

Fresno Pacific University
Center for Professional Development

Course Syllabus

MAT 925 Algebraic Thinking in the Intermediate Grades (Grades 3-5)

Number of Units: 3 semester units

Instructor: Paul Reimer

Contact Information

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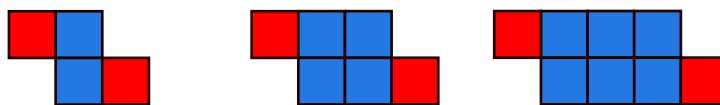
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Dear Student,

Welcome to this course! Algebraic thinking is a current topic that is receiving much attention in the field of mathematics education. Ensuring student success with higher levels of formal algebra requires thoughtful engagement with the thinking skills and concepts foundational to algebra.

So, let's get started. Take a look at the picture below. How many squares will be needed to draw the next figure in the sequence? How about the tenth figure?



How did you do? How might your students do? Looking at growth patterns is just one of the foundational experiences of algebraic thinking you'll explore in this course.

I am currently working with K-12 teachers as a mathematics coach and have found that algebraic thinking experiences can provide students with necessary problem solving and critical thinking skills. I trust that this course will be a valuable, engaging experience for you as well as your students.

Paul Reimer

About the Instructor

Paul Reimer completed his master's degree in mathematics education at Fresno Pacific University and has been active in education for more than 13 years. He is an experienced teacher, mathematics coordinator, workshop presenter, and designer of mathematics curriculum programs and units at the K-12 level.

Course Description

This course will introduce teachers to the nature of algebraic thinking in the intermediate grades. Teachers will explore current research and relevant pedagogy related to algebraic thinking. The readings and assignments will support teachers as they integrate the suggested strategies and activities into their own classroom practice. Some of the themes throughout the course will include the exploration of growth patterns, variables, and coordinate graphs. Teachers will find that many of the activities and lessons suggested will support and enhance their current mathematics instruction.

All of the learning activities in this course have been designed to further teachers' knowledge and depth of experience with algebraic thinking, while supporting the principles and standards for students communicated by the National Council of Teachers of Mathematics. This course completes a series of algebraic thinking courses offered through Fresno Pacific University, joining courses targeted at the K-2 and 6-8 grade levels.

Included Course Materials

Cuevas, G., and Karol Yeatts. *Navigating through Algebra in Grades 3- 5*. Reston, Va.: National Council of Teachers of Mathematics, 2001. (ISBN #: 0-87353-500-6)

The following journal articles are used with permission:

Suh, J. "Developing 'Algebra-'Rithmetic' in the Elementary Grades." *Teaching Children Mathematics*, November 2007.

Billings, E., Tiedt, T., & Slater, L. "Algebraic Thinking and Pictorial Growth Patterns." *Teaching Children Mathematics*, December 2007/January 2008.

Blanton, M. L., & Kaput, J. J. (2003). Developing Elementary Teachers' "Algebra Eyes and Ears." *Teaching Children Mathematics*, 10(2).

Course Requirements

To complete this course satisfactorily, students will complete the assignments outlined in the Schedule of Topics and Assignments section of the syllabus.

In summary, students will

- 1) Reflect thoughtfully on personal experiences with and attitudes toward algebra.
- 2) Identify aspects of algebraic thinking appropriate for current instructional standards.
- 3) Analyze their understanding of algebraic thinking through problem solving activities and investigations.
- 4) Create/modify two tasks from their curriculum to support algebraic thinking.
- 5) Create a pictorial growth pattern to be explored with students.
- 6) Design, teach, and reflect on three algebraic thinking lessons.
- 7) Reflect on appropriate technology use in developing algebraic thinking.

National Standards

This course is based upon the following standards:

NCTM Algebra Standards for Grades 3-5

Understand patterns, relations, and functions

- describe, extend, and make generalizations about geometric and numeric patterns;
- represent and analyze patterns and functions, using words, tables, and graphs.

Represent and analyze mathematical situations and structures using algebraic symbols

- identify such properties as commutativity, associativity, and distributivity and use them to compute with whole numbers;
- represent the idea of a variable as an unknown quantity using a letter or a symbol;
- express mathematical relationships using equations.

Use mathematical models to represent and understand quantitative relationships

- model problem situations with objects and use representations such as graphs, tables, and equations to draw conclusions.

Analyze change in various contexts

- investigate how a change in one variable relates to a change in a second variable;
- identify and describe situations with constant or varying rates of change and compare them.

Mathematical process standards proposed by NCTM:

Problem Solving:

Students identify and solve problems that arise from a variety of experiences and encompass connected mathematical ideas. They analyze problems and apply a wide range of strategies in flexible ways.

Reasoning and Proof:

Students make conjectures (informed guesses), express these conjectures in multiple ways (through language and other forms of representation), and analyze and evaluate their reasonableness.

Communication:

Students organize their thinking by expressing their ideas clearly, and by considering and analyzing the ideas of others.

Connections:

Students recognize the connections among mathematical ideas and across experiences. They acknowledge, appreciate, and apply mathematical ideas outside the mathematics curriculum.

Representation:

Representation is both a process (to represent) and a product (or artifact). Representations include such forms as symbols, pictures, charts, models, and graphic displays. Representations are not ends in themselves, but tools for understanding and communication.

NBPTS five core propositions:

Proposition 1: Teachers are Committed to Students and Learning

Dedication to making knowledge accessible to all students; belief that all students can learn; recognition of the individual differences that distinguish students from one another

Proposition 2: Teachers Know the Subjects They Teach and How to Teach Those Subjects to Students.

Mastery over the subject(s) they teach; familiarity with the skills gaps and preconceptions students may bring to the subject; use of diverse instructional strategies to teach for understanding.

Proposition 3: Teachers are Responsible for Managing and Monitoring Student Learning.

Effective instructional delivery; use of range of instructional techniques; organization of instruction to meet instructional goals; assessment of the progress of individual students as well as the class as a whole; use of multiple methods for measuring student growth and understanding; clear explanations of student performance to parents.

Proposition 4: Teachers Think Systematically about Their Practice and Learn from Experience.

Willingness to try new things; familiarity with learning theories and instructional strategies; critical examination of teaching practice on a regular basis to deepen knowledge, expand repertoire of skills, and incorporate new findings into practice.

Proposition 5: Teachers are Members of Learning Communities. Collaboration with others to improve student learning; involvement with other professionals regarding instructional policy, curriculum development and

staff development.

Students will be required to reference their respective state mathematics content standards for specific assignments. These standards can be found online at: <http://www.educationworld.com/standards>

Learning Objectives/Outcomes:

By the end of this course, students will be able to:

1. Demonstrate through written reflection an understanding of the value of incorporating algebraic thinking into mathematics instruction (NCTM Process Standards: Communication; NBPTS Prop. 2)
2. Identify foundational concepts and experiences that support algebraic learning in intermediate grades (NCTM Algebra Standards; NCTM Process Standards: Problem Solving; NBPTS Prop. 2)
3. Design, teach, and reflect on algebraic thinking lessons which engage students in problem solving, generalizing, and critical thinking (NCTM Algebra Standards; NBPTS Prop. 2)
4. Model and explain how selected algebraic thinking activities align with current standards-based mathematics instruction (NCTM Process Standards: Connections; NBPTS Prop. 4)
5. Collaborate with peers and colleagues at their school/district sites to share insights, strategies, and deepen their professional practice (NBPTS Prop. 5)

Schedule of Topics and Assignments:

Please see the following section of the syllabus for detailed readings and assignments.

1) Getting Started

Reflect on algebraic thinking, personal experiences with algebra

2) What is Algebraic Thinking?

Definitions of algebraic thinking, identification of key concepts

3) Let's Think Algebraically!

Explore algebraic thinking through problem solving experience

4) "Algebrafying" Your Mathematics Curriculum

Modify current standards-based instructional tasks to engage students in algebraic thinking

5) Exploring Growth Patterns

Patterns and questioning with students

6) Lesson Design: Navigating through Algebra in Grades 3-5

Design, teach, and reflect in classroom application

7) From the Classroom: Algebraic Investigations

Incorporate investigations into mathematics instruction

8) Using Technology to Enhance Algebraic Learning

Explore resources, identify several which support algebraic thinking

9) Reflection

Personal experiences, share with colleague, summarize conversation

Evidence of Learning:

- 1) Student demonstrated critical thinking and thoughtful engagement with the course objectives through reflective written assignments. (Assignments 1, 2, 4, 5, 7, 9)
- 2) Student applied new learning to teaching practice through thoughtful lesson design and reflection. (Assignment 4, 5, 6)
- 3) Student made connections to local instructional goals/state standards in the design and implementation of algebraic activities. (Assignment 6)
- 4) Student demonstrated effective and appropriate integration of technology in exploring algebraic concepts. (Assignment 8)
- 5) Student demonstrated thoughtful and insightful collaboration with school site community. (Assignment 9)

Instructor/Student Contact

As you complete the assignments for this course, there are several opportunities for you to share your thoughts with me. Since it is my hope that this course is a meaningful, interactive experience for you, please email me your response to Assignment 1. I will look forward to hearing how you are engaging with the course ideas and activities.

Grading Policies and Rubrics

Evaluation:

Written Responses (4)	40
Lesson Plans (3)	30
Pictorial Growth Pattern	10
Algebrafied Tasks	10
Problem Solution	5
Technology Summary	5

100%-90% = A

89%-80% = B

79% or below = no credit

Students who take the course for credit/no credit must earn a 80% or above to earn credit. Students who enroll in the course for a letter grade must achieve a grade of "A" or "B." Coursework that earns below a "B" mark will not receive credit; this applies to both the credit/no credit and the letter grade option.

Assignment Rubrics

1. Type of Assignment

Written responses

Exceptional (A)

Student's written responses show an exceptional investment of time, energy and thoughtful reflection. The work submitted by the student is original and thorough. The student effectively organizes key insights and demonstrates evidence of interaction with the texts.

Adequate (B)

Student's written responses show an adequate investment of time, energy and thoughtful reflection. The work submitted by the student is complete, but lacks thoroughness and originality. The student sufficiently organizes insights and demonstrates evidence of interaction with the texts.

Insufficient (No credit)

Student's written responses show little investment of time, energy and thoughtful reflection. The work submitted by the student does not show adequate thought or effort.

2. Type of Assignment

Lesson plans

Exceptional (A)

Lesson plans show an exceptional investment of time, energy and thoughtful reflection. Student consistently makes connections to local instructional goals/standards in the design and implementation of lessons.

Adequate (B)

Lesson plans show an adequate investment of time, energy and thoughtful reflection. Student makes some connections to local instructional goals/standards in the design and implementation of lessons.

Insufficient (No credit)

Lesson plans submitted by the student do not show adequate thought or effort, and may not address specific goals.

3. Type of Assignment

Lesson evaluations

Exceptional (A)

Student includes the use of critical thinking and reflection in the evaluation of lessons implemented.

Adequate (B)

Student includes the use of reflection in the evaluation of lessons implemented, but may lack sufficient detailed analysis.

Insufficient (No credit)

Student does not demonstrate critical thinking or reflection in the evaluation of lessons implemented.

4. Type of Assignment

Presentation

Exceptional (A)

Student effectively organizes key insights into a thoughtful and well-structured presentation.

Adequate (B)

Student includes minimal key insights in a presentation.

Insufficient (No credit)

Student presentation lacks key insights.

5. Type of Assignment

Research

Exceptional (A)

Research accesses multiple sources available via the internet. Web descriptions demonstrate thorough engagement with site information.

Adequate (B)

Research accesses minimal sources available via the internet. Web descriptions demonstrate adequate engagement with site information.

Insufficient (No credit)

Research fails to access sources available via the internet. Web descriptions demonstrate little engagement with site.

References:

Additional resources on algebraic thinking are located on the CD-ROM provided with the course text.

Policy on Plagiarism

"All people participating in the educational process at Fresno Pacific University are expected to pursue honesty and integrity in all aspects of their academic work. Academic dishonesty, including plagiarism, will be handled according to the procedures set forth in the Fresno Pacific University Catalogue."

"Graduate level course work reflects Fresno Pacific University's Desired Student Outcomes as it applies to professional development to demonstrate the following:

- Oral and written communication in individual and group settings
- Content knowledge, and application of such knowledge in the student's area of interest to affect change
- Reflection for personal and professional growth
- Critical thinking
- Cultural and global perspectives to understand complex systems
- Computational/methodological skills to understand and expand disciplines, including an understanding of technological systems"