

Chapter 3

MATHEMATICAL EPIC ORAL STORYTELLING

Structural Relationships Among Teachers, Children, and Mathematics

Let us observe a fourth grade classroom on two consecutive days.

On Monday when we observe at 10:00, the teacher is standing in front of the class presenting a mathematics lesson using an instructional format that might be described as lecture while calling on children to answer questions. The class is quiet and orderly, but over half of the students in it are disengaged. Several students are daydreaming, off in another world of their own. Several are poking at each other with some private joke. Several are following what the teacher has to say from a slouched position at their desks. Several others are attending to the teacher while sitting stiffly upright. The classroom seems to have little coherence that binds its members together.

On Tuesday when we observe the same classroom at 10:00, the teacher is again standing in front of the class presenting a mathematics lesson. But this time the teacher is telling an oral story. All of the students have their eyes riveted on the teacher while they lean alertly forward in their desks. As the teacher moves to one side of the classroom the entire class sways in that direction as a single entity. As the teacher moves back toward the center of the classroom, the entire class seems to shift their bodies toward the center of the room. The teacher and students are so engrossed in the lesson that they seem to be a single organism moving together.

These two classroom observations of one teacher and twenty-five children portray two very different views of how teachers, children, and mathematics can be structurally related to each other during instruction. This chapter will explore the nature of these relationships during epic oral storytelling. It will partially do so by comparing more traditional instruction with mathematical oral storytelling.

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In more traditional American classrooms the instructional model that defines the way teachers, children, and mathematics interact can be characterized as transmission of abstract, generalized, objective mathematical truths by a knowledgeable teacher from a textbook to a student. In this model mathematical knowledge is seen to exist outside the learner and teacher in an impersonal, logically organized, objective form that is usually stored in a book. The teacher is seen as acting primarily as a transmitter of these impersonal truths, be it as a conveyer of truths to the child's intellect or as a trainer of the child's mind to perform mathematics skills. The teacher's stance is that of an agent disconnected from both the mathematics and the child in any intimate way.

Let us now examine how the relationships among teachers, children, and mathematical content function during epic oral storytelling.

THE TEACHER-STUDENT RELATIONSHIP

The intersubjective sharing of meanings between teacher and student during the collective endeavors of telling and listening to an oral story are very different from the transmission of objective information from a teacher to a student that takes place during more traditional mathematics instruction. The resulting relationships between teacher and student are also different.

While telling an oral story such as "The Wizard's Tale," storytellers take their students into their confidence as they share a personal fantasy that is laden with both subjective and objective meanings, with both affective and cognitive messages. They share the story in the way a person might share a piece of good news or a secret. They share both the content of a message and their personal feelings about that message.

Both the storyteller and the listener stand on the same side of an oral story as they travel through its adventures together. They interact together more as leader and followers on an adventure than as transmitter and receivers of information. For example, Doris and her students accompany each other as companions—with Doris leading the way—as they project themselves into "The Wizard's Tale" and help Tinkerbell and her friends on their adventures.

Both storytellers and listeners have complementary roles to play as they construct a story. Storytellers construct a story from within themselves and share it with listeners. Listeners take what a storyteller offers and reconstruct the fantasy within their own conscious and sub-conscious minds for themselves as they join the storyteller in the story's adventures. Storyteller and listeners suspend a certain amount of worldly belief as they enter a fantasy world together.

During an oral story, listeners are not passive receivers of information from a storyteller. Not only do listeners reconstruct the story for themselves in their minds in order to give it meaning, but they also help the storyteller tell the story by doing such things as magic clapping, singing songs, answering questions, and taking on roles such as bulldozer, parrot, and gorilla. In addition to joining in the construction of a story, listeners join the story's characters on their adventure as they project themselves (in their fantasies) into a story. During the adventure the teacher, students, and story's characters share many subjective and objective meanings as they get to know each other, have adventures together, and learn from and teach each other. In doing so a closeness and trust develops between teacher and students, between a more experienced leader and less experienced followers.

In comparison, a more formal impersonal relationship exists between teacher and students during traditional mathematics instruction. The more formal impersonal relationship exists for at least three reasons: First, the knowledge transferred from teacher to student is primarily impersonal, logical, objective information in which neither teacher nor students have a personal vested interest. Second, their relationship is between a superior person who has the knowledge and an inferior person who lacks the knowledge. Teacher and students are not pursuing an adventure together with danger before both of them; rather the teacher has a desirable item—knowledge—that needs to be transferred to students who lack that item. The relationship is between a giver and a taker who are on opposite sides of information, rather than between two helpers who are both on the same side of the adventure. Third, the instructional medium of lecture and examination that connects them places the teacher and student on opposite sides of instructional endeavors rather than on the same side of an adventure encountered together.

The more personal relationship that develops between teacher and student during oral storytelling, in comparison to what exists between teacher and student during more traditional instruction, might be partly described as an *I-thou* relationship in comparison to an *I-you* relationship. The difference between an I-thou relationship and an I-you relationship can be partly described in terms of how the more personal, familiar, and affectionate French pronoun *tu* is used in comparison to *vous*. Persons having an I-thou relationship share emotions, thoughts, and awareness in a more personal manner than persons in an I-you relationship, in which objective information is the major item passed between them. In I-thou relationships there is a joining or meeting of people's minds and feelings, whereas in I-you relationships there is a more formal transmission of intellectual capital from one individual to another.

This intersubjective sharing of meanings between teacher and students takes place both while the teacher is telling the story and while the teacher is circulating among, monitoring, and helping students as they solve (mathematical and social) problems in their small groups.

THE STUDENT-STUDENT RELATIONSHIP

Students do not listen to stories alone. They listen as members of a collaborative group. This raises the question, "How is a group of students collaboratively listening to an oral story different from the following types of groups found within more traditional mathematics classrooms: a group of students listening, as individuals, to a lecture (in which a teacher delivers a monologue that is received by many separate individuals); a group participating in a discussion (involving multiple individual exchanges between students and a teacher who acts as a moderator); a group doing worksheets (during which students work alone); or even a group listening to a children's book being read (in which a teacher delivers a monologue replicating text that is received by many separate individuals)?"

One difference is that together students are collaboratively constructing the story's meaning, jointly acting within the story, and sharing subjective and objective meanings with each other. The "togetherness-as-a-group-of-colleagues" on a joint adventure, is very different from the "one-among-many-separate-individuals" working alone through a task. Two issues will be examined to illustrate how the relationships among these groupings of students are different. The first issue relates to how oral storytelling facilitates the building of unique mathematical cultures in classrooms. The second issue relates to how the collaborative

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learning environments in which oral storytelling takes place help students acquire knowledge and construct meaning.

Culture Building

Every classroom in which mathematics is taught has a set of rules and regulations, instructional rhythms, roles for students and teachers, myths, traditions, values, expectations of students and teachers, and modes of communication. Together these make up the classroom's mathematical culture. The mathematical cultures of most more traditional classrooms are fairly uniform, and the casual observer could step from a third grade Massachusetts classroom into a third grade California classroom and hardly notice a difference.

One of the unexpected things that occurs during epic oral storytelling is that groups of children (under the guidance of a teacher) build distinct mathematical cultures in their classrooms that are very different from one classroom to another. These cultures are likely to include such things as unique special languages, heroes, myths, traditions, knowledge, symbols, values, and modes of communication. Surprisingly, these distinct cultures can be fairly quickly established and can have an enormous influence on how students interact with each other and learn.

As an example let us look at some of the unique elements of Doris Lawson's fourth grade that came into existence and remained in existence in her classroom for the duration of the school year as a result of "The Wizard's Tale." By the time "The Wizard's Tale" was complete, all of Doris's students acquired the habit of uttering the sounds "beep, beep, beep" during addition. Everyone knew that this simultaneously meant a bulldozer backing up and the process of "carrying" a ten, hundred, or thousand to the next column once a "trade" was made during addition. This "beep, beep, beep" sound continued to be quietly uttered by students throughout the year, and everyone accepted it and knew exactly what it meant, just as they would know what it meant if students raised their hands after a teacher asked a question.

In Doris's classroom students occasionally said to each other, "You are going to turn to stone." Everyone understood what this phrase meant. It was a warning that someone was making a mathematical error. Similarly, everyone in Doris's classroom also knew what was being requested of them if they were asked to talk like a parrot (using a particular type of mathematical language) or write like a gorilla (using specific types of mathematical symbols). And if Doris asked, "Would Tinkerbell do that?" or if one of her students asked, "Help me the way Tinkerbell would," everyone knew what this meant, for everyone knew Tinkerbell's values and her standards for kind and helpful behavior. These expressions were classroom regularities just as much as the ringing of the school bell to signal the end of the school day is a classroom regularity.

If, however, uninitiated visitors stepped into Doris's mathematics class for the first time, they would not know what lay behind all of these unique cultural elements because they are regularities only within Doris's classroom.

During epic oral storytelling children (under the guidance of their teacher) seem to quickly build unique, powerful mathematical cultures within their classrooms. Part of the reason for this is that oral storytellers, such as Doris, view their stories as microworlds that they and their classes temporarily live within, microworlds that have their own unique rules for causality and their own unique systems of expectations for social interactions. When children listen to a mathematical epic oral story they have to learn how to act within it in ways that are

consistent with its story and its underlying social structure. They have to both understand (at either the conscious or subconscious level) the story's culture and adapt their behavior so that it is consistent with that culture. They have to suspend acceptance of their own everyday classroom culture and enter a new culture and behave in accordance with its special linguistic elements, heroes, myths, traditions, symbols, values, knowledge and meanings, rules and regulations, instructional rhythms, roles for students and teachers, expectations of students and teachers, and modes of communication.

There are two aspects of oral storytelling that facilitate children entering a story's microworld and then transforming elements of their regular classroom culture to correspond to the story's culture. Both have been previously discussed. They include (1) the ability of listeners to take an active role in a story and act within it in ways that make a difference in the story, and (2) the ability of oral storytellers to tailor their stories to the unique interactions that occur between themselves and their audiences (such as when the oral storyteller uses the name, piece of clothing, gesture, or utterance of a member of the audience in a story).

During an oral fantasy, students do not simply sit and hear the story. They actively engage in, listen to, and act within the story. It is the active engaging in, listening to, and learning to act within the fantasy's culture that helps students learn to behave (or *live*) in accordance with its cultural traditions and values and then later to transfer selective components of the fantasy's culture into the normal everyday culture of their classroom. Also, as a result of learning to successfully act in a fantasy's mathematical culture in ways that make a difference in that culture, children have an incentive to carry their success within the story into their classroom. They use the mathematical modes of behavior learned within the story in their classroom because it allows them to feel—and be—powerful mathematical actors. And when many children collectively bring behavior learned in the context of a story into their classroom, with strong motives to behave in accordance with the story's culture because it makes them feel powerful, then (under the guidance of their teacher) they have the ability to transform their previously existing classroom's mathematical culture into a new one. If students only passively observed the story, rather than actively engaging it, they would not get to practice new behaviors that they could then use during their normal mathematics time.

The ability of storytellers to tailor their stories to the unique interactions that occur between themselves and their audiences also facilitates the creation of unique classroom cultures. Typical ways of drawing part of a classroom's culture into a mathematical fantasy include naming a story's characters after students and incorporating into the fantasy memorable classroom events. By connecting classroom events with occurrences in an oral fantasy, aspects of the fantasy become part of a class's collective cultural memory. By having a flexible interplay between the culture underlying the oral fantasy and the culture underlying normal mathematical class time, transfer of the culture underlying the fantasy to the culture of the classroom is also facilitated. It is facilitated as a result of associating and connecting aspects of the two cultures in students' collective mathematical memory. The transference of the fantasy's culture to the normal classroom culture is further reinforced because the memories of the story are in the children's collective consciousness, and any class member's reference to an element in an oral story during normal classroom time reinforces all class members' memory and association with the mathematical culture underlying the story. The unique collaborative experiences children share while experiencing a story also provide a bond that ties them to the story's underlying cultural elements and in doing so helps them mold and sustain a new mathematical culture outside of the story within their classroom.

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Two examples illustrate how elements can transfer between a normal classroom culture and a story's culture. Laura McBride tells "The Wizard's Tale" and other mathematical oral stories in ways that connect her third grade class's cumulative memory during stories with that of their normal classroom time. One day the teacher from the classroom next to Laura's ran into her classroom very upset because she had a tick on her. Laura calmed the teacher down, removed the tick, and disposed of it in front of her class while talking about what to do if you get a tick on yourself. Soon afterward the teacher's behavior and the tick showed up in an oral epic tale; and yes, it could only be removed when a particular mathematics problem was solved. What is important here is that all of Laura's students associated the story's tick with the adjacent classroom teacher's tick, and this mental connection enriched the story and the class's cumulative memory. In an oral tale about multiplication that was set in ancient Greece, Laura named a mathematical wizard after one of the girls in her class who had very little confidence in herself as a mathematician. During the story the girl's namesake was spoken of as someone who was a marvelous mathematician, and the children in Laura's classroom (including the girl) associated the wizard with the girl. During the story the girl gained increased confidence in her ability to do mathematics as a result of the association. In addition, other students in Laura's class associated the girl with the wizard with the same name and began to treat the girl as particularly competent in mathematics. As a result, the girl's mathematical self-esteem, skills, and understanding increased greatly as elements of the story's culture flowed into Laura's normal classroom culture.

Collaborative Learning Environments

In "The Wizard's Tale" students learn in small and large (whole-class) collaborative groups. Examining the dynamics of the groups will provide insight into the structural regularities of collaborative groups and how collaborative learning environments can help students acquire mathematical knowledge and construct mathematical meanings. To do so, three issues need to be explored: role differentiation, collaborative social interactions, and collaborative learning.

Role Differentiation

When Doris puts students into small groups during "The Wizard's Tale," she does not just tell them to work together. Rather, she very clearly defines the roles in which students are to function. These functional roles represent different types of mathematical endeavors. They also define the ways in which she wants her students to think about mathematics and learn mathematics.

The major roles Doris assigns students are those of mute bulldozer (Tinkerbell), talking parrot (Gandalf), and writing gorilla (Habble). All students also have two other (seemingly hidden) roles that they must always function in: listeners to what each other says and watchers of what each other does.

When Doris's students are the bulldozer, they are a *doer* and physically demonstrate how to do addition with base ten blocks using *bodily-kinesthetic* actions. These actions provide the learner with an intuitive subverbal action-oriented understanding of the meaning of addition.

When they are the talking parrot, they are a *talker* and *verbally articulate* the mathematical processes occurring as the base ten blocks are manipulated by the doer. The role of talker

forces students to clarify their understanding of addition by using verbal language to bring to a fully conscious level their intuitive understanding of addition.

When they are the writing gorilla, they are a *writer* and *record using mathematical symbols* the actions demonstrated by the doer and verbalizations articulated by the talker. Each recording of a number is contextualized by its correspondence to a physical action and a verbal articulation that fits it into the overall algorithm.

All group members must constantly listen to what each other says and *aurally interpret* the meaning of verbal articulations. Both the doer and writer must listen carefully so they can follow the instructions of the talker. All group members must listen to each other so that they can constructively participate in group discussions.

Actions with blocks also provide all group members with a series of *visual images*, each relating to a stage in the addition algorithm. The images provide a series of pictorial storyboards that illustrate how the base ten blocks are physically arranged at each stage of the addition process and that visually guide learners through the addition process.

These five roles define both how students are to act in small groups and how students need to think about and learn mathematics. Every student must learn how to function in each of the five roles. This is because Doris believes that if a student can experience the meaning of mathematics from each of these different perspectives, and intellectually coordinate their understanding from all of these perspectives, then the coordinated relational understanding that they construct will be of greater depth and provide them with greater conceptual flexibility than if they can think about mathematics in only one way.

Collaborative Social Interactions

During “The Wizard’s Tale” Doris structures the social interactions among students in their small groups around four principles. The first is *mutual independence* (Johnson, Johnson, & Holubec, 1991). This refers to structuring groups so that group members see themselves as linked together in such a way that no one in the group can succeed unless all members of the group succeed, and if the group as a whole succeeds then all members of it have succeeded. Within small groups (and the story) children (and wizards) are indispensable members of their group and must carefully coordinate their endeavors with those of other group members.

The second principle underlying group behavior is *clear role accountability* (Johnson, Johnson, & Holubec, 1991) for both the group as a whole and individuals in the group. This involves clear specification of the group’s goals and the role each student is to perform in their group. In “The Wizard’s Tale” the group goals and the group member roles (as doer, talker, and writer) are clearly defined.

The third principle is *mutual peer tutorial interaction*. In essence, mutual peer tutorial interaction means that children take responsibility to help each other learn, as needed, by being each other’s peer tutors. This involves children assessing each other’s endeavors, providing each other with constructive feedback, teaching and learning from each other as necessary, and discussing the nature of the learning being jointly experienced. Doris emphasizes the importance of this principle during the story when she says, “The characters comment on how explaining a concept to someone else helps the one who is explaining it understand it better themselves.”

The fourth principle guiding groups is *group reflective processing*. This involves establishing an environment where students reflect on their experiences and share their insights

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and thoughts with each other. Group reflective processing is distinguished from the phrase *group processing* in the sense that the former primarily involves reflections on content issues while the latter primarily involves reflections on how the group is working together as a dynamic social entity. In “The Wizard’s Tale” group reflective processing takes place as group members monitor each other’s behavior, discuss what they learn each day, and share, as groups, their reflections with the whole class.

The five roles within which students function and the four principles guiding social interactions do not just happen by accident. Doris actively promotes them, both while telling the story and while circulating among, monitoring, and helping students as they solve problems in their small groups.

Collaborative Learning

The five roles for students and the four principles for group interactions are important because they define the structure of the social interactions in Doris’s class during “The Wizard’s Tale.”

They are also important because they define the structure of the intellectual environment of small groups that governs how mathematical knowledge and meanings are exchanged among group members (through teaching and learning). These exchanges of knowledge and meaning between group members will be called *interintellectual* exchanges—or intellectual exchanges *between* people.

In addition, they are important because they define the structure of the intellectual environment in which individuals speak to themselves, teach themselves, and learn from themselves. These intellectual exchanges within individuals, through which they construct meaning, will be called *intraintellectual* exchanges—intellectual exchanges *within* a single person.

What is significant here is that the principles that guide how people socially interact and the roles within which they function provide a structural model that governs how they exchange ideas, teach each other, and learn from each other (interintellectual exchanges). In addition, these rules and roles that determine how people physically interact with each other also provide a structural model that governs how individuals construct meaning within themselves (intraintellectual exchanges).

This models current learning theory that suggests that intellectual development cannot be separated from the social contexts in which it occurs and that the intellectual communication of knowledge and meaning between people and within a single individual are greatly affected by the social context in which they occur (Albert, 2000). Vygotsky suggests this when he says that “[all] the higher [level intellectual] functions originate as social relations between [people]” (1978, p. 57).

It also goes beyond current learning theory, however, to suggest that as educators we can intentionally construct social environments in classrooms where the rules and roles for social interactions that we insist children work within provide the intellectual model for how they exchange ideas between each other (interintellectual exchanges) and within themselves (intraintellectual exchanges).

In fact, this is what Doris attempts to do in her classroom when she tells “The Wizard’s Tale” and sets up a social structure that designates how students are to act and interact, a social structure that in turn determines how learning takes place between individuals and within individuals. Two examples help explain this.

Let us first examine interintellectual exchanges among three students working in a collaborative group as doer, talker, and writer in Doris's classroom during "The Wizard's Tale." Assume the writer erroneously records a trade of ten ones for one ten. Several things might happen. First, the talker or doer might make a comment that what was done by the writer is incorrect. (This follows the principle of mutual interdependence.) This might be followed by an explanation of the correct behavior by reference to the actions of the doer and verbalizations of the talker. (This follows the principle of role accountability.) The doer might now demonstrate to the writer the actions that parallel the correct recordings and point out the discrepancy between those actions and the writer's erroneous recordings. The talker might now describe in words to the writer what the doer demonstrated and again point out the discrepancy between the verbal description he or she offered and the erroneous written symbols. (This follows the principle of mutual peer tutorial interaction.) These cross-modality discrepancies (between action and recording and between talking and recording) are what pressures the writer to rethink how the writing should take place, and either re-perform the recording correctly or ask for more clarification in order to better understand what to do. (This follows the principles of mutual peer tutorial interaction and group reflective processing.) Finally, the doer and talker will ask the writer to explain in words and recordings what should be recorded and why those recordings should be made. (This follows the principle of group reflective processing.) When everyone is satisfied that the writer knows what to do, and why to do it, the members of the group continue their work. (This follows the principle of mutual interdependence.)

Let us now examine a hypothetical example of an intraintellectual exchange by viewing what might occur within one of Doris's male students when that individual thinks or speaks to himself during "The Wizard's Tale." Imagine the student working an addition problem all by himself while using only recordings. The student progresses satisfactorily until making a mistake. Assume the error involves a trade of ten ones for one ten. The student is monitoring his own behavior and stops himself. You can see the troubled look on his face. The student says to himself, "There is something wrong here." Now the student reconstructs in his mind what underlies the recording by reference to actions he imagines in his mind (using visual images) that he would perform as a doer and by making subverbalizations to himself during which he recounts to himself what he would say to himself as the talker as he describes his imaginary actions. You can see the child doing this. His hands are moving above his paper as though he is pushing base ten blocks around (he is doing the real pushing of images in his imagination), and his lips are moving as he imitates the speech of the parrot (as he speaks quietly to himself). While rethinking to himself the actions and talk that accompany the erroneous recordings, the student discovers the discrepancies between what was recorded and the actions and talk that underlie those recordings. You can see that the child has discovered something because of the "Aha!" look on his face. The cross-modality discrepancies (between action and writing and between talking and writing) clarify for the student what is wrong and how to correct it. The need to eliminate the cross-modality discrepancies (or the cognitive dissonance) is what pressures the student to reconstruct for himself (as a result of assimilation and accommodation to preexisting intellectual constructs) new cognitive structures that do not contain the discrepancy. In the process the student reconstructs for himself a new conception of how to do multidigit addition and why things work as they do during addition. (This is called learning.) The student then continues working on the problem.

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Several things are important here. First, there are principles of social interaction that underlie the interpersonal dynamics of social groups, knowledge exchanges among members of a social group (interintellectual knowledge exchanges), and knowledge construction within an individual (intraintellectual knowledge construction). The principles discussed above are *mutual interdependence*, *clear role accountability*, *mutual peer tutorial interaction*, and *group reflective processing*. These are not the only principles that exist, and oral storytellers, including Doris, do structure groups differently. Principles such as these do not just emerge in a classroom by themselves. They are modeled and described by teachers as they tell a story and reinforced by teachers as they circulate among, monitor, and help students as they work in small groups.

Second, these principles can parallel each other at the level of group social dynamics, interpersonal knowledge exchanges, and intrapersonal knowledge construction.

Third, there are mathematical roles that group members can be given by a teacher that pressure them to act in a specific manner. The roles presented thus far are those of doer, talker, writer, visualizer, and listener. These roles are some of the major vehicles through which knowledge and meaning can be taught and learned in social settings. These are not the only roles available to oral storytellers. (For example, Doris has experimented with adding a fourth student to groups to function as a group coordinator.)

Fourth, the physical roles that students can be asked to assume within a group can parallel, provide models for, and shape interintellectual exchanges of knowledge between individuals and intraintellectual knowledge construction within an individual. When a person speaks to others (during interintellectual knowledge exchanges) or to him or herself (during intraintellectual knowledge construction) using the voices (or roles) of doer, talker, writer, visualizer, and listener, that person is using some of the major modes of mathematical communication and knowledge construction.

Fifth, learning can result when students working in a cooperative group take on distinct roles (such as doer, talker, and writer) and then notice and comment on discrepancies between their behaviors. Similarly, when a person speaks to himself or herself using different voices (such as those of doer, talker, and writer), this cross-voice speaking, along with natural impulses to minimize cognitive dissonance, offers a powerful way of clarifying meaning, generating knowledge, and constructing understanding.

Sixth, teachers can design the social structure of instructional groups and specify the cognitive roles that students must assume as they interact in groups. These social structures and roles can provide a model for both interintellectual knowledge exchanges and intraintellectual knowledge exchanges. The social context in which children learn, and the actions, talk, and writing that are expected of them as they work in groups, can provide a model for how they learn by communicating with others and with themselves.

This is what Doris attempts to do in her classroom when she tells “The Wizard’s Tale,” both while telling the story and while circulating among, monitoring, and helping students as they work on mathematical problems and social interactions in small groups. She sets up a social structure that designates how students are to act and interact that in turn shapes the intellectual structures that dictate how communication and learning take place between individuals and within individuals.

In fact, every teacher (including those teaching mathematics in more traditional ways) determines how children learn (through both interintellectual and intraintellectual knowledge exchanges) by the way in which they structure the social environment of their classrooms, the

roles they and their students are forced to assume, and the principles of social interaction. A question that each teacher must ask is, "Have I carefully thought about the social structure of my classroom and its effects on children's learning?"

THE RELATIONSHIP OF CHILDREN TO MATHEMATICS

The relationships between children and mathematics during oral storytelling are different from those during more traditional instruction. They are not different in the way *red* is different from *not red*, but in the way *red* is different from *red and not red*.

Underlying the relationship between mathematics and children during oral storytelling is a view of two different ways that the child can think about mathematics. One way is associated with children's natural childlike way of conceptualizing, thinking about, and speaking about their world. The other way is associated with adults' professional mathematical way of conceptualizing, thinking about, and speaking about their world. Oral stories introduce children to mathematics using children's concepts, thinking, and language and then systematically move children as far as possible toward the adults' conception of professional mathematics. In contrast, more traditional mathematics instruction attempts to present to children as pure a view as possible of adult professional mathematics. Several distinctions highlight the differences.

Logical Versus Logical and Imaginative Thinking

More traditional mathematics instruction tends to view mathematics as abstract, generalized, logical, objective truth that is free and separate from the influence of the person who created it, who transmits it, or who possesses it, and free from the influence of any specific social, cognitive, affective, or physical context within which it might exist, arise, or be used.

In more traditional classrooms during the process of learning mathematics, children are conceptualized as rational cognitive minds that are capable of acquiring knowledge and developing the ability to use algorithms, deductively solve problems, and reason logically. In many of the newer models of more traditional mathematics instruction, children are also recognized as social, physical, and affective beings having connections to their real physical and social worlds. But even so, while children are in the process of learning mathematics they usually continue to be conceived of as primarily rational minds capable of acquiring objective truth by using a variety of logical and rational modes of thinking that might employ symbolic, physical, graphical, or pictorial mathematical representations.

From the perspective of oral storytelling, children's minds contain more than just rational and logical capabilities. One of the most powerful parts of children's intellectual life is their imaginative and fantasizing capability.

Epic oral storytelling views the child as containing both imaginative and fantasy capabilities and rational and logical capabilities. When these two types of intellectual capabilities are simultaneously drawn upon during instruction, it is believed to be possible to intellectually touch a child more deeply than if only the child's rational and logical capabilities are drawn on. In general, oral storytellers attempt to *start where the child is* and move toward where we would like the child to be as an adult. At the very least, they attempt to facilitate children's understanding through the use of their rational and logical capabilities as a

result of employing the energy and motivation inherent in their imaginative and fantasy capabilities. The valuing of both types of capabilities can be seen in the way in which Doris asks children to use their rational and logical capabilities to understand and do mathematics while at the same time imagining themselves as mathematical actors in the fantasy world of “The Wizard’s Tale.”

Formalized Versus Formalized and Personalized Mathematics

Setting mathematics in a fantasy story that requires children to use both their rational and logical and imaginative and fantasizing capabilities transforms mathematics into something different from what it is if it is only viewed as a subject in which children use their rational and logical capabilities.

As previously mentioned, more traditional instruction views mathematics as abstract, generalized, logical, objective truth that is free and separate from the influence of the person who created it, who transmits it, or who possesses it, and free from any specific and particular social, cognitive, affective, or physical context within which it might exist, arise, or be used. During oral storytelling mathematics is also viewed as personalized, particularized, temporalized, socialized, concretized, physicalized, contextualized, and made intuitive as it is given both subjective and objective meaning through the child’s actions in the child’s cognitive, affective, physical, and social consciousness. The word *also* is very important here, for in oral storytelling mathematics has associated with it both objective truth and personalized meaning, as well as both dimensions of all the dualities mentioned above.

Crucial here is that oral fantasy stories broaden our conception of school mathematics, mathematics instruction, and the nature of the child as a mathematician. In so doing they transform our conception of mathematics and the way in which children and mathematics relate during instruction. For example, because children use both their logical and imaginative capabilities while doing mathematics during oral storytelling, oral storytelling in turn imbues mathematics with both imaginative and fantasy and rational and logical dimensions, with both objective truth and personalized meaning.

To elaborate on what this means, “The Wizard’s Tale” will be examined to illustrate eight dimensions of this broader view of mathematics.

Personalized

When Doris tells “The Wizard’s Tale,” the mathematics that her students encounter originates from within her. It is Doris’s personal creative interpretation of the fantasy (that I wrote) and its mathematics that is shared with her students in such a way that Doris is sharing a part of herself. By doing so, Doris personalizes the story’s mathematics.

She also personalizes mathematics in other ways. One way is by associating it with the endeavors of the story’s characters. When Tinkerbell becomes a bulldozer that acts out the addition algorithm, addition is personalized by being embedded in her persona. Another way is by asking children to pretend to be a character in the story and to do mathematics the way that character would. When children are asked during “The Wizard’s Tale” to pretend to be a bulldozer, talking parrot, or writing gorilla, they are being asked to project themselves into the role of story characters and imitate their mathematical actions—and in so doing they embody and personalize that mathematics within themselves.

Once mathematics has been learned in a personalized context, the storyteller systematically proceeds to begin to generalize that mathematics in such a way that it can float free from the particular individuals associated with it. Through this process mathematics learned in a very personal way also becomes understood in its more objective, abstract, symbolic form. By the end of “The Wizard’s Tale”—after the bulldozer and parrot are stripped from the story—students do addition using only numerical symbols.

Particularized

In “The Wizard’s Tale” mathematics is first presented in the context of very specific situations and problems that arise as Tinkerbell moves about two particular sets of base ten blocks. It is particularized in such a way that it has meaning only with respect to one problem and one specific set of actions. Later, once the algorithm has been mastered and understood in very specific contexts, it is generalized so that students can apply it to a wide range of mathematical situations. Eventually, generalized mathematical understandings will be built upon a foundation of particularized mathematical experiences.

Concretized and physicalized through the child’s actions

When Doris tells “The Wizard’s Tale,” she first gives her students very concrete physical ways of thinking about mathematics (that are consistent with Piaget’s concrete operational stage of development). She does so in two ways.

One involves using concrete models of abstract mathematical ideas by having specific (concrete) characters in the story actively (and concretely) do mathematics by manipulating physical materials. Here we see Tinkerbell the Bulldozer acting out mathematical operations (with concrete actions) using “stone” base ten blocks (concrete representations of numbers) on a magic place value symbol (a concrete representation of our place value number system meant to embody attributes such as different columns for a number’s differently valued digits). The other involves having children give meaning to this concrete mathematics by physically acting out the mathematics *themselves* using physical manipulatives. Here children use their own real, concrete bodily actions to act out mathematical operations. As a result, mathematics becomes something inherent in children’s own concrete way of behaving and not a formal construction separate from their physical selves.

After mathematics has been concretized and physicalized through the child’s actions, an attempt is made to generalize it and make it abstract in such a way that it stands free from individuals’ specific concrete behaviors. This transition takes place during the last two episodes of “The Wizard’s Tale.” Moving from the use of base ten blocks to numbers is moving from a concrete, physical, and enacted conception of mathematics toward a more abstract, generalized, and objective form of mathematics. In the story, telling another person how to do something mathematical is one step removed from only knowing how to do it oneself.

Socialized

In “The Wizard’s Tale” the addition algorithm is given meaning in four very specific social contexts: through the social interactions of Doris (the storyteller) and her students; through the social interactions among the story’s characters (Tinkerbell, Gandalf, etc); when

Doris's students help the story's characters (teaching each new wizard liberated from stone how to do addition); and when students work together in small social groups to learn mathematics. Doing so involves cooperatively explaining and acting out the algorithm, coordinating clearly defined roles (such as acting bulldozer, talking parrot, and writing gorilla), monitoring and assessing each other's behavior, and teaching and learning from each other as necessary.

Important here is that mathematics is not presented separate from social contexts. The learning of mathematics originates in actual social interactions that take place between human beings. Of course, by the end of the story Doris's students must do mathematics by themselves.

Contextualized and temporalized

When Doris Lawson tells "The Wizard's Tale," she places mathematics in a very specific story context and time frame. In addition, she attempts to tell the story in such a way that her students project themselves into the story and see themselves as accompanying its characters on their adventures. This gives mathematics meaning by connecting it in numerous ways to the children's real and fantasy lives in ways that are consistent with Piaget's concrete operational stage of development (when children are believed to best understand new knowledge by relating it to very concrete situations in which they act or visualize themselves acting).

This is in contrast to the way in which more traditional instruction presents mathematics in a decontextualized, abstract, and generalized form. Of course, by the end of "The Wizard's Tale," children are asked to begin to build more decontextualized, abstract, and generalized mathematical ideas, but those ideas are based on their contextualized and temporalized concepts.

Made intuitive

One of the difficulties faced by many mathematics teachers is finding a way to help children transform the abstract, generalized, objective truths of mathematics into personal meanings that become part of their intuitive way of acting within their world. One of the reasons why Doris tells oral stories is to help children understand mathematics on the intuitive level where they "know it in their bones." She wants children to act mathematically as though it was "second nature." She wants to help children know mathematics as well as they know how to walk. Once they have an intuitive understanding of and feel for mathematics, they can then move on to understand it at a more abstract, generalized, objective level.

As it is given both subjective and objective meaning

When Doris tells "The Wizard's Tale," she attempts to intertwine both subjective meanings and objective knowledge, and to link them to each other in order to give subjective meanings increased objectivity and to give objective meanings increased intuitive meaning. During the story mathematics is constantly placed in a context that is rich with fantasy, imagination, and specific personalized idiosyncratic meaning. At the same time, however, Doris presents objective mathematical algorithms, and she regularly asks her students to meet in social groups where they must perform a variety of mathematical roles that are constantly assessed against a standard rooted in objective mathematics. Doris believes that to make mathematics

come alive for children in meaningful ways educators must nurture both subjective and objective mathematical understanding.

In the child's cognitive, affective, physical, and social consciousness

Oral storytellers see children as cognitive, affective, physical, and social beings. They attempt to teach mathematics to the *whole child*. The physical, cognitive, and social dimensions of Doris's endeavors have already been commented on above.

Doris is also concerned with her students' affective stance toward mathematics. Her concern for her students' feelings about mathematics and their feelings about themselves as mathematicians is part of the reason why she places mathematics in the context of an exciting fantasy where its characters enjoy doing mathematics and where successfully doing mathematics enables its characters to thrive within their social and physical environment. Doris believes that when her students project themselves into the roles of the story's characters (as bulldozer, parrot, and gorilla), they also try on those characters' positive attitudes toward mathematics, see how they feel, and often accept those feelings as their own. As previously mentioned, Laura McBride reports surprising success in naming characters in her stories after students in her class with the result that her students take on the positive attitudes toward mathematics of the characters that were named after them.

Telling stories that involve the whole child in learning mathematics (cognitively, affectively, physically, and socially) broadens the more traditional conception of mathematics as primarily a body of logical objective truths that can be cognitively understood.

Dualities

If children are to grow to be creative mathematicians, they will need to be able to handle the creative tension between the abstract and the concrete, the formal and the personalized, the general and the particular, the deductive and the intuitive, the logical and the imaginative, the objective and the subjective, the cognitive and the affective, and the social and the individual. Inherent here is not just a view of children learning two forms of mathematics and how to transition between them, but also a view of children learning how to use different types of mathematical intelligence: their more rational and logical and their more imaginative and fantasizing intellectual capabilities. If children are to become mathematicians—either as creators of new mathematics or applicers of mathematics already understood—they will eventually need to experience both of these modes of thinking, understand how to move between them, be able to bring both to bear separately and simultaneously while doing mathematics, and know how to handle the creative tension between them (Kline, 1980, p. 298).

Underlying these dualities might be an assumption that the extremes are distinct from each other with a no-man's-land in between. These dualities might be seen as similar to the Western construction of the mind versus body duality or the subjective versus objective duality, with everything being one or another and nothing being both. This is the way more traditional instruction views mathematics, with the assumption that only the rational and logical extreme is of value. This is not, however, the assumption underlying oral storytelling, in which mathematical activity is viewed as a mixture of both of these dualities—like the interaction of the yin and the yang that the Chinese believe comprise everything rather than like Western dualities.

THE RELATIONSHIP OF TEACHERS TO MATHEMATICS

Most of what needs to be said about the relationship between teachers and mathematics has already been presented. One point, however, needs elaboration. The relationship of teachers to mathematics during oral storytelling is quite different from that within more traditional instruction. More traditional mathematics instruction tends to depend on lecture, recitation, and seatwork (that extends into homework). When teachers lecture, by and large, they act as instruments whose job it is to deliver to students objective truth, the origins of which lie entirely outside themselves (usually in textbooks or curriculum guides). During recitation teachers stand outside of the re-presentation process and act as coordinators and evaluators of children's activity. When children do seatwork (or homework), teachers are supervisors or evaluators of children engaging in mathematical endeavors, and they stand separate from the mathematical endeavors in which children are engaged. In most traditional instruction, teachers stand separate from mathematics and have little vested interest in it or personal involvement with it, except to the extent that they are invested in helping children learn it.

During oral storytelling, teachers present mathematics and mathematical stories from within themselves. The telling of each story is a very personal affair in which teachers present their fantasies and mathematical meanings to groups of children in such a way that feelings and thoughts, affect and ideas, and subjective and objective meanings are mixed together in a fantasy story line. In presenting mathematics in this way, teachers become personally invested in the mathematics, for teachers are presenting parts of themselves and not simply transmitting objective information that originates outside and separate from themselves. Doris Lawson says that when telling an oral story she presents much more of herself—in the sense of exposing her personal thoughts, feelings, hopes, joys, humor, and fears—than she ever did when teaching from a textbook.

During more traditional instruction, the mathematics being transmitted originates outside the teacher, and the teacher is simply an instrument through which that impersonal mathematics is communicated. During oral storytelling, the mathematics and story presented come from within a teacher, and that mathematics is intimately tied into a teacher's persona. When Doris tells "The Wizard's Tale," the mathematics and story are mixed together and come from within Doris in such a way that Doris is telling her students about herself, her fantasies, and her mathematical meanings. When telling an oral story, teachers tell their students something about themselves. In taking mathematics into themselves in this way, teachers transform both themselves and mathematics. They transform mathematics from an impersonal decontextualized subject to a very personal contextualized one, from an abstract generalizable subject to a very concrete and contextually specific one. And they transform themselves from an instrument, whose job it is to deliver objective truth, into a person who is presenting to an audience his or her own personal beliefs, meanings, feelings, and fantasies.

For children the difference in these roles is enormous. It is similar to the difference between reading an impersonal historical account of a military battle and hearing a soldier who was in the battle tell about his or her own personal experiences during the battle with all of that soldier's excitement, fears, horrors, and triumphs mixed in with the telling. The personal investment of the storyteller in the story and its mathematics transforms the way in which listeners view the story and its mathematics.

For teachers the difference in these roles is also enormous. One of the most tragic elements of more traditional American mathematics instruction today is that so many teachers hate

teaching the subject and are so uninvested in the subject that they develop little real understanding or appreciation of it (Ma, 1999). Part of the problem is that most teachers teach mathematics by teaching a textbook in which they have no real personal interest, they convey to children something outside of and disconnected from themselves, and they transmit a subject in which they are not personally involved.

When teachers tell an oral story, something very different happens, for the story and its mathematics must come from within themselves, and they offer to their students a little bit of themselves with the story and its mathematics. This has a transforming effect on many teachers and the mathematics they teach. It can help teachers embrace mathematics and make it more meaningful to themselves, and it can help teachers begin to have fun and enjoy teaching mathematics—because they are teaching a part of themselves.