

Title

Developing Algebraic Thinking in Grades K-2

Target Audience

This course is intended for pre-service and in-service elementary school teachers.

Prerequisites

- Knowledge of how to plot points on a graph
- Ability to identify a pattern in a set of numbers, if one exists, and to express that pattern as an equation
- Understanding of the concept of ratio as a relationship between two values with the same unit of measure

Course Description

This course introduces ways to encourage algebraic thinking in students' earliest experiences with numbers and patterns, particularly by encouraging learners to identify and expand the algebra in those teaching activities they already use. The course offers strategies for providing students with a solid foundation for algebra through the study of arithmetic.

Learners will develop a deeper understanding of the connections between algebraic thinking and arithmetic as students learn it in grades K–2, as well as gain experience using variables in several different ways in the K–2 curriculum. Course activities include work with algebraic principles and strategies, such as the use of a function machine, variables in “missing number” problems, various properties of the number system, and common student misuses of the “=” sign. By the end of the course, learners will create function machines and research tools that can be used immediately in the classroom to improve student learning.

Instructor/Facilitator

See instructor/facilitator sheet

Credits

To be determined by college or university

Objectives

Learners will gain:

- A deeper understanding of the connections between algebraic thinking and arithmetic as students learn it in grades K–2
- Experience using variables in several different ways in the K–2 curriculum
- The ability to diagnose the potential misconceptions in children's uses of the “=” sign
- Strategies for providing students with a solid foundation for algebra through the study of arithmetic



Outline of Content and Assignments

After previewing the Course introductory information, learners will solve some mathematical problems that are structurally similar to those your students encounter and analyze them to reveal the algebraic thinking that underlies the arithmetic. You will learn how to approach these arithmetic problems in ways that will help your students begin to develop the foundations of algebraic thinking. You will read NCTM's Principles and Standards for School Mathematics for grades K-s. As a final task, you will work with two students as they explore simple functions using "function machines."

Part 1: Orientation (Session 1)

Learners will:

Test their computers

- Run "The Wizard"
- Install all required plug-ins to run PBS TeacherLine courses

Become familiar with the course website

- Click on the different sections of the course
- Watch "Launch Video," a short, informative video about preparing themselves to think like a learner as well as a teacher for this course
- Run the "Launch Applet" program
- Download a copy of the Learning Log, used to describe how the math problems presented in this course were solved.
- Open the Learning Log to get acquainted with the kinds of questions that learners will answer throughout the course.
- Print out the Digital Drop Box instructions for later use in Sessions 3 and 6 (used to post Learning Log to the facilitator).

Read

Carraher, D.W., Schliemann, A.D., and Brizuela, B.M. (2000) "Bringing Out the Algebraic Character of Arithmetic." This paper, presented at the 24th annual Psychology of Mathematics Education (PME) Conference, Hiroshima, Japan, reports findings from a one-year teaching experiment designed to document and help nurture the early algebraic development of third grade students.

Collaborate

- Introduce themselves on the Discussion Board
- Learn how to communicate by posting messages on the Board

Part 2: Variables as Unknowns (Session 2)

Learners will:

- Express "missing addend problems" as algebraic expressions
- Write equations using variables to represent the balancing problems
- Create multiple mathematical representations of a situation
- Analyze students' approaches to balancing problems

Read

- Missing Addend Problem
- This reading is an early example of algebraic reasoning.
- Balancing Problems
- This reading exemplifies more complex algebraic reasoning that is accessible to elementary school students

Activities

- Watch “Balancing Problem with Two Scales” and “Balancing Problem with Three Scales,” taking notes on each

Write in Learning Log

- Create two balancing problems—one simple and one more complex—and describe them in terms of both scales and equations

Participate in an Online Discussion

- Elaborate on the aspects of algebraic thinking and next steps

Part 3: Uses of the Equals Sign (Session 3)

Learners will:

- Identify computational and relational interpretations of the “=” sign
- Analyze students’ work to assess their understanding of equality
- Develop classroom practices that support the students’ development of the relational view of the “=” sign

Readings/Activities

- Discussion regarding students’ misconceptions of the “=” sign
- Read about inappropriate uses of the “=” sign in the classroom
- Read about powerful thinking about numerical relationships

Write in Learning Log

- Create three problems in which elementary grade students may be able to find the value of X without solving for X algebraically (example: $16 + 25 = 15 + X$)
- Comment on how the students could do these problems by noticing relationships between the numbers rather than doing all of the computations

Participate in an Online Discussion

- Describe a student’s reasoning and suggest a problem to further that student’s thinking

Part 4: Variables that Vary: Function Machines (Session 4)

Learners will:

- Use function machines to introduce and work on the concept of function with K-2 students
- Use equations with two unknowns as an example of a function

Read

- A basic definition of a function and about how function machines work as functions
- “Problems with Two Unknowns”

Activities

- Use an interactive that animates a function machine
- Use the results of the function machine game to answer the questions in notebook
- Complete the “Leaves and Butterflies” activity

Participate in an Online Discussion

- Share ideas for when and how it is appropriate to introduce ideas about functions to students

Part 5: Variables in Generalizations and Conjectures about Numbers (Session 5)

Learners will:

- Learn the commutative and associative properties and use them to create true number sentences
- Use variables to create conjectures about the number system and prove whether or not they are true
- Consider the instructional strategies for using conjectures with students

Read

- “Commutative and Associative Properties of Addition and Multiplication”
- Description of conjectures

Activities

- Continue work on final project

Write in the Learning Log

- Create two additional problems that students could rearrange using the commutative or associative property of addition or multiplication, making it easier for them to solve
- Explain the reasons for selecting problems, as well as how they could be modified

Participate in an online discussion

- Share mathematical conjectures and ideas for using number properties to deepen students’ mathematical understanding

Part 6: Final Project (Session 6)

Learners will:

- Investigate complex conjectures of numbers
- Work with their students and report on their work with function machines
- Develop a final project

Read

- More Complex Conjectures

Participate in an online discussion

- Reflect on uses of function machines to work with a range of students

Complete Final Project

Work with two students and create function machines for their use. Observe and record the students’ ideas generated by the function machines, how they performed on these problems and describe the students’ abilities to do these kinds of problems.

Criteria

Create and include a clear description of each of the function machines
 Write a clear description of each student’s work on each function machine
 Write a convincing rationale for each of the problems created in the project
 Compare the two students in terms of their abilities to do these kinds of problems and the different approaches taken with each student.

Write in the Learning Log

Learner will respond to the following question: “What one or two ideas do you take away from this course that you believe will be of the most use for you in your classroom, and why?” When finished, the Learning Log is sent to their facilitator.

Schedule

This course is scheduled to take approximately 15-20 hours to complete readings, activities, video, assignments, reflections and a final project.

Requirements

Learners are expected to:

- Complete all assignments
- Maintain and online journal
- Participate regularly in discussion boards

Evaluation

Pass/fail upon satisfactory completion of assignments and discussion board participation

Materials (hardware, software, plug-ins)

Technical Requirements

- Word processor
- Internet service provider
- Email

Academic Dishonesty Policy

To be inserted by university institution only