Using Learning Maps to Reimagine Instruction and Redefine Assessment

Angela Broaddus
Benedictine College
Lindsey Weiland
Nicki Lindner
University of Kansas

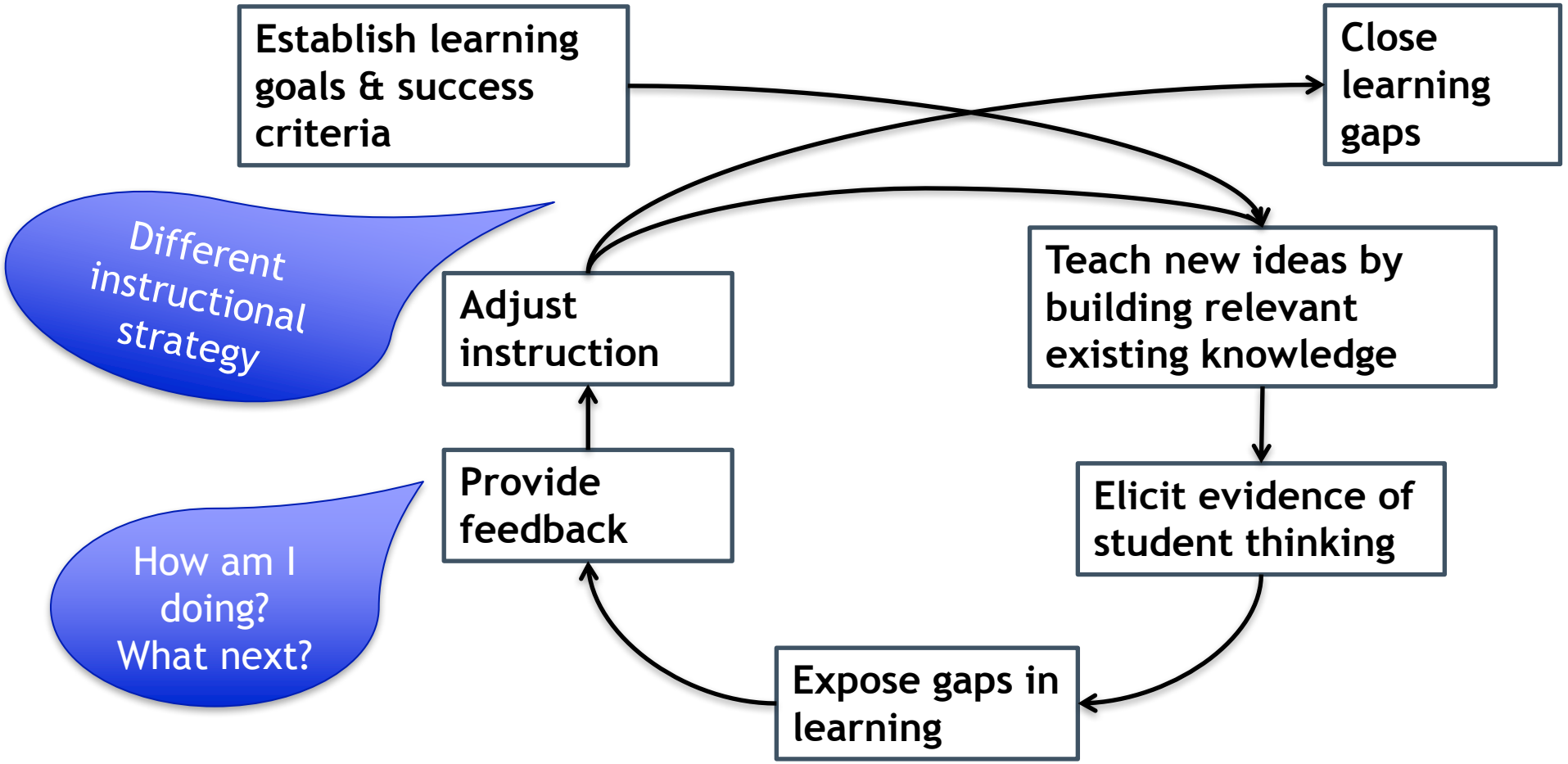
Agenda

- Our perspective on formative assessment
- Organized learning models
- Informed instruction
- Background on learning to understand functions
- Activity

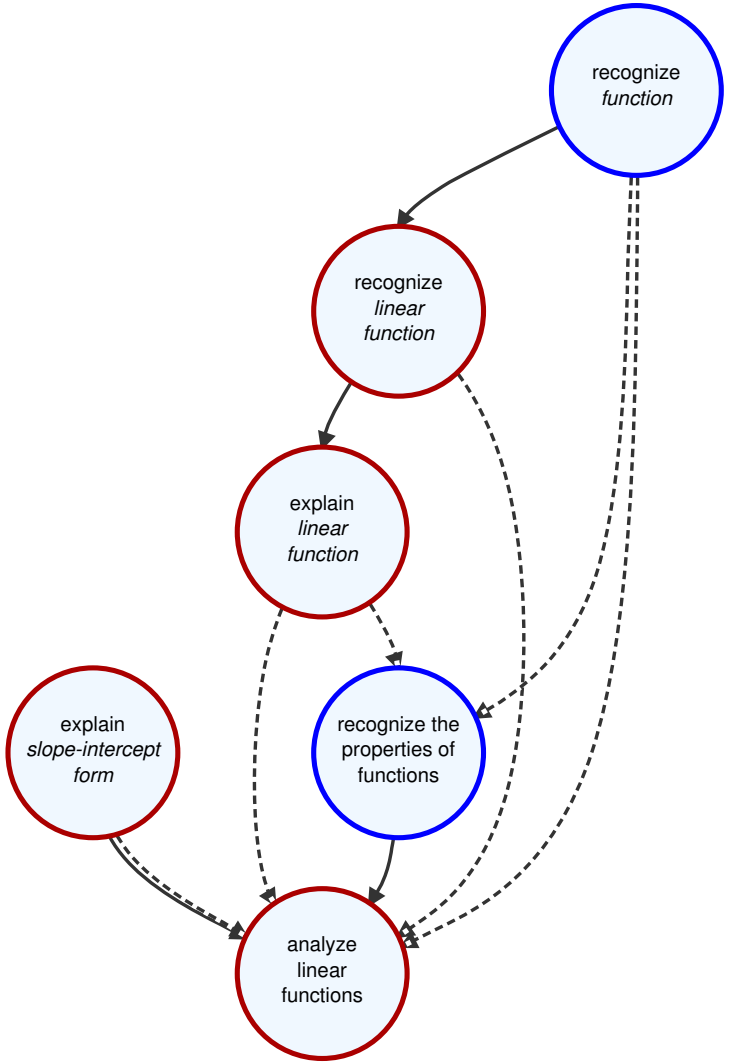
Formative Assessment

- A process, NOT a test
- Aims to reveal student thinking
- Occurs within instruction, moment-to-moment
- Continuous, iterative
- Informs instructional decisions

Formative Assessment – A Process



Adapted from Heritage, 2010

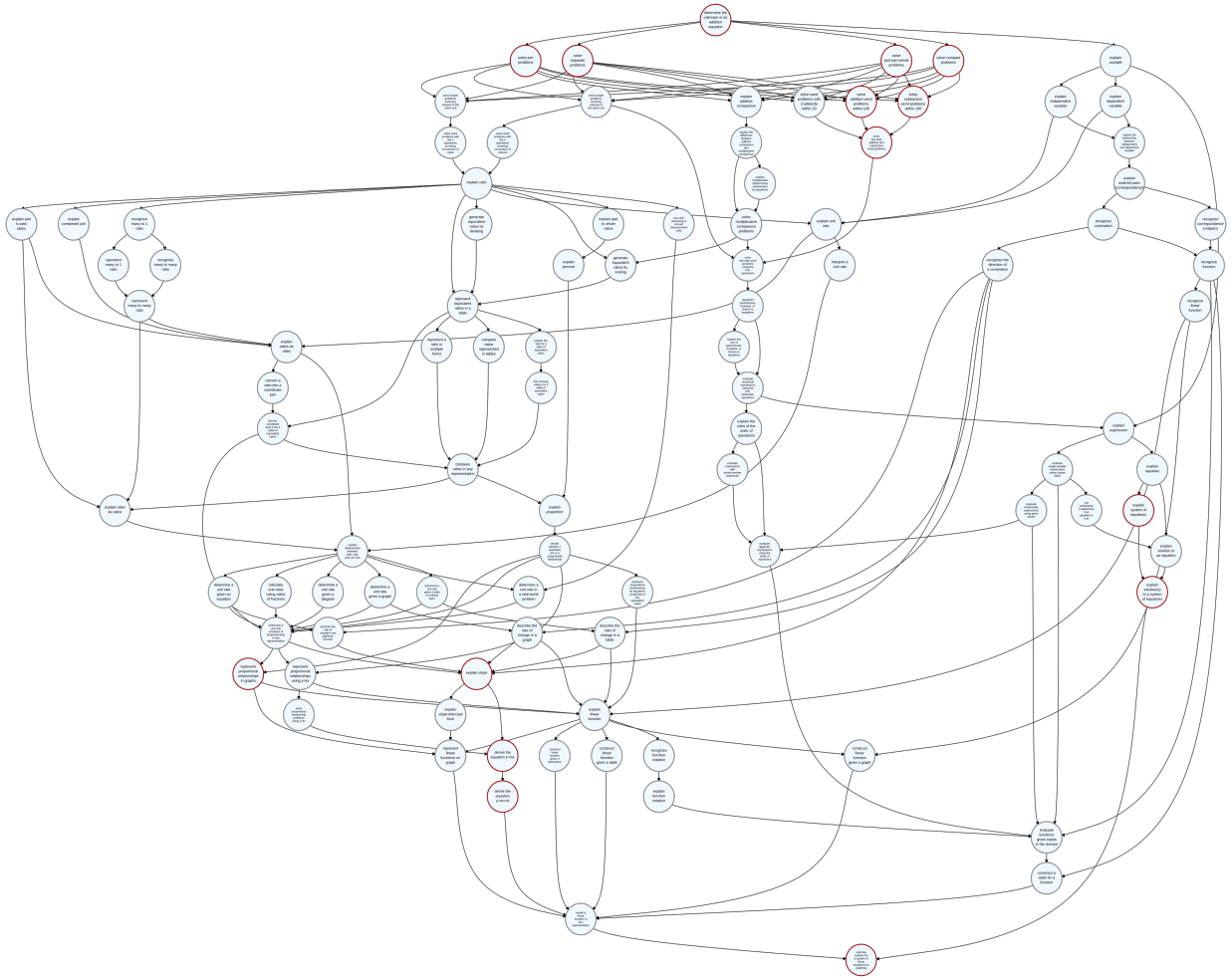


Organized Learning Models

- Progressions
- Trajectories
- Hierarchies
- Networks
- Pathways
- Granularity

Our Learning Map Model

- ELA
- Mathematics
- Birth through HS
- History of the map

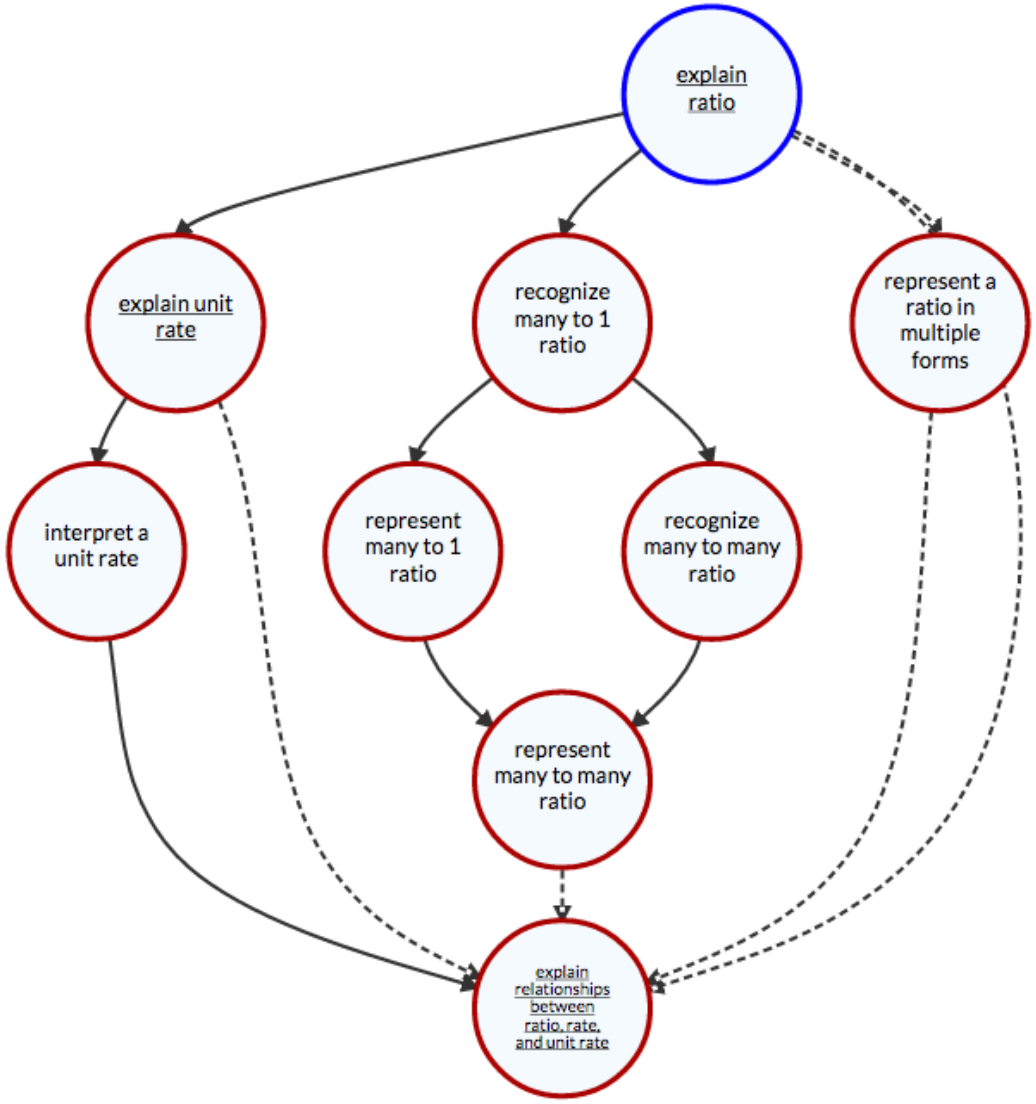


Learning Map History

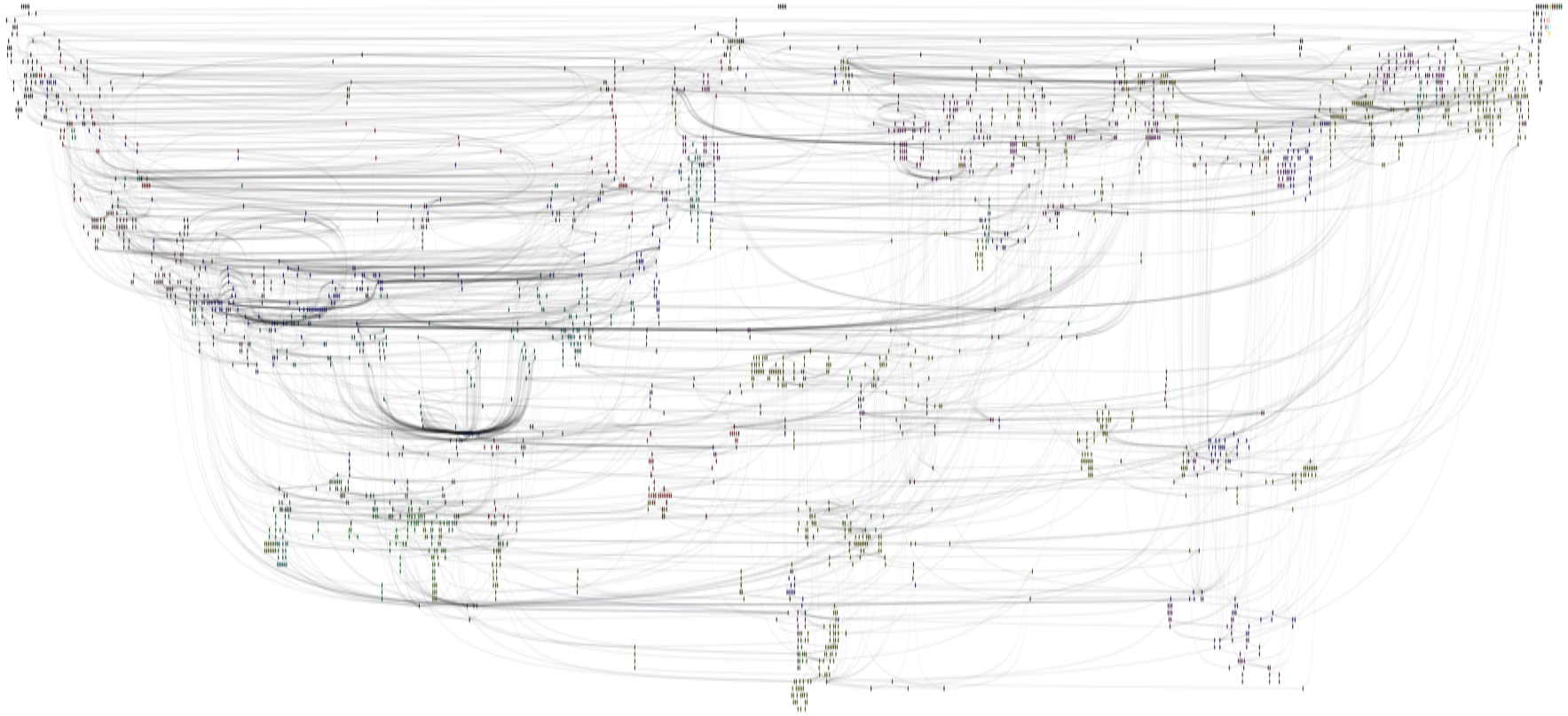
- Initial purpose – structure for an assessment program
- Developers – mathematics educators and researchers
- Sources – literature about student learning of mathematics, standards documents
- Current focus – explore use of the learning map by teachers as an instructional tool

Learning Maps

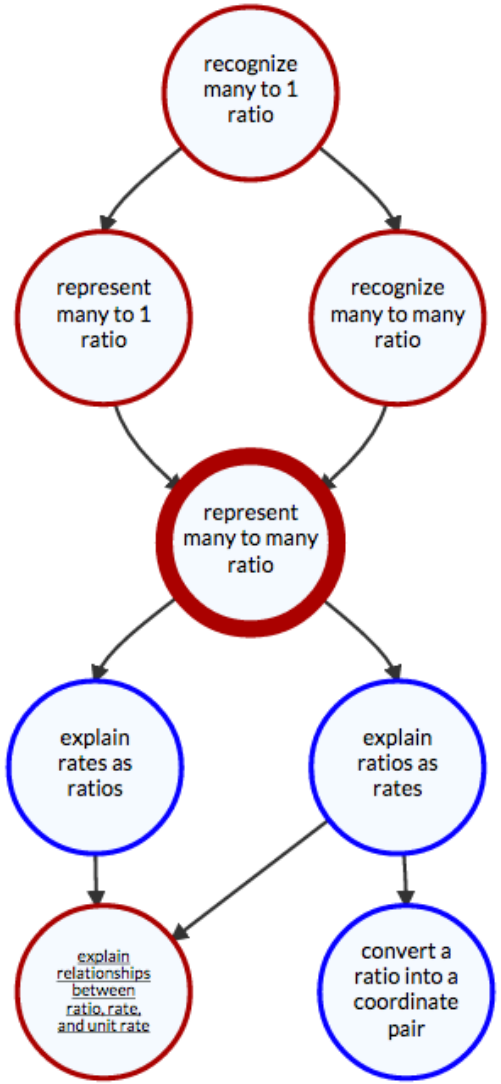
- **Visual display** of concepts and skills
- **Connections** show prerequisites
- **Multiple pathways**
- **Granular detail**



Mathematics Map



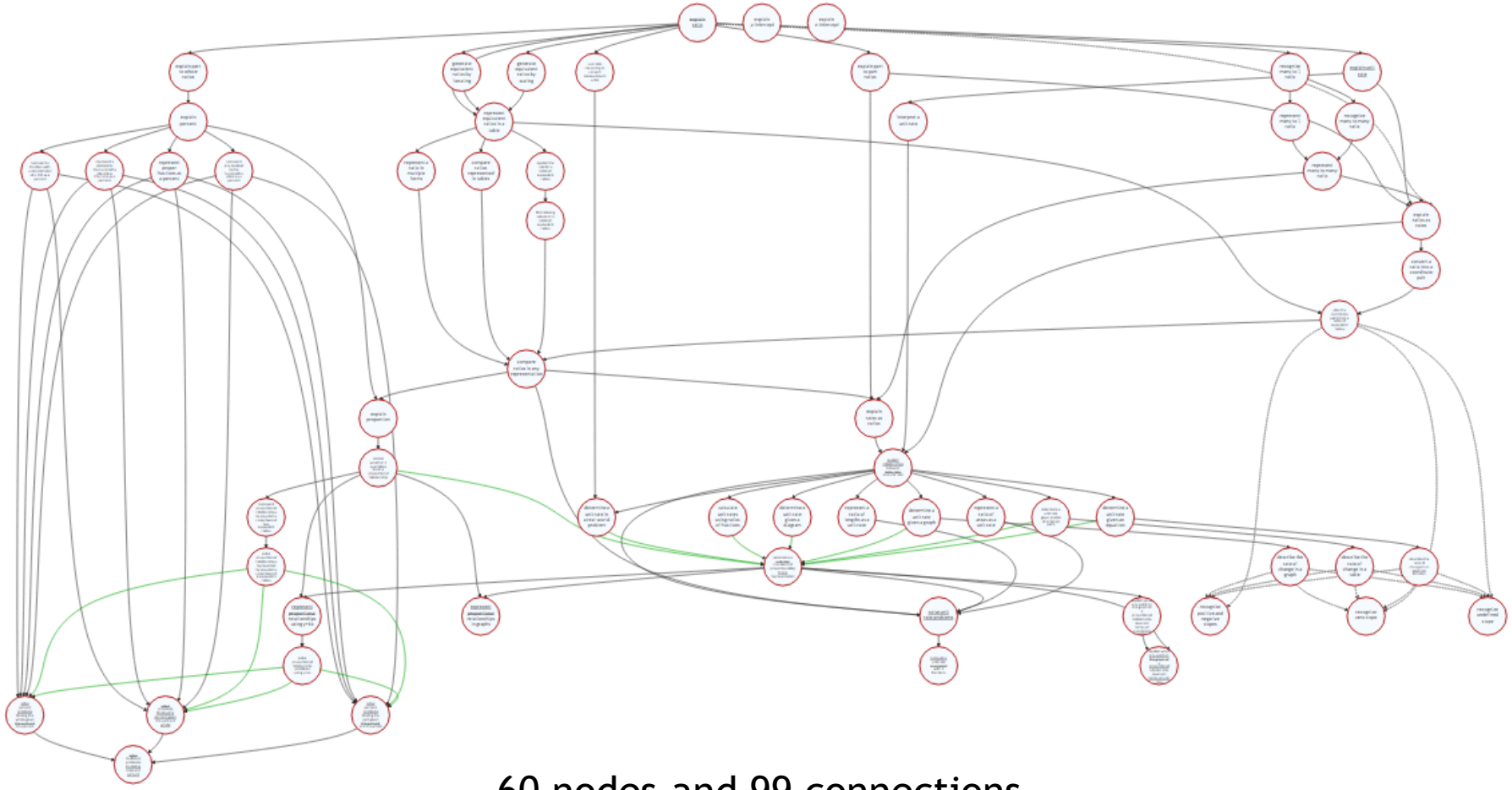
2407 nodes and 5325 connections



Challenges

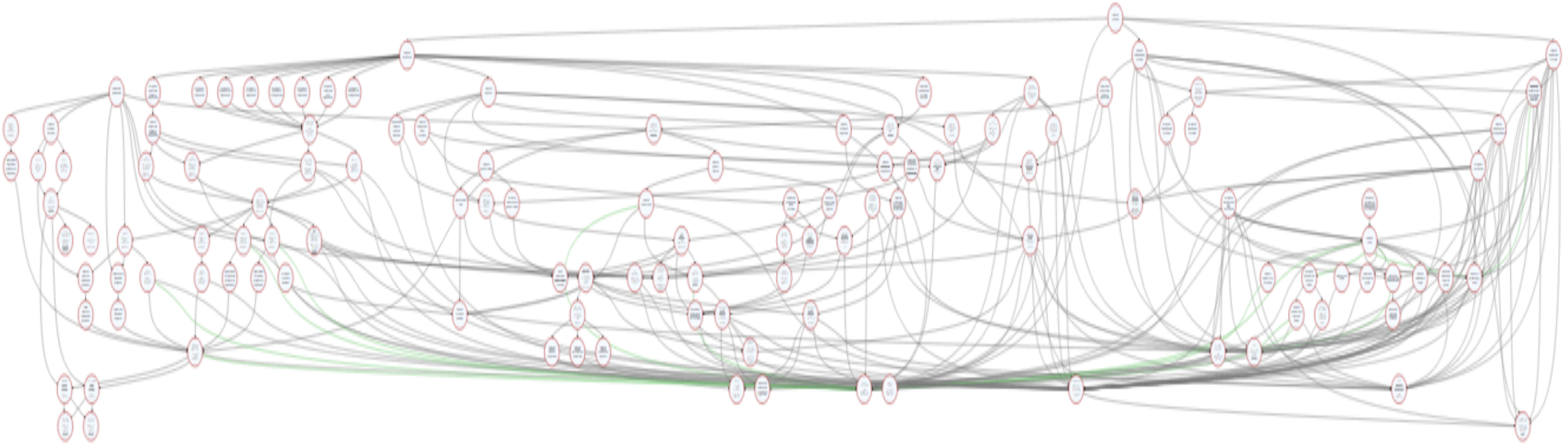
- Grain size of nodes
- Vocabulary
- Acyclic model
- Alternate pathways
- Display – context and focus

Ratios and Proportion Domain



60 nodes and 99 connections

Expressions and Equations Domain



123 nodes and 175 connections

Learning Maps Models and Teachers

- Explore **relationships** among concepts and skills
- Identify **connections**
- Identify nearby and distant **prerequisites**
- Identify **next steps** or **extensions**
- Consider **students' different learning needs**

Learning Map Models and Mathematics Teaching Practices

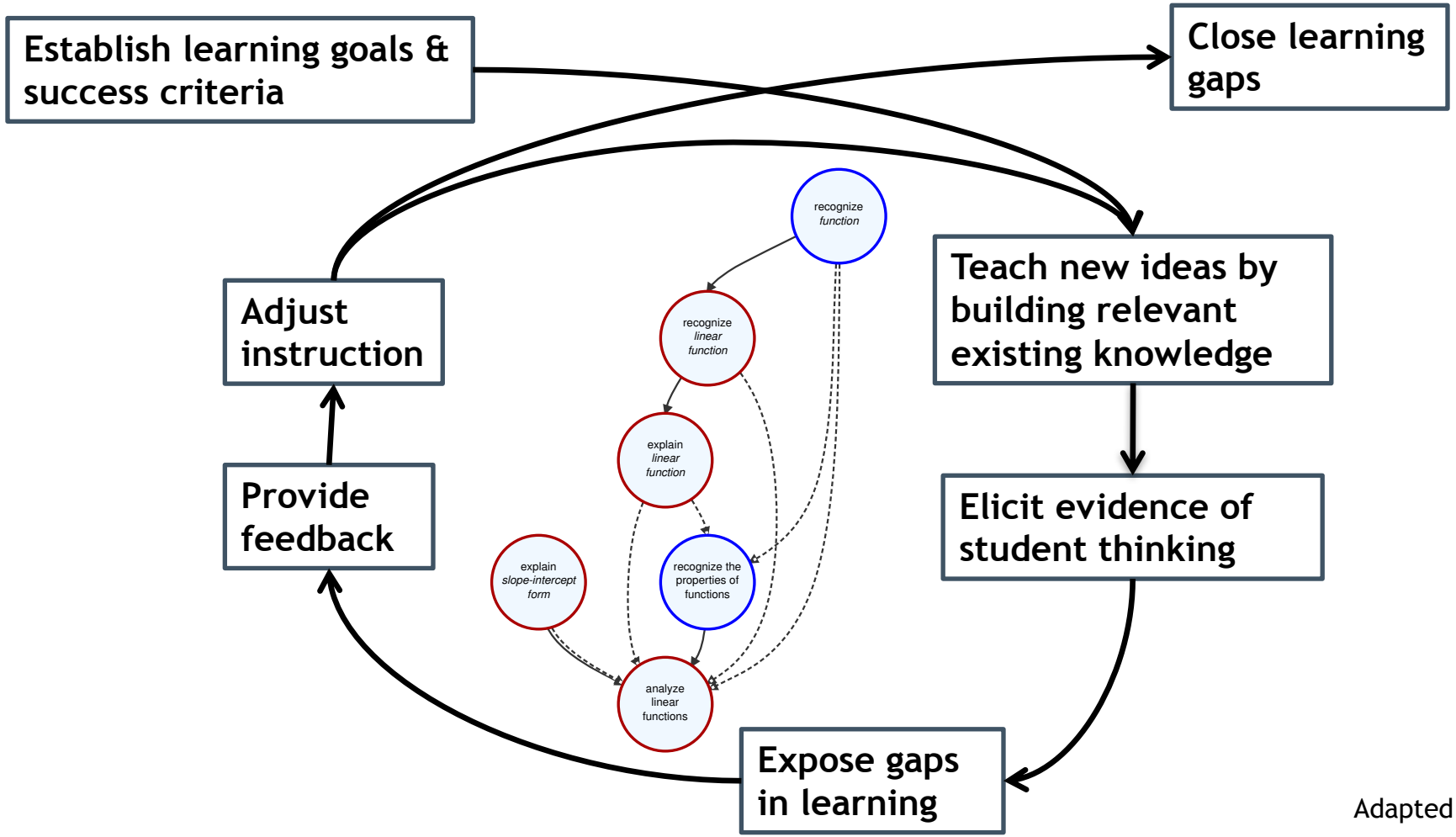
1. Establish mathematics goals to focus learning.
2. Implement tasks that promote reasoning and problem solving.
3. Use and connect mathematical representations.
4. Facilitate meaningful mathematical discourse.
5. Pose purposeful questions.
6. Build procedural fluency from conceptual understanding.
7. Support productive struggle in learning mathematics.
8. Elicit and use evidence of student thinking.

Learning Map Models and Formative Assessment

- **Clarify learning goals**
- **Promote effective learning** by focusing on connections
- Help to **determine where students are in their learning and move them to next steps.**

Informed Instruction

Informed Instruction



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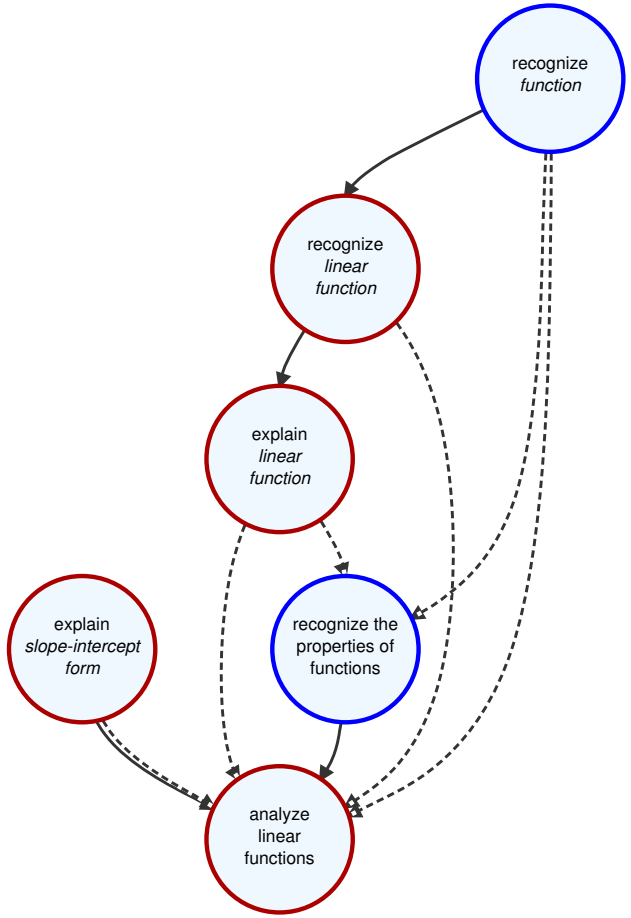
Scaffolding the Process

- Learning map information
- Teacher notes
- Instructional activity
- Student activity
- Solution guide



Comparing Linear and Nonlinear Functions

Content Overview

- The sequence of activities will address the following:
  - Describing linear and nonlinear functions
  - Comparing functions

- Overview

LEARNING MAP INFORMATION

Learning Map Model

8.F.2: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.

8.F.3: Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear.

INSTRUCTIONAL ACTIVITY

Guiding Questions

Elicit student thinking:

- How do different representations of the same function show you details about the function?

Determine if the student can RECOGNIZE THE PROPERTIES OF FUNCTIONS:

- Looking at this function only, what is its *y*-intercept?
- Is this function increasing, decreasing, constant, or both increasing and decreasing?

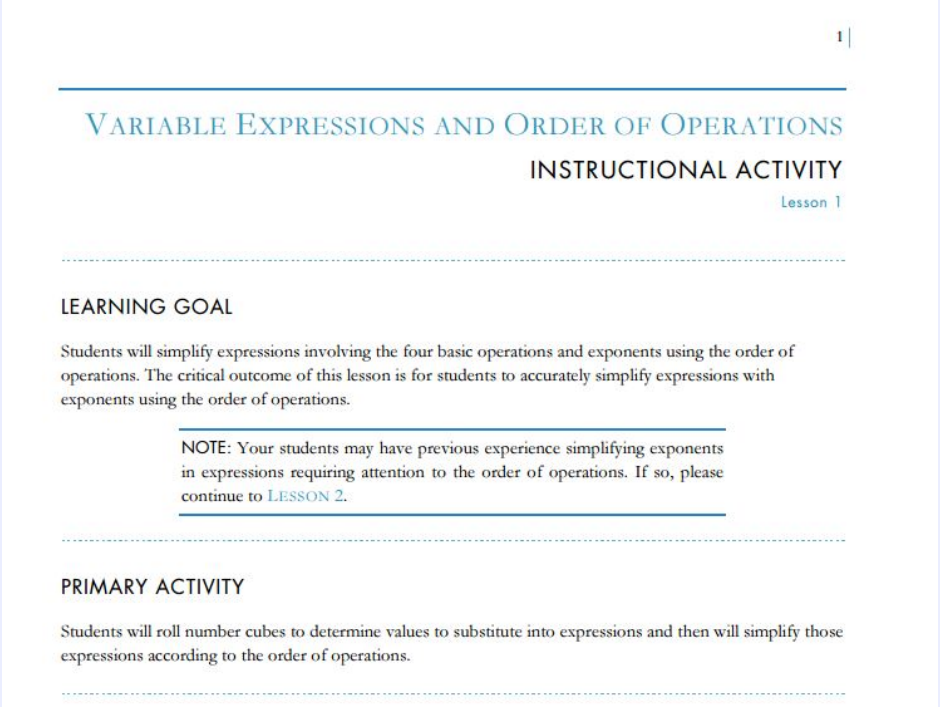
Recommendations from Literature

- Consider multiple representations of a single function.
  - Symbolic/algebraic
  - Graphical
  - Numerical
  - Verbal

- Compare different functions in the same and different representations by identifying similarities and differences.

Lessons

- Lesson 1: Multiple representations of the same linear function
- **Lesson 2**: Describing linear and nonlinear functions
  - Guess My Function
- **Lesson 3**: Comparing functions in the same representation
  - Comparison Mat
- **Lesson 4**: Comparing functions in different representations
  - Comparison Mat



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VARIABLE EXPRESSIONS AND ORDER OF OPERATIONS

INSTRUCTIONAL ACTIVITY

Lesson 1

LEARNING GOAL

Students will simplify expressions involving the four basic operations and exponents using the order of operations. The critical outcome of this lesson is for students to accurately simplify expressions with exponents using the order of operations.

NOTE: Your students may have previous experience simplifying exponents in expressions requiring attention to the order of operations. If so, please continue to LESSON 2.

PRIMARY ACTIVITY

Students will roll number cubes to determine values to substitute into expressions and then will simplify those expressions according to the order of operations.

INSTRUCTIONAL ACTIVITY

Instructional Activity: Lesson 2

- Guess My Function
  - Modeled after the popular game “Guess Who”
- Goal: Ask yes or no questions to determine your partner’s function
- How to Play:
  - Each partner needs a game board
  - Draw one function from the deck
  - Take turns asking yes/no questions
  - First person to guess their partner’s function wins

Mathematics Teaching Practices

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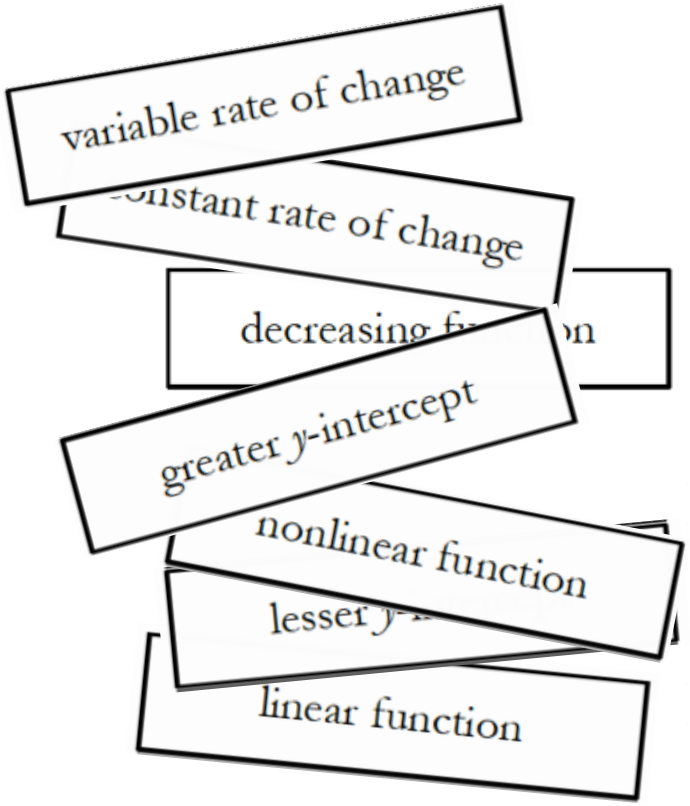
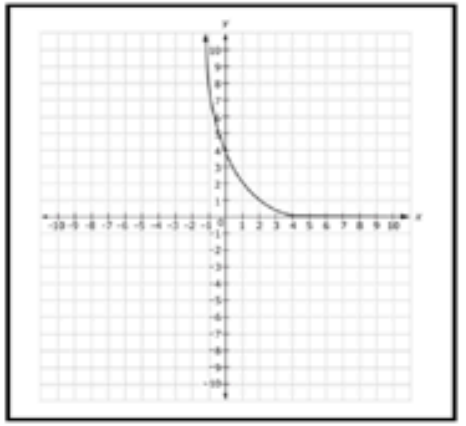
Instructional Activity: Lessons 3 and 4

INSTRUCTIONAL ACTIVITY



Function 1	Common Properties of Functions 1 and 2	Function 2

x	y
0	0
1	–5
2	–10
3	–15
4	–20



INSTRUCTIONAL ACTIVITY

Instructional Activity: Lessons 3 and 4

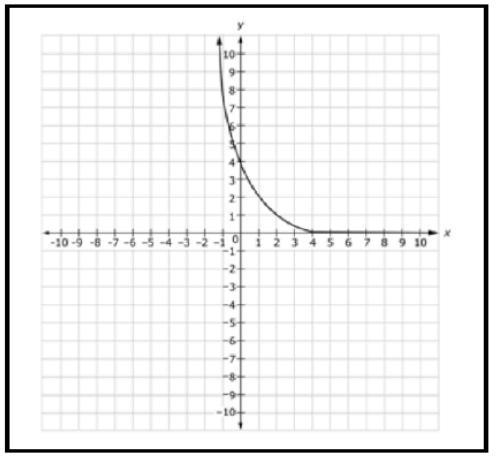
Function 1	Common Properties of Functions 1 and 2	Function 2
	decreasing function	

x	y
0	0
1	–5
2	–10
3	–15
4	–20

linear function

lesser *y*-intercept

constant rate of change



nonlinear function

greater *y*-intercept

variable rate of change

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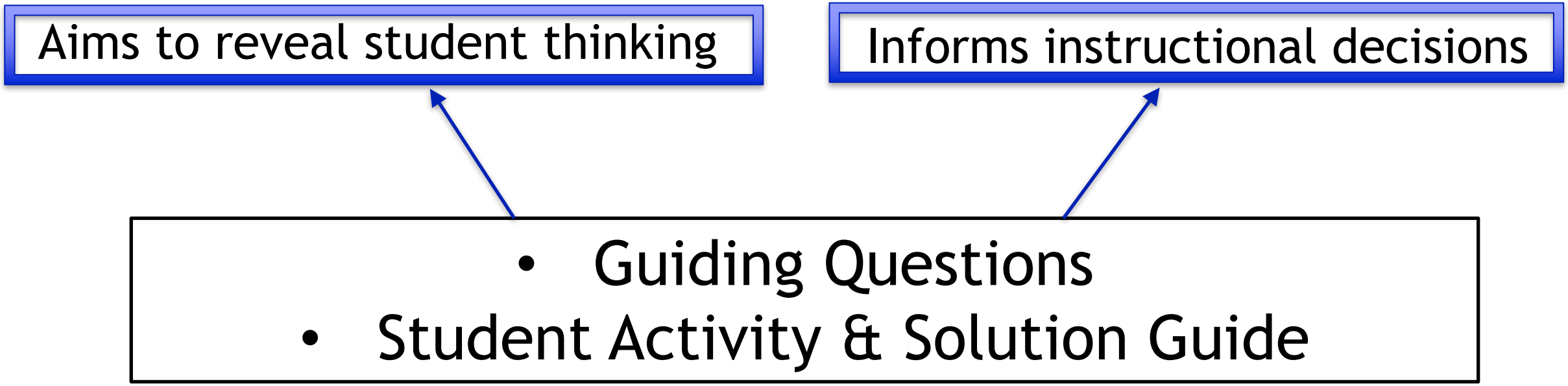

Student Activity

STUDENT ACTIVITY
& SOLUTION GUIDE

CORRECT ANSWER

FUNCTION 1	FUNCTION 2
$y = 1 + x$	Sam has \$12. Sam buys baseball cards for \$1 each. How much money does Sam have left if he buys x baseball cards?
PROPERTIES OF FUNCTION 1	**PROPERTIES OF FUNCTION 2**
greater rate of change lesser y-intercept increasing function	lesser rate of change greater y-intercept decreasing function
COMMON PROPERTIES OF FUNCTION 1 AND FUNCTION 2	
constant rate of change linear function graphs are equally steep	

Solution Guide

STUDENT ACTIVITY
& SOLUTION GUIDE

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
The student misplaces or does not identify *greater rate of change* or *lesser rate of change* as properties of the individual functions.	is not able to identify the rate of change in all function representations	DESCRIBE THE RATE OF CHANGE IN AN ALGEBRAIC FUNCTION
The student misplaces or does not identify *greater* y-*intercept* or *lesser* y-*intercept* as properties of the individual functions.	is not able to identify the *y*-intercept in all function representations	EXPLAIN Y-*INTERCEPT*
The student does not identify *equally steep* as a shared property.	does not understand the difference between steepness and the rate of change or slope	EXPLAIN *SLOPE*; EXPLAIN THE RATE OF CHANGE IN AN ALGEBRAIC FUNCTION
The student does not identify *linear function* as a shared property.	cannot recognize linear functions in different representations	RECOGNIZE *LINEAR FUNCTIONS*
The student does not mention the correct similarities.	can identify properties of a single function but cannot compare functions in order to identify common properties	COMPARE THE PROPERTIES OF 2 FUNCTIONS REPRESENTED IN DIFFERENT FORMS

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Questions?

Enhanced Learning Maps
Center for Educational Testing and Evaluation
University of Kansas
www.enhancedlearningmaps.org
EnhancedLM@ku.edu

Angela Broaddus
abroaddus@benedictine.edu

Lindsey Weiland
lwiegele@ku.edu

Nicki Lindner
nlindner@ku.edu

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