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Wonderful Ideas

...for teaching, learning, & enjoying Mathematics!

Dancing Digits, Nimble Numbers

Welcome this year's focus, "Dancing With Decimals—a five-part series featuring lessons on decimals developed by Wonderful Ideas' mathematician-in-residence, Rachel McAnallen. In this issue, the woman known as Ms. Math to thousands of learners across the globe, presents a lesson designed to introduce students to the numbers on the left side of the decimal point. (Yes—whole numbers do have decimal points!) Rachel playfully guides a class through a succession of tactile cooperative and competitive games, using colorful foam digits, base-ten blocks, "real fake money," and numbered polyhedra dice. By physically adding and subtracting money, students will learn the difference between digit and number, and gain a strong understanding of place value.

Topics Involved: *number sense, place value (number versus digit), decimal placement in whole numbers, addition and subtraction of whole numbers.*

Materials: *pairs of students share a set of base-ten blocks* or $1, $10, $100 bills and $1000 yellow chips; an egg carton or tray containing digits 0 through 9, and the symbols .,+, - and < ; an addition/subtraction hexahedron; and four decahedron dice marked with the place value for ones, tens, hundreds, and thousands, respectively. Each student also needs a white sheet of paper to represent their wallet.*

Type of Activity: *small group activity*

Grade Level: *2nd and up. *We recommend using base-ten blocks with students in the lower grades.*

Decimal/Place Value

"We are going to play a money game today," Rachel tells students. "You are going to have three things—a wallet, a tray of digits, and some numbers. The numbers will be your money."

The partners sit side by side and arrange their work space according to Rachel's directions. Each student begins with a white sheet of paper in front of them. "Your sheet of paper is your wallet," explains Rachel.

Next, they sort a pile of colored foam digits 0 – 9 and various mathematical symbols into an egg carton placed between them. Finally, they organize their numbers across the top of their work area. "Make sure you both can reach the bank equally!" advises Rachel. Depending on the grade level of the class, the numbers students work with are represented by hundred, ten, and one dollar bills, or by base-ten blocks in the same values. "I don't use fives and twenties in this particular lesson because our place value system isn't base-five or base-twenty," Rachel explains. "Our place value system is base-ten."

Using the overhead projector, Rachel models how she would like students to arrange their money with base-ten blocks, even if the students are using bills. "I use the base-ten blocks no matter what," she says, "because there will always be some upper grade students who don't have the concept of conservation yet. I will need to show those learners certain concepts that cannot be illustrated with a ten dollar bill.

She goes over the assigned values for the base-ten blocks with the students. "Who is one today?" she asks. The class quickly establishes that the little cube is the equivalent of a one dollar bill, the long strip is represents ten dollar bill, and the big square is worth a one hundred dollar bill.

Dancing Digits *continued from page 1*

Rachel teaches the class a mantra to help them arrange their money in the correct place value order, whether their numbers are in bill or base-ten block form. "Hundreds on the left," she chants, sticking her left arm out to the left. "Tens in the middle," she says, putting both hands in front of her. "Ones on the right!" she finishes, moving her right arm out to the right. "Hundreds on the left, tens in the middle, ones on the right," the class chants in unison, complete with arm motions. "Hundreds on the left! Tens in the middle! Ones on the right!"

After a quick check to confirm that everyone has correctly set up their work area, Rachel directs the students to find the small round circles in their tray. "This is a decimal point," she explains. "I want everyone to place your decimal point in the bottom right hand corner of your wallet."

Although the students will be working with whole numbers in this particular lesson, it is important to establish where the decimal point belongs, says Rachel. "Students really do not know where the decimal point is placed in a whole number, because we don't show it enough," she explains. "It is not enough to show it once or twice on the board. When I ask middle school students to write down the number 49 with a decimal point, half of the class will put it to the left of the four. In order for students to understand and remember, they need to practice putting the decimal point down when they write a whole number." (see figure 1)

As Rachel walks around the room, she corrects the students who have put their decimal point on the left hand side of their wallet. "Some learners still have difficulty with left and right, even though I've gone through the little chant several times."

Change Your Money—Fix Your Digits!

The first activity is a cooperative large-group activity. In the beginning, Rachel decides how much the class adds or subtracts—this allows her to determine whether the students know certain mathematical concepts.

"Everyone go to the bank and get two dollars," she instructs. "Place the two one dollar bills in your wallet on the right hand side, and place them so they are vertical." Next, she tells each student to retrieve a digit 2 from their tray. "Place the digit 2 underneath your two dollars—your digit 2 still has to be on your wallet."

2.

Rachel looks around to see that the students have completed the first transaction, then gives the next direction. "Everybody, add three dollars!" She gives them time to count and stack their bills, then announces, "Fix your digits!"

Rachel watches as some students remove the 2 from the wallet and replace it with the digit 5. Others students retrieve a digit three and addition sign from the egg

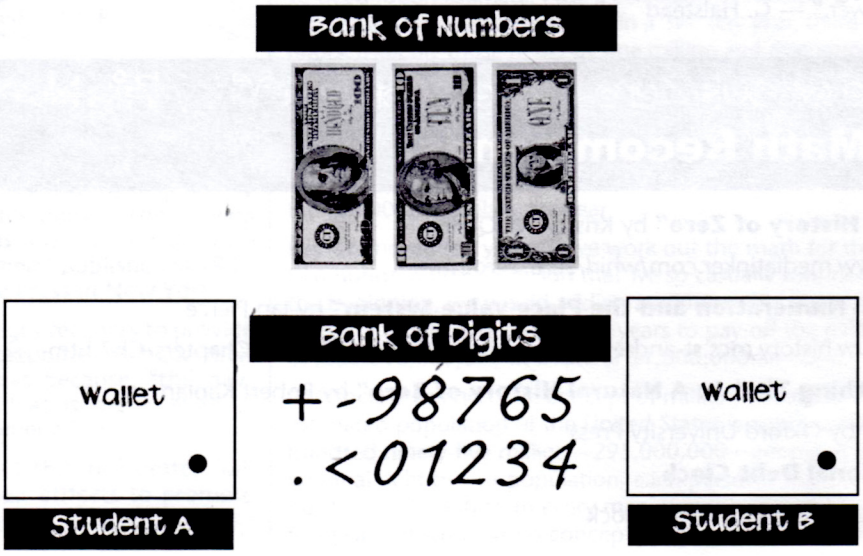


figure 1

5.

carton to create the following: 3 + 2.

On the overhead projector, Rachel arranges her base-ten blocks so that five ones are laid out in a vertical line in her wallet, creating a ones column. Using the blocks to illustrate, she shows students that right-hand digit represents how many ones are in the ones column, the middle digit represents how many tens students have, and the left-hand digit represents how many hundreds are in their wallet. "You are only allowed to have one digit in each column—otherwise it would look like you have three tens and two ones in your wallet." The students who need to adjust their digits place a 5 in the ones column.

"You are doing such a great job," encourages Rachel. "Now, you all have to go to the store and you are going to buy a dollar candy bar. Everybody subtract one dollar from your wallet."

Students remove one bill from their wallet and return it to the bank.

"Fix your digits" Rachel calls out. Students replace the digit 5 beneath their stack of ones with a digit 4 .

"Everyone add five dollars," says Rachel. The room rustles with the sound of students counting out five one-dollar bills. "Fix your digits!"

Choosing a student to call on, Rachel asks, "What does your digit say?"

"My digit says nine," the girl replies.

"Does your digit correspond with the money in your wallet?" Rachel wonders. Carefully, the student counts her money and confirms that there are nine one-dollar bills in her wallet.

"Guess what?" continues Rachel. "Your mother sent you out to buy two gallons of milk—everybody subtract 7 dollars!" With a groan, the students reluctantly remove the bills from their stack.

"Fix your digits!"

Rachel gives students a chance to replace the 7 with a 2, then asks the class, "Does your digit tell you how much money you have?"

"Yes," they reply.

"Those digits always tell a story," says Rachel. "Now—guess what? You won the lottery! Add ten dollars." The students eagerly add their first ten-dollar bill to their wallet.

"Fix your digits!"

Rachel walks around the room watching to see how students place their digits under their money.

Some students correctly place the digit 1 beneath the ten dollar bill, creating the number 12.

Other learners add two digits to their wallet—a one and a zero—to create the number 102.

Rachel selects a student who has made this mistake and asks, "May I sit in your chair? Gathering the class around the table where she's sitting, Rachel removes the money from the wallet in front of her and puts it out of sight.

Pointing to the digits, she instructs the owner of the wallet to read the number they've created. "One hundred two dollars," he says.

Placing the bills in the student's hand, Rachel asks, "Well...how much money do you have here?" "Twelve dollars."

"Oh!" says Rachel with a horrified gasp. "Your digits are lying to you!" She takes the money from the student and puts it back in the wallet. "Your digits say you have one hundred two dollars, but your money says you only have twelve dollars!" With a sheepish smile, the owner of the wallet removes the zero and slides the digit 1 into the tens place.

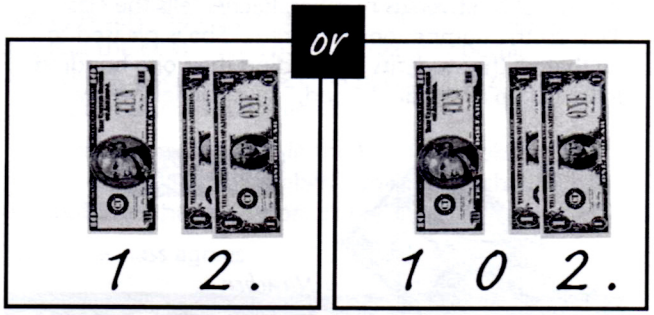
In the background, another student murmurs, "Oh, I get it!"

"What did just you get?" Rachel asks.

"Well, now it says they have one ten. The other way, it said there were zero tens."

"What a great mistake," says Rachel. "How many people are happy that he made this mistake?" Several learners raise their hands.

Which Digits' Story is True?



"I have one ten & two ones." *"I have one hundred, zero tens & two ones."*

When the students have returned to their seats, Rachel tells them, "You all did such a wonderful job with that--add twenty more dollars to your wallet."

After the class has fixed their digits to read 32, Rachel asks students retrieve an addition symbol from the egg carton and place it up between their two sets of bills.

Digit versus Number

"We are going to learn a little chant," she announces. "Go pick up your digit three from your wallet and wave it in the air." The room is filled with a sea of threes. " Repeat after me," says Rachel, waving her own three in the air. "This is the digit three. When I wave it in the air, it is the digit three. When I put it in it's place"—with a smack, she slaps her 3 into the tens place in her wallet—"it becomes a number. It is the number thirty. It tells a story. It says I have three tens."

Next, everyone holds up the digit 2. "Wave it in the air," urges Rachel. "Good!" In unison, the class chants, "This is the digit two. When I put it in it's place"—slap!—"it becomes a number. It is the number two. It tells a story. It says I have two ones!"

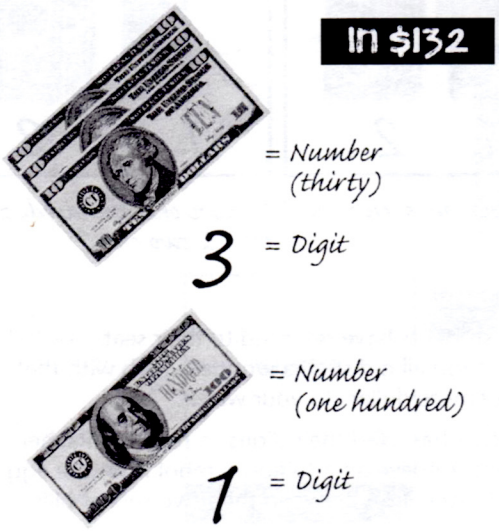
"You have done such a wonderful job! Everyone add one hundred dollars to your wallet!"

The announcement is met with enthusiasm as students quickly retrieve a one hundred dollar bill from the bank.

"Put an addition sign between your one hundred-dollar bill and your ten-dollar bills," Rachel directs, "then go ahead and fix your digits!"

Seeing that all the students have arranged their digits to read 132, Rachel suggests, "Lets say our little chant—pick up your digit one." "This is the digit one!" proclaims a chorus of voices. "When I put it in it's place"—SLAP!—"it becomes a number! It is the number one-hundred. It tells a story. It says I have one one-hundred!"

To test whether or not the students understand the concept of digit versus number, Rachel tells the class, "Pick up the number one hundred." She is pleased to see that all the students are holding their one hundred dollar bill up in the air. "Good," says Rachel. "Now, lay down your one hundred and pick up your digit one." The students wave their digits at her. "Hold up your number thirty." Three ten-dollar bills go up in the air. "Pick up your digit three." Rapidly, the class raises their digits. "They usually have the idea pretty quickly," observes Rachel.



The Zero Effect

Next she presents students with another scenario. "You need to go buy new clothes because school has just started," she explains. "You buy a shirt for $30. Everyone subtract $30 from your wallet."

While students complete the transaction, Rachel silently walks around the room to see how they will fix their digits. Many students have put a zero in the tens column, but a few have left the space blank.

Once again, she gathers the class around while she takes the seat of a student who has not put a digit in the tens place. Rachel removes the money from the wallet in front of her and asks the student, "What story are your digits telling you?" The student pauses, "Twelve?" Rachel swiftly places the money back in the wallet and covers the digits with her hands. "What is your money telling you?" "It says I have one hundred two dollars." "Oh," Rachel says in alarm, "Then your digits are not telling the correct story—your digits are cheating you!"

The student quickly recognizes her error. "I need a zero for my tens," she tells Rachel.

Rachel chooses a student to go up to the overhead and fix the digits so that they match her base-ten blocks—throughout the lesson she never changes the digits in her example until the students have fixed their own.

"Who understands about zeros a little better?" Rachel asks as the class takes their seats. A couple of students raise their hands. "Even some of our fifth and sixth graders don't always have the concept of place value and the zero yet," notes Rachel.

Standard & Expanded Form

"When you read the amount you have in your digits, that is known as standard form," Rachel informs the students. "If I tell you to read your number in the standard form, you will say, 'One hundred two.' If I tell you to read it in expanded form," she adds, "that means I would like you to read your money—in other words, 'One hundred, plus zero, plus two'."

To illustrate this idea, Rachel sends the class on another shopping trip. "You are going out to buy some candy for you and your friend. You spend two dollars on candy. Subtract two dollars from your wallet."

The students remove the two one-dollar bills from

their wallets, leaving them with a single one hundred-dollar bill.

"Fix your digits," says Rachel.

Walking around the room, she checks to see that each student has arranged their digits so that they read 100.

"Read your number in standard form," she says.

"One hundred dollars," the class responds.

"Read your number in expanded form."

The response is mixed. Many students answer, "One hundred, plus zero, plus zero." A few simply say, "One hundred."

"In this case, either answer is correct," Rachel tells them. "Go ahead and add ten dollars to your wallet."

Some learners retrieve a single ten-dollar bill from the bank. Other students decide to count out ten ones.

"Fix your digits," says Rachel as she walks amongst the tables. She pauses by the desk of a student who has added ten one-dollar bills. Instead of replacing the zero with a digit one in the tens column, he attempts to squeeze two digits into the ones column: 1 0 10. "How many tens do your digits say you have?" Rachel asks him.

"Zero."

"Does your money say you have a ten anywhere?" she says. He thinks about this for a moment, then exchanges his ten ones for one ten. He fixes his digits so they read 110.

"Remember," Rachel tells the class, "We can only fit one digit in each column. In real life you don't always trade in ten ones for one ten," she admits. "The only reason we ever do trading is so we can write the number in digital form or standard form."

They read the contents of their wallet in both standard and expanded form: "One hundred ten dollars—one hundred plus ten, plus zero or, one hundred plus ten."

Which Digit Is It?

"Add a dollar."

The class has no trouble fixing their digits this time: **111**

"Pick up your digit one," says Rachel, with a sly smile. The students are clearly puzzled by this instruction. She waits as some of them pick up a one from the ones place, some select the one from the tens place, and still others pick up the one in the hundreds place. Her smile widens when a girl finally asks, "Which one?"

"Oh—good question!" says Rachel. "Everyone put down the digits you've picked up. When I say pick up the digit one, you need to ask me, 'In what place?'"

"Pick up the digit one," repeats Rachel. Amidst scattered giggles, the students demand, "In what place?" "In the hundreds place," she replies, waving her own digit one in the air. Together they chant, "This is the digit one. When I put it in it's place"—SLAP!—'it becomes a number. It is the number one hundred. It tells a story. It says I have one one hundred."

"Pick up the digit one," Rachel says again.

"In what place?"

"In the ones place."

Again they repeat the chant, "This is the digit one. When I put it in it's place it becomes a number. It is the number one. It tells a story. It says I have one one."

"I love the little chant," confesses Rachel. "Suddenly the shyest kid in the room is now talking. The child is touching the money, they are seeing the money, they are seeing the digit form of the money, and they are speaking. There are so many different modalities of learning going on."

Zero Effect, Part II

Next, Rachel tells the students to subtract one dollar from their wallet. "Fix your digits," she reminds them. Surveying the room, Rachel checks that the digits in every wallet read 110 before she announces, "Now you are going to go buy a big ticket item—subtract one hundred dollars."

Fixing their digits, some learners remove the one from the hundreds column and replace it with a zero: **010**

Rachel selects one of these students to fix the digits on the overhead projector in the same way. "One of those zeroes is very important, and one isn't important at all," she tells the class. "Which zero is really important?" After much discussion, the class decides the zero in the hundreds column isn't needed.

"If we take away the zero in the hundreds column, we now have a two-digit number," observes Rachel. "Do our digits tell the same story as our money?"

"Yes," the class agrees.

Slow Trade—Quick Change

"Subtract nine dollars,"

The students' response to this direction varies. Many students immediately recognize that they can throw their ten-dollar bill in the bank and quickly retrieve a one-dollar bill to place in their ones column. Other students go through the process of exchanging their one ten-dollar bill for ten one-dollar bills, and then physically subtract nine ones from their wallet.

"This is the way they have been taught to subtract,"

reasons Rachel. "We teach students that they must take the ten—whether it is in base-ten form or money form--and they must go to the bank and trade it in for ten ones in order to subtract nine." Using the base-ten blocks, Rachel employs the "cover-up" method—sliding her finger up until only one of the blocks in visible--to demonstrate how they can quickly subtract nine ones from their tens column.

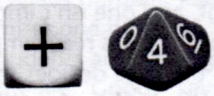
After her demonstration, she gives the next direction. "Add nine."

Rachel notes that the very same students who knew how to subtract nine from ten in the last example, will go to the bank and count out nine one-dollar bills before they see that they have ten in their wallet. "They are not quite ready to throw the one-dollar bill back in the bank and pull out a ten," she says. "That comes later on."

Partner Up!

Once the Rachel is confident that the students have the basic concept, they are ready to play a cooperative game with their partner. She provides each team with a 10-sided die (decahedron) numbered 0 – 9, and a 6-sided addition/subtraction die (hexahedron). Each team begins the game with a one hundred-dollar bill, two ten-dollar bills, and three one-dollar bills, with addition symbols between each column. As with the large group activity, players arrange their digits to accurately reflect the amount of money in their wallet: $123

Selecting a partner, Rachel gathers the class around to give a demonstration of the game. Taking the first turn, she rolls + 4. "Add four dollars," she reads.



Both she and her partner add four one-dollar bills to their wallet. "I've added four to three, so now I have seven dollars," she calculates, fixing her digits. "Remember—don't touch your digits until you have finished working with your money," says Rachel.

The person who rolls reads their digits in standard form, then their partner reads their money in expanded form. "One hundred twenty-seven dollars," reads Rachel. "One hundred, plus twenty, plus seven," reads her partner.

On the next turn, Rachel's partner rolls +8.

"How are you going to add 8 dollars?" asks Rachel.

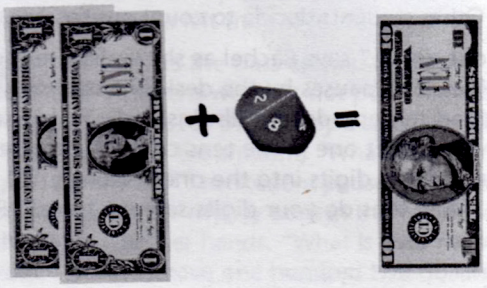
Going to the bank, the student counts out eight one-dollar bills. Looking at the stack of ones in her wallet, she counts out ten and trades them in for one ten-dollar bill. "Great," says Rachel. "I think I'll add mine differently." Picking up two one-dollar bills from her wallet, she holds them next to the 8 on the die. "What do I have?" she asks.

"Oh—ten!" says one student.

"Two plus eight is ten," says Rachel. She puts the two bills into the bank, pulls out a ten-dollar bill and places it in the tens column of her wallet. "Not all students will understand what I've done," notes Rachel, "but some will. I don't care at this point, because not everyone learns at the same rate."

Fixing her digits, Rachel observes that the digit in her ones column is less than it was before. "We only have five and we had seven before," she muses. "What happened?"

"We gained another ten in the tens column," her partner explains.



$2 + $8 = $10

"Yes, we lost two ones, but we gained a ten," agrees Rachel. "Read your answer in standard form."

"One thirty-five dollars," says her partner.

"One hundred, plus thirty, plus five," Rachel reads in expanded form.

On her next turn she rolls subtract 6.

Thinking out loud, she says, "I can subtract five right away." She removes the five ones from her wallet and places them in the bank. "Now, I still have to subtract another one." Taking a ten-dollar bill from her wallet, she decides to trade it for ten one-dollar bills and subtracts one dollar.

Her partner decides to put her ten in the bank and retrieves four ones. "You just took the six dollars out of your ten," Rachel observes. "You didn't even mess around with ones."

Fixing their digits, they read the amount in their wallet in standard and expanded form. "One hundred twenty-nine," and "One hundred, plus twenty, plus nine."

After Rachel and her partner have each taken three turns, Rachel puts the students in to pairs. She groups students by skill level and personality. "I put the shy students together, which forces them to talk and I put the talkers together and let them drive each other crazy," she

laughs. "If you put a shy child with a talker, the quiet student will never speak up." Pairing two students who don't have the concept, or are reluctant to speak allows Rachel to keep a closer eye on them. "I can differentiate the game," she explains.

As the activity progresses, Rachel walks around the room observing. She notices that a pair of students is not reading their answer in standard and expanded form. "Not everyone is talking! If I don't hear you saying your number in standard and expanded form," she warns, "I will come over and take highest bill in your wallets!" True to her word, when Rachel catches a group not reading their numbers aloud she makes a big production. "Oh, this group wasn't talking!" she announces. "I'm taking one hundred dollars from each of you!" Once she sees the group has begun to talk, Rachel returns their money.

Moving around the room, Rachel pauses whenever she notices a group has rolled a subtraction sign. "I don't stop if they are rolling addition—they know how to add. I want to make sure they can subtract." The digits are especially helpful—if the students have $137 and they roll – 9, Rachel can see right away that they will have to go into the tens column." "I know when to stop according to what they have rolled."

High Rollers

The students play the game quite a while before Rachel stops them and asks, "Who would like to roll tens and ones?" Bringing them around, Rachel gives another demonstration with a new partner. "When we roll the tens and ones, we don't roll the addition/ subtraction at the same time," she explains. "It makes the game more exciting."

Rolling the two numbered dice together, she rolls a 20 and a 5. "Oh, twenty-five!" she says. Rachel picks up the operation die and gives it a small shake. "Will it be add twenty-five or subtract twenty-five?" she wonders. When the suspense is over, she is not happy with the result of her roll. "Oh, subtract twenty-five dollars!"

Her wallet contains $137. She subtracts twenty from thirty in her tens column, and five from seven in her ones column. Fixing her digits, she reads, "One hundred twelve dollars." "One hundred, plus ten, plus two,' reads her partner.

In the next roll, they add sixty to their wallet. When Rachel hears her partner counting his tens and saying "One, two, three," she corrects him. "When you count your tens, then you must count by tens—ten, twenty, thirty…" she explains. "It's a matter of language."

They fix their digits and read what is in their wallets:

"One hundred seventy-two dollars."

"One hundred, plus, seventy plus two."

Rachel rolls: 70 and 1, and +

"I want to have a lot of tens first," she says, counting out seven ten-dollar bills from the bank. "Ten, twenty, thirty, forty, fifty, sixty, seventy." After checking to make sure she has counted correctly, Rachel lays the bills in the tens column of her wallet. Next she adds a one-dollar bill to her ones column. "I've got a lot of tens," she says. Counting out ten ten-dollar bills, she exchanges them at the bank for one hundred-dollar bill.

"It's okay to carry a big stack of tens in your wallet," Rachel says, "But once you go to change your digits, you have to exchange them." She fixes her digits and reads, "Two hundred forty-three."
"Two hundred, plus forty, plus three," reads her partner.

Some teachers wonder if students should be writing the numbers down, but Rachel disagrees. "To have them roll the dice, work out the addition or subtraction, exchange the money, fix the digits, and then write it down is too much—that is what the digits are for. The time will come for writing it down, but right now they are getting the concept."

Rachel emphasizes that students must finish working with their money before they touch their digits. "Sometimes learners get confused and if they've changed their digits, they can't remember where they started."

Rachel's partner takes the next roll: 20 and 8, and -

"What's the easiest way to subtract twenty-eight?" Rachel asks.

"Take it out of thirty," suggests a student.

"Oh, good idea." She picks up three ten-dollar bills from her tens column and puts them in the bank. "How much do I get back?"

"Two dollars."

Rachel takes two dollars and places them in her ones column.

Her partner decides to trade back. He doesn't have eight ones, so he trades in a ten-dollar bill for ten one-dollar bills and puts them in his ones column. Next he takes eight one-dollar bills from the thirteen ones in his wallet and puts them in the bank, leaving him with five ones. Finally, he takes two ten-dollar bills from his ten column and puts them in the bank. He fixes his digits and reads in standard form, "Two hundred fifteen dollars."

"Two hundred, plus ten, plus five dollars," says Rachel in expanded form.

After the demonstration, students play the cooperative game rolling the ones and tens dice together. Rachel continues to monitor the groups. She stops at a pair of students who have rolled subtract 75. Reading their digits, she sees they have $116 in their wallets. Without missing a beat, one learner picks up his one hundred-

dollar bill, tosses it in the bank and counts out $25 in change. Seeing he has eleven one-dollar bills, he trades ten of them in for one ten-dollar bill.

Fixing his digits, he reads, "Forty-one dollars." "The students will work at their own level," says Rachel. " Let the kids work it out on their own."

In-the-Hole-y Rollers

Eventually, students will roll a combination that requires them to subtract more money than they have in their wallets. "If you get in financial trouble, wave to me furiously," Rachel tells the class. It isn't long before a pair of students calls her over. "We rolled subtract sixty-one dollars, but we only have fifty-one in our wallets," they tell her.

"Oh goodness," says Rachel. "Can I sit in your seat?" she asks one of the partners. The class gathers around to watch. She takes the five ten-dollar bills and one one-dollar bill and puts them in the bank, leaving the wallet empty. "We can subtract fifty-one," she says, "but we still need to subtract ten dollars." Below the wallet she fixes the digits so they read – 10. "Now we can see that we have negative ten dollars. We are in debt. Negative ten dollars means subtract ten dollars. I really owe the bank ten dollars."

She rolls the dice: 80 and 3, and –

"Oh boy—I already owe ten, and now I owe another eighty-three. So that is ninety-three dollars I owe the bank."

She has her partner make the next roll: 20 and 6, and +

"Let's add that money to our wallet," she instructs. "What should we do now?"

One student pipes up, "You could pay some of your debt."

She pays back twenty dollars to the bank. "Now I'm not in debt so much," she agrees. Noticing she has six dollars in her ones column, she decides to pay another three dollars to the bank. "I have three dollars in my wallet, and I owe seventy," explains Rachel.

"Can you have money in your wallet and still be in debt?" a student asks.

"Yes," says Rachel. "That's real life—the seventy dollars is what I owe the credit card company, but I still need to have some cash in my wallet for groceries." She asks the student, "Even though I have that three dollars in my wallet, where am I financially, really?"

After some thought, the student replies, "Sixty-seven?"

"That's right," agrees Rachel. "In this game, I need to clear up my wallet and fix my digits to reflect where I am financially. She puts the three dollar-bills in the bank and adjusts the digits to read – 67.

When most of the students have mastered rolling the tens and ones, Rachel offers them the option of rolling the hundreds die. Yellow chips representing $1000 are added to the bank, left of the hundreds. Changing places with a student in one of the groups, Rachel has the class gather around for another demonstration. She rolls: 500 and 50 and 6, and +

Looking at her digits she sees that she owes eighty-eight dollars. "I'm not going to deal with the negative number yet," Rachel says. She takes the money out of the bank and arranges it in her wallet. "Now I want to get out of debt. I owe eighty-eight dollars. I want to subtract that from one hundred. She takes a one hundred-dollar bill and puts it in the bank. I get twelve dollars back. She puts her change in her wallet and counts up her money. Fixing her digits, she reads, "Four hundred sixty-eight dollars." "Four hundred, plus sixty, plus eight," reads her partner.

In the next turn, they roll: 100 and 50 and 3, and -

"It's nice to have the money to pay it," says Rachel's partner. She completes the money transaction and fixes her digits. "Three hundred fifteen," she reads.

"Three hundred, plus ten, plus five," says Rachel.

"It's okay if some students still aren't ready to roll the hundreds." she says. "They might choose to stick to rolling ones and tens for now. This is differentiation in it's purest form--they are all doing the same activity, but at their own level."

Competitive Game

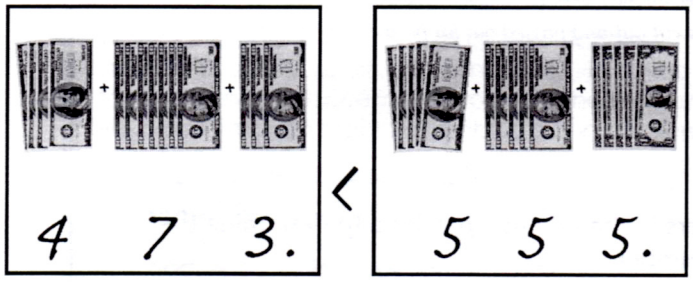
Students spend a couple of days playing the cooperative game, rolling ones, tens, and hundreds before Rachel introduces the final activity. "Who would like to play a competitive game today?" Rachel asks the class. She chooses a new demonstration partner, and the rest of the students circle around. "Each person starts with $555," Rachel says. After she and her partner have arrange their money and their digits in their wallets, Rachel places an equals sign between her digits and her partners: 555 = 555

"My five hundred fifty-five dollars is equal to your five-hundred fifty-five dollars," she reads.

In addition to the hundreds, tens, and ones dice, students now have the option of rolling a thousands die. "I can choose whether I want to roll thousands, hundreds, tens or ones," Rachel explains. "Its up to me." She decides to play it safe and roll the tens and ones: 80, 2... -

In the competitive game, only the person who rolls must adjust their wallet. "I am going to subtract eighty out of one hundred, says Rachel. "I have to tell my partner what I'm doing—I subtract eighty out of one hundred and have twenty left." She exchanges a one hundred-

dollar bill for two ten-dollar bills. I'm going to subtract two from five. That leaves me with four hundred seventy-three dollars." She fixes her digits, removes the equals sign and replaces it with a greater than/less than sign: 473 < 555



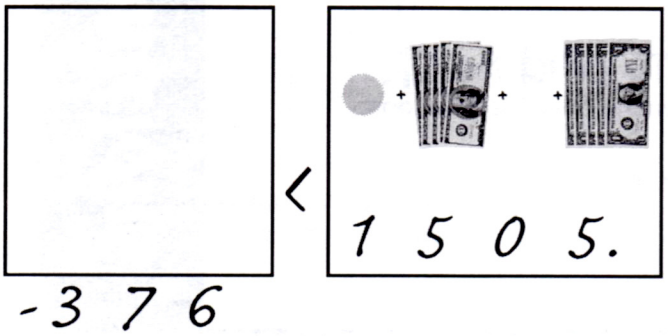
"Four hundred seventy-three dollars is less than five hundred fifty-five," she says. Her partner must read the sentence from the other direction. "Five hundred fifty-five dollars is greater than four hundred seventy-three dollars."

It is the partner's turn. "I'm going to roll ones, tens, hundreds," he decides. He rolls a 900, a 50, and a 0. The air is filled with suspense as he rolls the operation die. "Add!" he says in relief. He takes a one hundred-dollar bill from his wallet and takes a thousand-dollar chip from the bank, which he places to the left of his hundreds column. Next, he adds five ten-dollar bills to his wallet. Realizing he has ten ten-dollar bills, he exchanges them back for a one hundred dollar bill. He fixes his digits and reads, "One thousand five hundred five dollars is greater than four hundred seventy-three dollars."

"Four hundred seventy-three is way less than one thousand five hundred five," says Rachel in dismay. It doesn't get any better—on her next turn she rolls: 400 and 80 and 9, and -

"Oh boy. Subtract eight hundred forty-nine!" She takes four one hundred-dollar bills and puts them in the bank. "I still have to subtract another four hundred," she says. "That puts me four hundred in the hole." From her tens, she subtracts forty. "I still have thirty dollars in my wallet," mutters Rachel. "I'll take nine from one of my tens, which leaves me with twenty-four dollars in my wallet."

"You still owe four hundred!" her partner reminds her.



"Oh yes—I need to know exactly where I am in debt. If I pay the bank twenty-four dollars, that will leave me owing three hundred seventy-six dollars and nothing in my wallet," she says sadly, fixing her digits.
– 376 < 1505

Rachel reads, "Negative three-hundred seventy six is way, way less than one thousand five hundred five."

"One thousand five hundred five is way MORE than negative three hundred seventy-six," her partner reads with glee.

"If I were to read my number in expanded form," says Rachel, "I would say, subtract 300, subtract seventy, subtract six. Or I could say, negative three hundred, negative seventy, negative six."

Once the students have watched this last demonstration, most students choose to play the competitive game with their partner. "Give students enough time to play and work through the addition and subtraction, Rachel advises. It is possible that one or two groups will want to stick with the cooperative game a bit longer.

"On rainy days, students ask if they can play the money game during recess," reports Rachel. "They love manipulating the money and rolling the dice. It is a wonderful activity—it has become one of my favorite lessons to teach." Ω