.

Capability: Possessing the basic skills and capacities to carry through with the behaviors.

Commitment: Constantly striving to reflect on and improve performance of the pattern of intellectual behaviors.

(Costa, 2000, p. 9)

Two Broad Categories of Habits of Mind

1. General Habits of Mind
2. Discipline-specific Habits of Mind

1. Habits of Mind

Costa's (2000) 16 Habits of Mind

1. Persisting
2. Managing impulsivity
3. Listening with understanding and empathy
4. Thinking flexibly
5. Thinking about thinking (metacognition)
6. Striving for accuracy
7. Questioning and posing problems
8. Applying past knowledge to new situations
9. Thinking and communicating with clarity and precision
10. Gathering data through all senses
11. Creating, imagining, innovating
12. Responding with wonderment and awe
13. Taking responsible risks
14. Finding humor
15. Thinking interdependently
16. Remaining open to continuous learning

Discipline-Specific Habits of Mind (e.g. Math)

Habits of Mathematicians (Seaman & Szydlik, 2007, p. 170-171)

- Seek to understand patterns based on underlying structure
- Make analogies by finding the same essential structure in seemingly different mathematical objects
- Make and test conjectures about mathematical objects and structures
- Create mental (and physical) models for examples (and non-examples) of math objects

Mathematical Habits of Mind

Cuoco, Goldenberg and Mark (1996)

- *An organizing principle for math curricula in which students think about math the way mathematicians do*
- *General habits of mind in math*
  - Pattern sniffers
  - Experimenters
  - Describers
  - Thinkerers
  - Inventors
  - Visualizers
  - Conjecturers
  - Guessers
- *Math-specific habits of mind*
  - Talk big and think small
  - Talk small and think big
  - Use functions
  - Use multiple points of view
  - Algebraic approaches to things
  - Geometric approaches to things

Mathematical Habits of Mind

Algebraic Ways of Thinking

- Doing-undoing
  - Working the steps of a rule or procedure backward
  - Finding input from output, or initial conditions from a solution
- Building rules to represent functions
  - Organizing info to uncover patterns
  - Noticing a rule at work
  - Describing the steps of a rule without using specific inputs
  - Justifying why a rule works for “any number”
- Abstracting from computations
  - Looking for shortcuts in computation
  - Thinking about calculations independently of the particular numbers used
  - Expressing generalizations about operations symbolically

(Driscoll, 1999)

What is Problem-Based Learning?

Problem-based learning is a teaching method that "consists of carefully designed problems that challenge students to use problem solving techniques, self-directed learning strategies, team participation skills, and disciplinary knowledge"

(Center for Research in Teaching and Learning)

One Way to Use Problem-Based Learning

- Teacher poses a meaningful problem
- Students work individually
- Students discuss in small group
- Students present solutions
- Teacher orchestrates whole-class discussion, and highlights key concepts and useful habits of mind

The
“5 4 3 2 1 and I Know Your Number”
Magic

5 4 3 2 1 and I Know Your Number

Think of a Secret Number

(make it difficult for me to guess)

(choose wisely because you will need to do math with it)

Write your number somewhere and don't tell anyone!

You may get a piece of paper to do the math, or you may do the math mentally.

Are you Ready ?

5 4 3 2 1 and I Know Your Number

Think of a Secret Number

(make it difficult for me to guess)

(choose wisely because you will need to do math with it)

- Increase Your Number by 5
- Multiply Your Sum by 4
- Minus Your Product by 3
- Divide Your Answer by 2
- Add 1 to Your Quotient

Wait

- Add ½ More

It's Time to "Show Off"

5 4 3 2 1 and I Know Your Number

Think of a Secret Number

(make it difficult for me to guess)

(choose wisely because you will need to do math with it)

- Increase Your Number by 5
- Multiply Your Sum by 4
- Minus Your Product by 3
- Divide Your Answer by 2
- Add 1 to Your Quotient
    - Add ½ More

What's My Secret?

5 4 3 2 1 and I Know Your Number

Think of a Secret Number
(make it difficult for me to guess)
(choose wisely because you will need to do math with it)

- Increase Your Number by 5
- Multiply Your Sum by 4
- Minus Your Product by 3
- Divide Your Answer by 2
- Add 1 to Your Quotient
  - Add ½ More

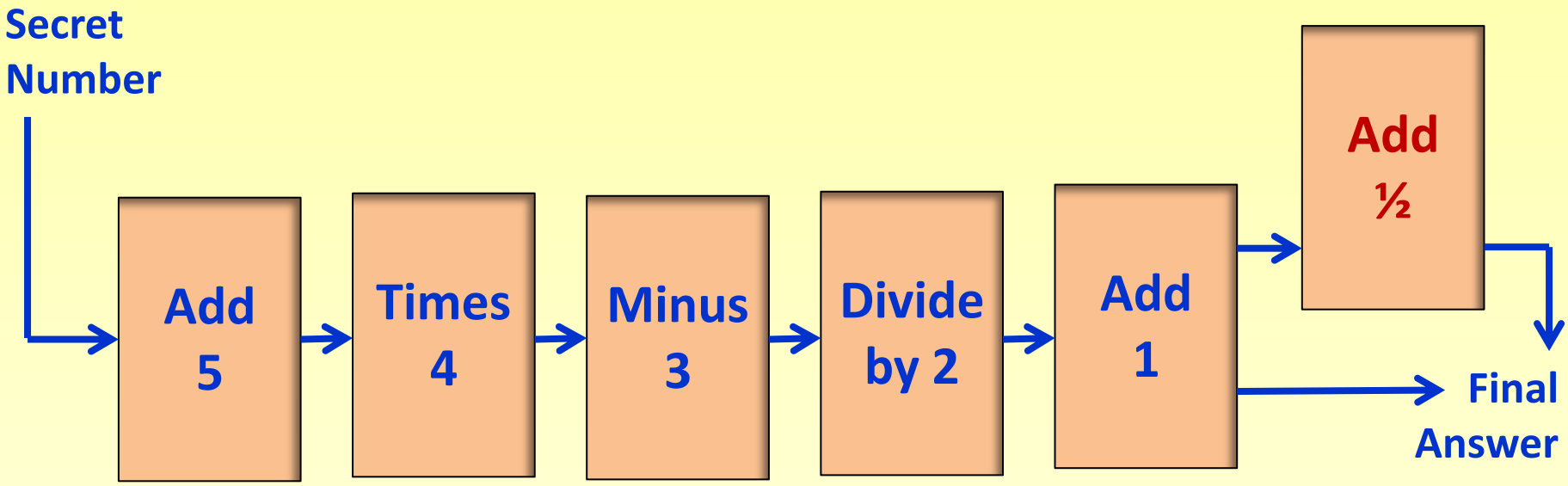
1. Subtract 10
2. Half it

Can you figure out why this "magic" works all the time?

3. An Example

What mathematical habits of mind are fostered?

- Working the steps of a rule or procedure backward
- Justifying why a rule works for "any number"
- Using functions
- Using pictorial representations



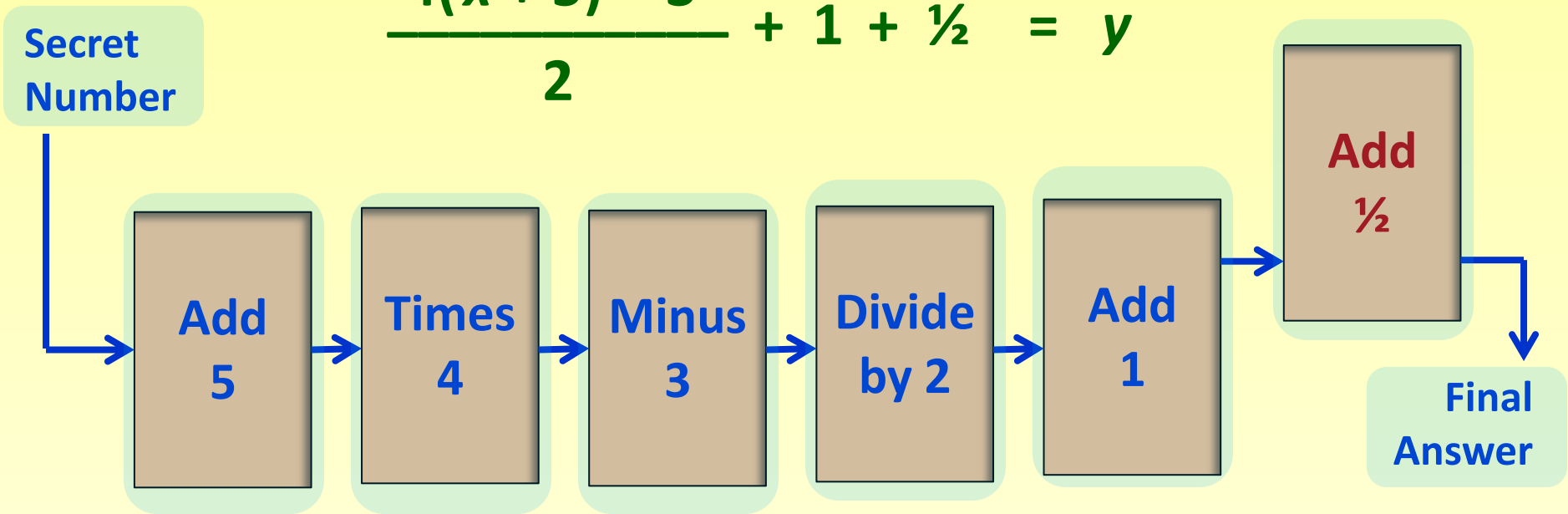
Can you figure out why this "magic" works all the time?

3. An Example

What math concepts are involved here?

- Function as an input-output process
- Using symbols to represent the process

$$\frac{4(x+5)-3}{2} + 1 + \tfrac{1}{2} = y$$

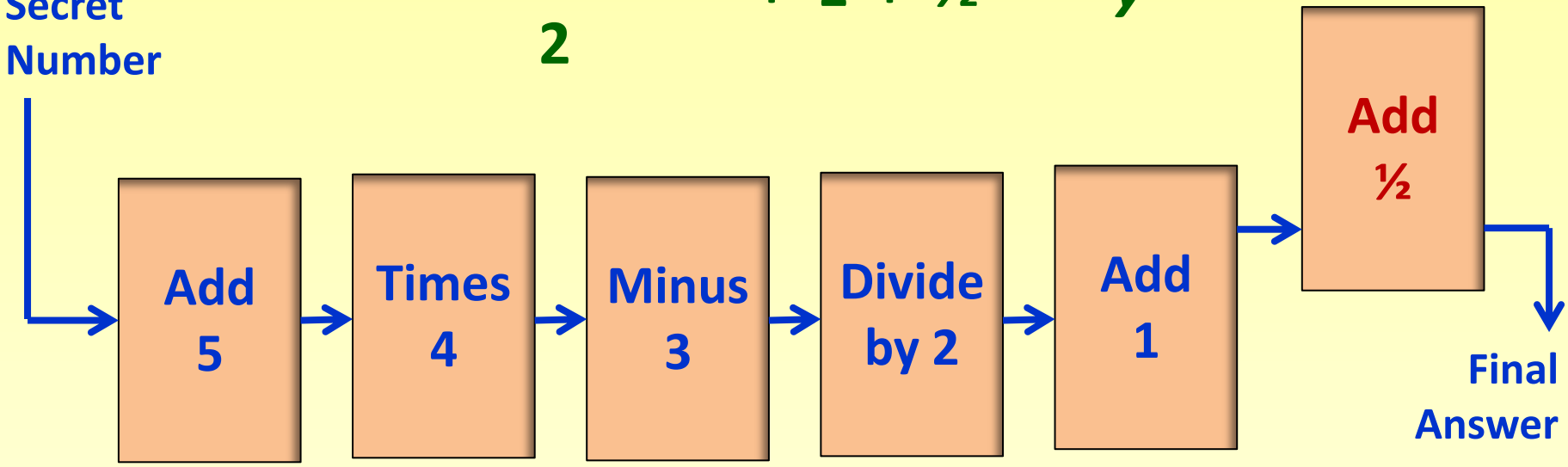


3. An Example

What math concepts are involved here?

- Function as an input-output process
- Using symbols to represent the process
- Simplifying expressions

$$\frac{4(x+5)-3}{2} + 1 + \tfrac{1}{2} = y$$

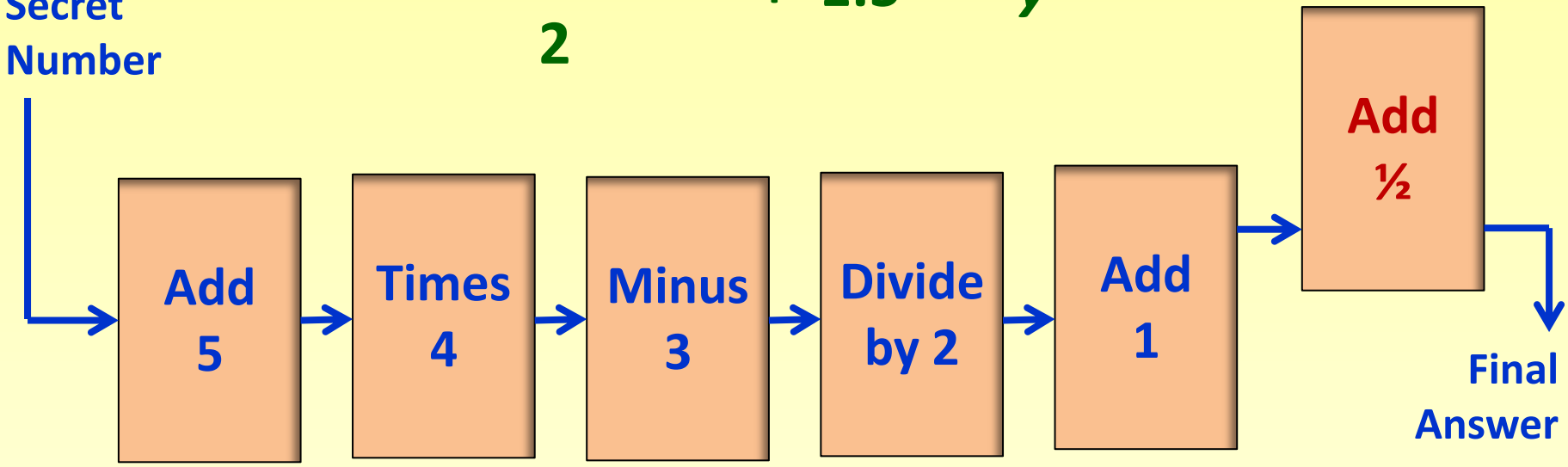


3. An Example

What math concepts are involved here?

- Function as an input-output process
- Using symbols to represent the process
- Simplifying expressions

$$\frac{4x + 20 - 3}{2} + 1.5 = y$$

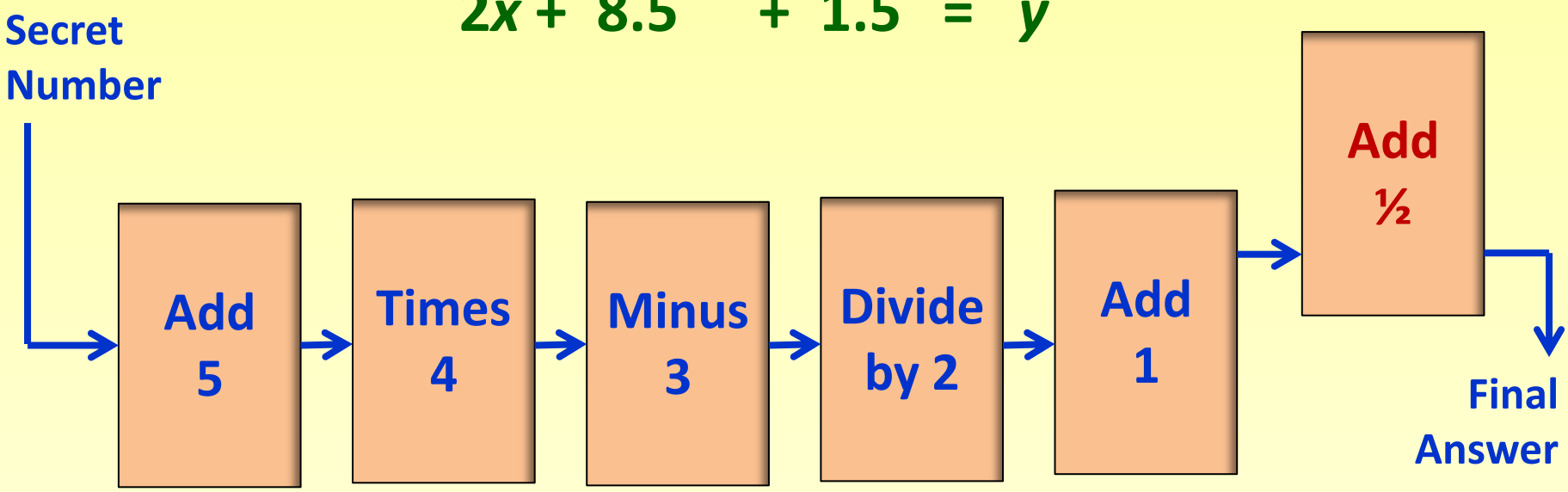


3. An Example

What math concepts are involved here?

- Function as an input-output process
- Using symbols to represent the process
- Simplifying expressions

$$2x + 8.5 + 1.5 = y$$

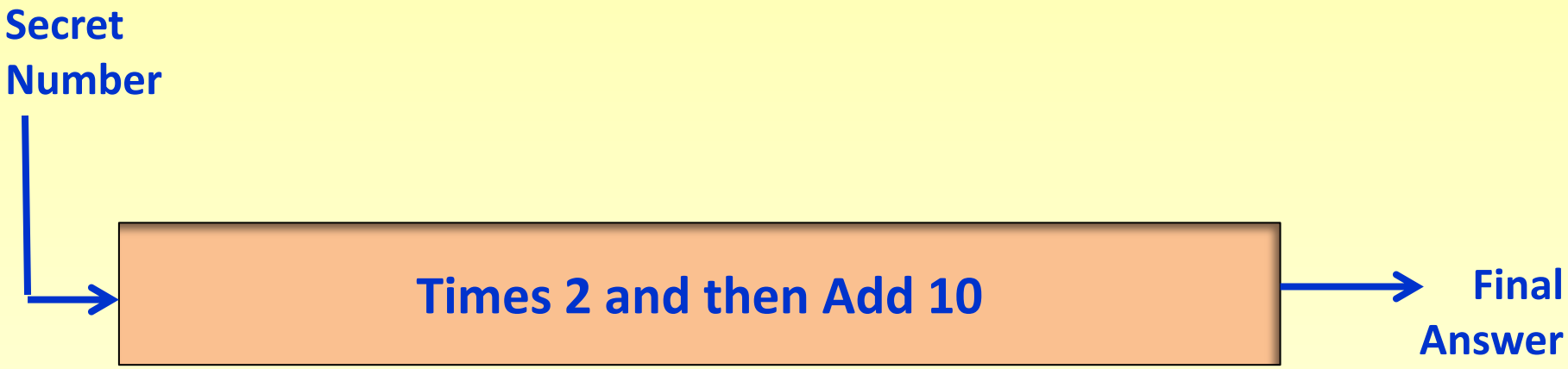


3. An Example

What math concepts are involved here?

- Function as an input-output process
- Using symbols to represent the process
- Simplifying expressions

$$2x + 10 = y$$

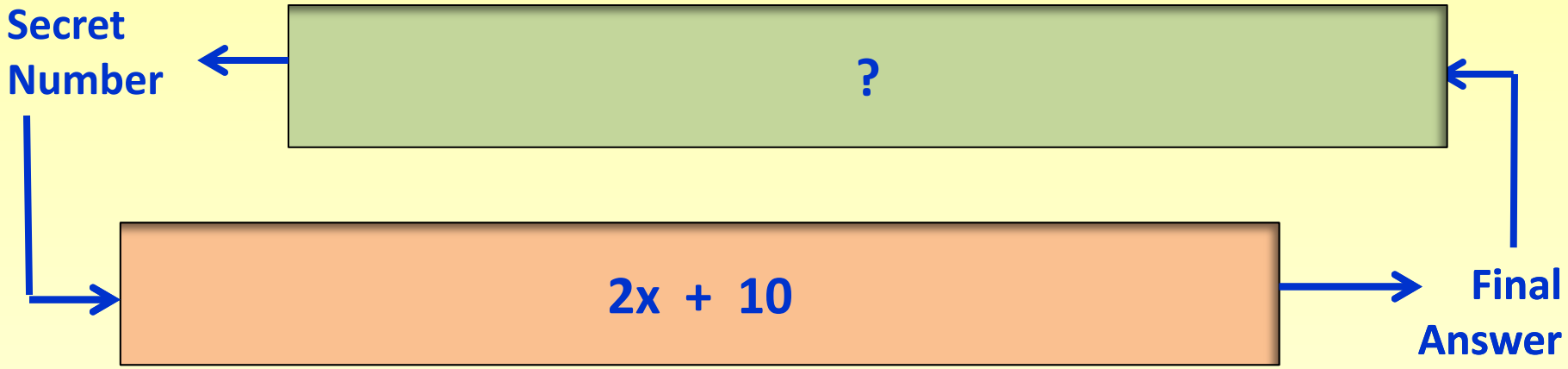


3. An Example

What math concepts are involved here?

- Function as an input-output process
- Using symbols to represent the process
- Simplifying expressions
- Inverse function as an undoing process

$$2x + 10 = y$$

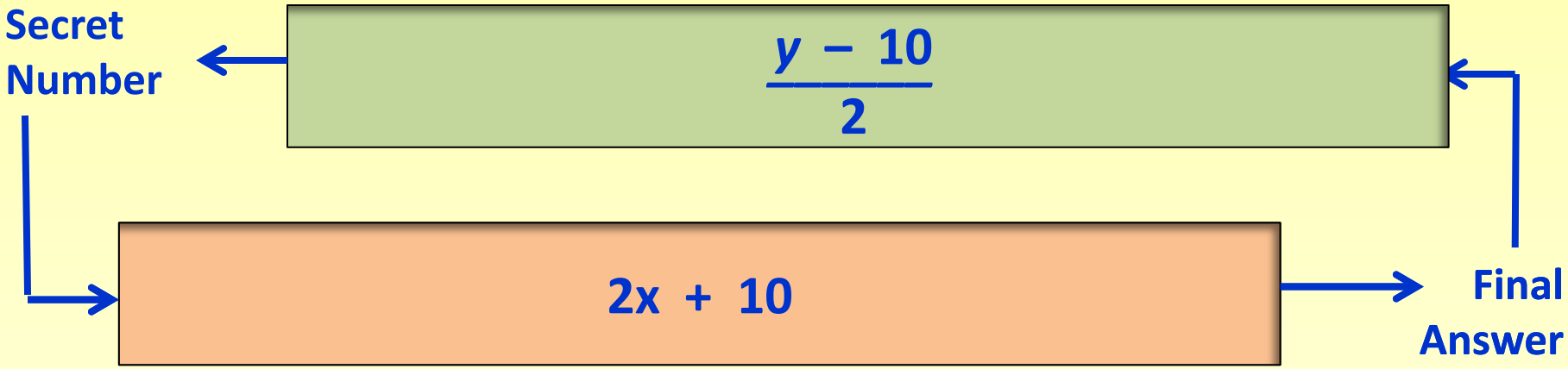


3. An Example

What math concepts are involved here?

- Function as an input-output process
- Using symbols to represent the process
- Simplifying expressions
- Inverse function as an undoing process

$$2x = y - 10$$



3. An Example

What mathematical habits of mind are fostered?

- Working the steps of a rule or procedure backward
- Justifying why a rule works for “any number”
- Using functions
- Using pictorial representations
- Making connections
- Seeking efficiency

4. Open Discussions

4. Resources

Websites

- The Institute for Habits of Mind

  http://www.instituteforhabitsofmind.com/

  Its Mission:

  To transform schools into learning communities where thinking and Habits of Mind are taught, practiced, valued and infused into the culture.

- EDC's Habits of Mind Problems

  http://www2.edc.org/MathProblems/searchHabit.asp

- Mathematical Habits of Mind: A Network for Educators

  http://habitsofmind.ning.com/

Thank You