Cooperative Learning & Algebra 1

Secondary Activities

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Hawker Brownlow
EDUCATION

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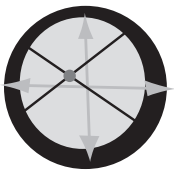

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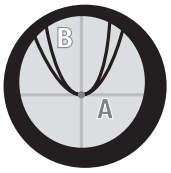


Chapter 8
QUADRATIC FUNCTIONS

INTRODUCTION

Have you ever been frustrated with your students because they don't seem to understand what you have taught and retaught several times? Do you ever feel like you are teaching rocks rather than young people? Do you go home at the end of a day and ask, "Why did I even come?" I have felt that way many times and went home asking myself those questions. The number of children that would come after school for help because they did not understand what had been taught ranged from 10 to 20 students a day. I knew there had to be a better way—I just did not know how. I knew that I could not change my students, nor could I pick and choose who I taught. That was when I decided that I was the one who would have to be transformed. In my quest for more effective ways of teaching, I discovered Kagan Cooperative Learning. I had put students together before to work on a project and it was disaster. I did not know why, and swore that I would never do that again. What amazed me about the structural approach to cooperative learning was how it ensured equal participation, required dependence of the group members on each other, and held the students individually accountable. As I investigated further, I was sold.

The human mind can only hold so much information before it goes into overload. In overload mode, all that it hears never gets past the ears because the brain is full. So in a 30-minute lesson, my students were with me for the first 10 minutes, then they went into overload. No wonder they did not know how to do the homework. With the structural approach, a lesson is broken down into 10-minute increments. Students process the information they received with an activity that uses a Kagan structure at the end of each increment. Because the brain has processed this information, it is ready to receive new information so the next part of the lesson can be absorbed. Because the structures ensure positive interdependence among the students, equal participation, individual accountability, and at least 25 percent of the class actively processing at once, there are no "hogs" (students who want to do it all) and no "logs" (students who won't do anything). Now the only students who stay after school are the ones who were absent and missed the lesson. The transformation has been amazing, and my passion, enthusiasm, and zeal for teaching has returned. After my first 5 years of teaching, I was burned out. I left teaching for 8 years and 2 years after I returned, I found the structural approach. That was 10 years ago. Instead of burnout I actually love going to school each day. My students enjoy it as much as I do because it adds variety in the classroom, they bond with their teammates, and they are more successful than they have ever been in mathematics. It is a win-win situation for all.

Besides the activities to process the Algebra 1 curriculum, exploratory exercises are included for the students to discover most of the algebra concepts. I taught geometry for years and was able to develop hands-on investigations using compasses, straightedges, and tracing paper. The curriculum could be made so concrete for the students that it was much easier for them to understand. Because I had taught geometry for so long, I wanted a change and chose to teach Algebra 2. Be careful what you ask for! After a month in Algebra 2, I realised that algebra was very abstract. I missed the concrete investigations and went back to geometry the next year. Several years later, I was given the opportunity to develop a non-advanced placement calculus class. The book I chose to teach the class gave me the insight I needed to make discovery activities for algebra. This text presented

everything from a numeric, graphic and algebraic perspective. I know that we teach all of these in Algebra 1, but I believe that we have failed to show the students how intricately related they are. The fact that I didn't even see this until 15 years into my teaching and after majoring in mathematics education, shows that we have failed to link these perspectives sufficiently. This revelation began the transformation of the algebra curriculum. Exploratory activities could be developed for students to discover the order of operations, rules for exponents, definitions of zero and negative exponents, linear function concepts and even more. Some of the investigations have students explore numeric patterns or graphical patterns and then develop a conjecture based on the patterns (inductive reasoning at its best). Some begin with an exploration of the graphical perspective that leads to an understanding of the numeric perspective, which allows for the generalisation to the algebraic perspective. The teacher is transformed from "giver of all information" to facilitator of what students have discovered. When students discover concepts—the concepts are theirs. It is well worth the time. Because these explorations use inductive reasoning, the student may feel that by the end of the exploration, it is getting repetitive. Part of this is inherent in inductive reasoning. I have tried to give enough problems so that the struggling students will be able to see the pattern.

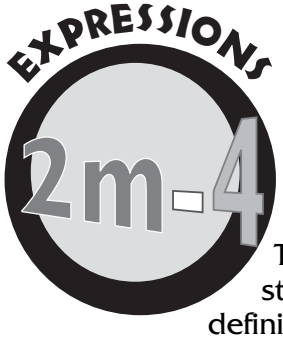
Another revelation that I had was vocabulary development. It is a no-brainer that vocabulary development in a geometry class is essential because so much of the geometry is rooted in definitions. Vocabulary can't be ignored. It did not occur to me that the vocabulary development in the algebra classes is as critical as it is in the geometry classes. Sure I defined "exponent", "coefficient" and such. I assumed that the students were fluent with the vocabulary without putting activities in place to ensure its development. It wasn't until I was doing my portfolio for National Board for Professional Teaching Standards that I realised that my Algebra 2 students did not know their vocabulary! They were doing an activity that required them to write about their understanding. They used "x-axis" when they referred to an "x-coordinate" and "y-axis" for "y-coordinate." I was shocked since this was Algebra 1 vocabulary. Vocabulary development doesn't happen unless we ensure that it happens. With state and national tests requiring students to be able to communicate mathematically, we must take seriously vocabulary development. Included in this book are exploratory activities for the students to look at examples and non-examples of a vocabulary word and develop their own definition, which will ultimately result in a definition refined by the class. After these explorations follow cooperative learning activities designed for students to process the definitions. Because all of the exploratory activities require students to write about their mathematical discoveries, this vocabulary development is essential.

The book is divided into 8 chapters that cover the core concepts of the Algebra 1 curriculum. Many of the concepts are also taught in pre-algebra classes and could be used for those also. Each chapter is broken down into lessons, and each lesson contains exploratory and cooperative learning activities. Each processing activity uses a Kagan Cooperative Learning structure. At the beginning of each chapter is a detailed list of each lesson and the activities it contains, along with a synopsis of the chapter. Each lesson also begins with a synopsis. Most of the lessons end with students generating a graphic organiser of what they have

INTRODUCTION CONTINUED...

learned, giving them an opportunity to synthesise their understanding. Following the synopsis of each lesson are teacher notes for the activities, the name of the structure used, materials required for the activity, and step-by-step directions on how to do the activity. The chapters, lessons, and activities are numbered sequentially. This system makes navigating through the book a breeze. Answers are included on the activities page or in the teacher's notes.

This book was written for the teacher. My hope is that this book opens a whole new way to look at the Algebra 1 curriculum—that through the vocabulary development, exploratory investigations, and cooperative learning activities to process the curriculum, your students will have a grasp of Algebra 1 in a way that is unparalleled. Enjoy!



EXPRESSIONS

This chapter begins with a lesson on vocabulary. The first activity requires students to generate definitions. Several activities follow to process the definitions. One goal is for students to understand the difference between a "coefficient" and an "exponent" and what each of them means. Students will write expressions using words and then symbols. Students will also see how expressions are used in real–world applications.

The second lesson works with evaluating expressions. One activity ties geometry to algebra by requiring students to evaluate geometric expressions. A higher–level thinking activity requires the students to find the mistake in an expression that has been evaluated. This lesson concludes with real–world applications of expressions.

The third lesson focuses on simplifying expressions. Two exploratory activities have students discover like and unlike terms and the distributive property. Several activities are included to process each of the investigations. This lesson ends with an activity where the students develop a graphic organiser that summarises the entire lesson.

The fourth lesson focuses on exponents and the rules of exponents. Explorations have students discover the product, quotient, power rules of exponents, and negative and zero exponents. Activities are included to process each of these explorations. The final activities revisit common factoring and the distributive property. The chapter concludes with an activity to synthesise the unit.

LESSON 1

VOCABULARY DEVELOPMENT

ACTIVITY 1: Define Me!
ACTIVITY 2: Name My Coefficient
ACTIVITY 3: Identify My Terms
ACTIVITY 4: Name the Factors
ACTIVITY 5: Can You Write Me?
ACTIVITY 6: Expression, Equation or Inequality? Oh My!
ACTIVITY 7: Write Me Using Words
ACTIVITY 8: Write Me as an Expression
ACTIVITY 9: Apply Expressions
ACTIVITY 10: What Did We Learn?

LESSON 2

EVALUATING EXPRESSIONS

ACTIVITY 1: Evaluate My Expression
ACTIVITY 2: Evaluate My Geometric Expression
ACTIVITY 3: Where Are the Mistakes?
ACTIVITY 4: Expressions in the Real World

EXPRESSIONS

LESSON 3

SIMPLIFYING EXPRESSIONS

ACTIVITY 1: Can You Form Me with Tiles?
ACTIVITY 2: Can You Put Me Together?
ACTIVITY 3: Can You Write My Expression?
ACTIVITY 4: Exploring Like and Unlike Terms
ACTIVITY 5: Find My Like Terms
ACTIVITY 6: Simplify Me With Tiles
ACTIVITY 7: Simplify Me Without Tiles
ACTIVITY 8: Make Me with Tiles
ACTIVITY 9: Make Me with Tiles—Advanced
ACTIVITY 10: Exploring the Distributive Property
ACTIVITY 11: Simplify Me with the Distributive Property
ACTIVITY 12: Find My Opposite
ACTIVITY 13: Simplify Me—Advanced
ACTIVITY 14: Factor Me—Distributive Property Undone
ACTIVITY 15: Create an Application
ACTIVITY 16: What Did We Learn?

LESSON 4

EXPONENTS

ACTIVITY 1: Expand Me
ACTIVITY 2: Rewrite Me
ACTIVITY 3: Exploring the Product Rule of Exponents
ACTIVITY 4: Use the Product Rule
ACTIVITY 5: Exploring the Quotient Rule of Exponents
ACTIVITY 6: Use the Quotient Rule
ACTIVITY 7: Exploring the Power of a Product/Quotient Rule
ACTIVITY 8: Use the Power of a Product/Quotient Rule
ACTIVITY 9: Exploring Negative and Zero Exponents
ACTIVITY 10: Rewrite Me with Positive Exponents
ACTIVITY 11: Distributive Property Revisited
ACTIVITY 12: Factor Me—Revisited
ACTIVITY 13: What Did We Learn?

LESSON 1

VOCABULARY DEVELOPMENT

This lesson begins with an activity that requires students to generate definitions. Because the words "coefficient", "factors" and "terms" are vocabulary words students often confuse, student–generated definitions become even more important. The activity is designed so students not only can identify these items in a problem but that they also understand what these terms mean. Also included are the words "sum", "difference", "product" and "quotient". In the expressions that are examples of these terms, parentheses have been used because when translating from words to symbols parentheses are needed. Several activities follow to process the definitions. The activity, "Can You Write Me?" has the students apply the definitions as they create terms, expressions, equations or inequalities, based on given criteria. Near the end of the lesson, students will take expressions written with words and write them symbolically. Then students will take a symbolic form of an expression and write it using words. The lesson ends with an activity to synthesise what they have learned by developing a graphic organiser.

ACTIVITY

1 DEFINE ME!

Exploratory

Solo

1. Individually, each student defines each vocabulary word by comparing and contrasting the examples and counterexamples. Students could do this part for homework.

Team with RoundRobin sharing and RoundTable recording.

2. In turn, each student reads to his/her team the definition he/she wrote.

3. The team discusses how to define the vocabulary word, based on the definitions just shared. The team must come to consensus on how to define the term.

4. Once the team reaches consensus, student 1 records the team definition on the team paper.

5. Repeat steps 2–4 for each vocabulary word, rotating the recording.

Class

6. Choose a team and a student at that team to read their team's definition of the first vocabulary word. (Team and student spinners work well here.)

7. Write the definition on the board. Ask the class if they agree with part 1, then part 2, and finally part 3 of the definition, reworking what they want to change.

Structure
- Solo Team Class

Materials
- Activity 1 (pp. 84–87)
- 1 sheet of paper and pencil per student

8. Once everyone has agreed, including the teacher, then it is recorded as the definition the class will use. You may find that lower–level classes prefer a somewhat longer definition if it has more meaning for them.

ACTIVITY 2

NAME MY COEFFICIENT

Structure
- RallyRobin

Materials
- Activity 2 (p. 88)

Algebraic

1. Teacher puts Activity 2 (p. 88) that presents several expressions on the overhead projector.

2. In pairs, students take turns orally stating the coefficient of the term.

ACTIVITY 3

IDENTIFY MY TERMS

Structure
- RallyRobin

Materials
- Activity 3 (p. 89)

Algebraic

1. Using Activity 3 (p. 89), several expressions are written.

2. In pairs, students take turns orally stating each term of the expression.

ACTIVITY 4

NAME THE FACTORS

Structure
- RallyRobin

Materials
- Activity 3 (p. 89)

Algebraic

1. Using Activity 3 (p. 89), several expressions are written.

2. In pairs, students take turns orally stating the factors in each term of the expression.

ACTIVITY

5 CAN YOU WRITE ME?

Algebraic Higher-Level Thinking

Set-up:
In pairs, Student A is the Sage; Student B is the Scribe. Students fold a sheet of paper in half and each writes his/her name on one half.

1. The Sage gives the Scribe step–by–step instructions on how to write the expression for problem 1.

2. The Scribe records the Sage's expression step–by–step in writing.

3. If the Sage is correct, the Scribe praises the Sage. Otherwise, the Scribe coaches, then praises.

4. Students switch roles for the next problem.

Structure
- Sage–N–Scribe

Materials
- Activity 5 (p. 90)
- 1 sheet of paper and pencil per pair

ACTIVITY

6 EXPRESSION, EQUATION OR INEQUALITY? OH MY!

Algebraic

Set-up:
The cards need to be copied onto cardstock and cut into individual cards. Cards are distributed to the students, 1 card per student.

1. Stand Up, Hand Up, Pair Up

2. Partner A quizzes his/her partner, asking what type of mathematical sentence is on his/her card.

3. Partner B answers.

4. Partner A praises or coaches.

5. Switch roles.

6. Partners trade cards.

7. Repeat steps 1–6.

Management Tip: Using music to begin and stop the mixing works well.

Structure
- Quiz–Quiz–Trade

Materials
- 1 set of expression, equation, inequality cards— Activity 6 (pp. 91–92)