Fraction Fun

Through Cooperative Learning

Revised Australian Edition

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Introduction

The traditional method for teaching division of fractions is to say to students, "Yours is not to question why, just invert and multiply." Giving students rules to follow may let them get answers, but does not help them understand maths concepts. In the long run teaching without understanding disempowers students. This book is designed to provide an alternative: To empower students by teaching for understanding, creating a love of maths.

This book is based on the premise that an understanding and love of maths comes through a discovery process based on plenty of hands-on experience with manipulatives in a supportive context. The book follows closely the standards provided by the National Council of Teachers of Mathematics, allowing students to obtain each new concept by working sequentially through the concrete, connecting and symbolic levels.

Free Explorations

To provide the initial positive experience with fractions, I strongly recommend students first freely explore fraction manipulatives with little structure. Children need a chance to explore, discover, arrange, build and play before they are ready for direct instruction. This takes place through Free Explorations: You simply pass out the manipulatives, let the students play with them, and then ask them what they have learned and what they are discovering.

Guided Explorations

Following the period of Free Explorations we move into Guided Discovery. In Guided Discovery there is still little instruction, but children learn what fractions are and the relationships among them as they work together to explore specific problems. The book provides 14 Guided Explorations to get you started. For example, in one of the Explorations, students simply work to "name halves". They choose a fraction piece and then work together to discover if there are two identical pieces which can build the target piece. In another Exploration students simply try to find the longest piece they can build with four fraction pieces.

Classbuilding Structures

After Explorations, we move into Classbuilding. The approach here is to use cooperative learning structures to create fun activities in which children learn more about fractions while working together as a class. For example, in one Line-Up activity each child selects his/her own fraction and then all the students in the class line up by the size of their fraction, from smallest to largest. In Similarity Groups, children find everyone in the class who has selected the same fraction as themselves. In the

Classbuilding section, you will find five co-operative learning structures. Each structure has many activities to get you started. Through classbuilding we create a love for and familiarity with fractions, in a fun, supportive context. Feel free to add you own activities and watch your class come alive helping each other learn about fractions.

Cooperative Learning Lessons

The book shows how to teach all of the most important fraction concepts through cooperative learning activities. There are twenty-four lessons. Students start at the beginning, learning to identify fractions. Each lesson is designed to be taught cooperatively in teams of four. Students use hands-on manipulatives including fraction dice and spinners to make learning fractions fun and easy. The lessons are designed for students from years 2 to 12. Even students who can divide fractions with ease using traditional methods can benefit by going through the levels of these lessons — to create the understanding which should underlie the symbolic abilities.

The lessons are paced, and students need to master each lesson before moving to the next. The concepts taught through the lessons are:

- Exploring Fractions
- Naming Fractions
- Comparing Fractions
- Equivalent Fractions
- Addition of Fractions
- Multiplication of Fractions
- Subtraction of Fractions
- Division of Fractions

To teach for understanding, each concept must be taught at three different levels, with practice provided at each. Instruction of each new concept must start with the **concrete** level — students build with manipulatives as they solve each problem. Next, we teach at the **connecting** level — students learn to draw a picture of each problem and add the numbers or symbols. In the last level, the **symbolic** level, students work out problems with numbers. Using all three levels, students learn what mathematics is, not just how to get answers. If they forget a rule they will be able to reason through the process.

My Hope

Fractions are one of the hardest concepts for us to teach and for students to understand. The old methods of having students memorise rules don't work. Cooperative learning, too, can be difficult. But it can provide a wonderfully supportive, fun atmosphere within which to learn. In the book, I have tried to provide simple-to-follow lesson plans to teach the most fundamental fraction concepts. Through the lessons, students have the opportunity to interpret mathematical theories and construct mathematical understanding for themselves. My hope is that by providing step-by-step ideas this book will make teaching fractions through cooperative learning easy for you, and exciting for your students. By walking with your students step-by-step through these explorations, classbuilding activities and lessons you will provide your pupils with a life long set of skills and a love for maths.

Definitions

Fraction: A term consisting of a numerator and a denominator, indicating some number of equal parts of a whole.

Denominator: The term below the line in a fraction, indicating the number of equal parts each whole is divided into.

Numerator: The term above the line in a fraction, indicating some number of the equal parts.

Restatement: If we divide one whole into equal parts, the denominator tells how many parts there are. The numerator indicates how many of these equal parts we select.

Examples: Given the fraction 2/6, 2 is the numerator and 6 is the denominator. The fraction 2/6 indicates we have broken a whole into six equal parts and selected two. The fraction 6/2, indicates we have broken a number of wholes into two parts each, and have selected six of those parts.

Numerator $= \dfrac{2}{6}$
Denominator

Numerator
$$\overbrace{\qquad}^{2}$$

$$\underbrace{\qquad\qquad\qquad}_{6}$$
Denominator
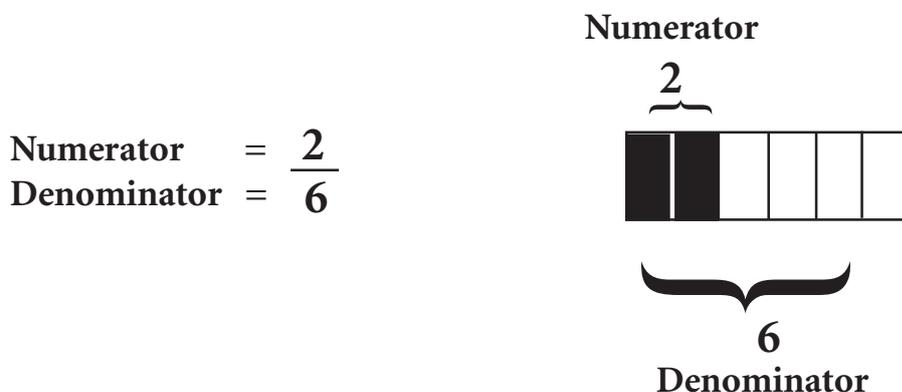
Lowest Common
Denominator: The lowest number into which two denominators will evenly divide.

Role Card: A card indicating the special job of a student.

／$Checker$ △   ／$Praiser$ △

Numbered Heads Together

See Explorations 5, 10, 11

Numbered Heads Together is a simple structure, consisting of four steps: (1) Students Number Off; (2) Teacher Announces a Question; (3) Students Put their Heads Together; and (4) Teacher Calls a Number.

Step 1. Students Number Off. Each student on the team has a different number.

Step 2. Teacher Asks a Question. The question asked of students during Step 2 is formulated as a directive. Instead of saying, "What fraction of the pie has been eaten?" the teacher says, "Make sure everyone on the team can explain what fraction of the pie has been eaten."

The question may be either high or low consensus, but is phrased accordingly. For example, for a high consensus question, the teacher might say, "Put your heads together and name how many pizzas it will take to feed nine people if we divide each pizza into six pieces." For a higher level thinking question, the teacher might say, "Make sure you are all ready to predict how many wholes we can build from the 37 fraction pieces in this envelope."

Variation:

To quicken the pace, the teacher may sometimes provide a time frame for students. So, for example, the teacher might say, "How many pieces are in one third; you have thirty seconds to make sure everyone on your team knows."

Step 3. Heads Together. Students literally put their heads together and make sure everyone knows the answer. The role of the Checker may be added here.

Step 4. Teacher Calls a Number. The teacher will call a number at random and students with that number raise their hands to be called upon if they know the answer, as in the traditional classroom.

Variation:

A Numbered Heads Together spinner or Student Selector for the overhead is available, and makes the structure more game-like. The spinner is also handy because teachers do not have to remember which numbers they have called.

If the answer is within the capacity of most teams, but only one or two students raise their hands, the the teacher might say, "Not enough Number Twos have their hands up; I'll give you one more minute, make sure all your Number Twos know the answer."

If the question has several answers, such as, "Name six fractions equivalent to one half," the teacher will get fuller participation by asking for the number ones to name one equivalent fraction, the number twos to name another, and so on.
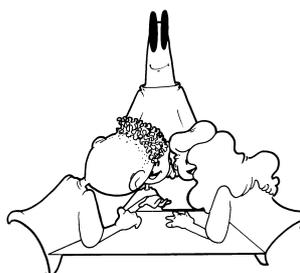
If a student gives a partially correct response, the teacher might ask, "Is there a Number Three who can add to that response?"
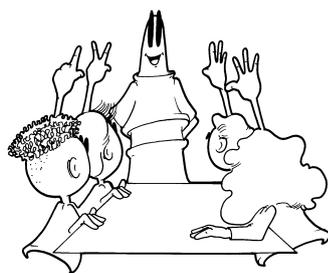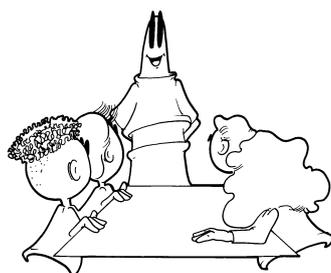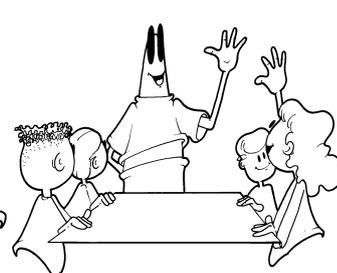

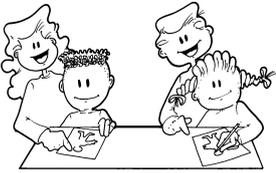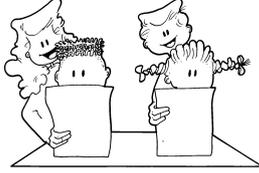**1. Students Number Off 2. Teacher Presents Problem 3. Heads Together 4. A Number is Called**

Pairs Check

See Lessons 9, 12, 15, 18, 20, 21

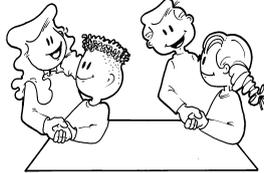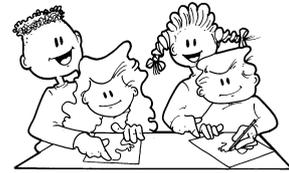**1. "A" does problem**   **2. "B" checks**   **3. "B" praises**   **4. "B" does problem**

Steps of Pairs Check

Sitting in teams of 4, each person has a partner on the same side of the table. One is "A", the other one is "B". Each A, B pair share one worksheet.

Step 1. "A" does the problem. In each pair, "A" works on the problem while "B", the coach, watches, and helps, if necessary.

Step 2. "B" Checks. The coach checks partner's work for agreement.

Step 3. "B" Praises. If the partners agree on the answer, the coach (B) praises his or her partner.

Steps 4-6. Partners Switch Roles. The partners switch roles and repeat steps 1-3. The student who had been the coach (B) now becomes the problem solver, while the other student (A) becomes the coach.

Step 7. Pairs Check. Each Pair compares its answers with the pair on the other side of the table. If they disagree and are unable to figure why, four hands go up, a signal to the teacher that the team needs help.

Step 8. Team Celebrates. If the team agrees on the answer, they celebrate with a team hand shake or cheer.

Teams will finish at different rates, so an attractive content-related sponge activity built into the worksheet is usually a good idea.

To help students do Pairs Check, a Pairs Check Worksheet like the one on the next following page is often used.

A ⃝ ▢ ▢ ⃝ A
B ⃝ ⃝ B
Step 1-3

A ⃝ ⃝ A
B ⃝ ▢ ▢ ⃝ B
Step 4-6

A ⃝ ▢ ⃝ A
B ⃝ ▢ ⃝ B
Step 7: papers go side by side to check
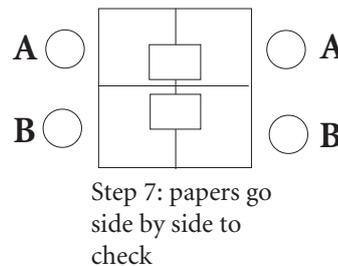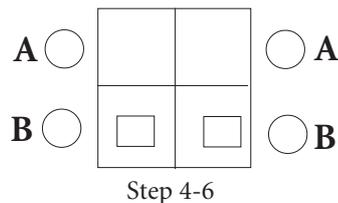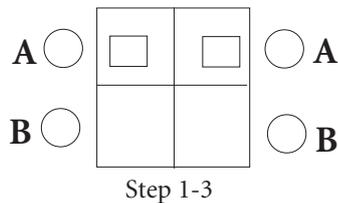
5. "A" checks   **6. "A" praises**   **7. Pairs Check**   **8. Team Celebrates**