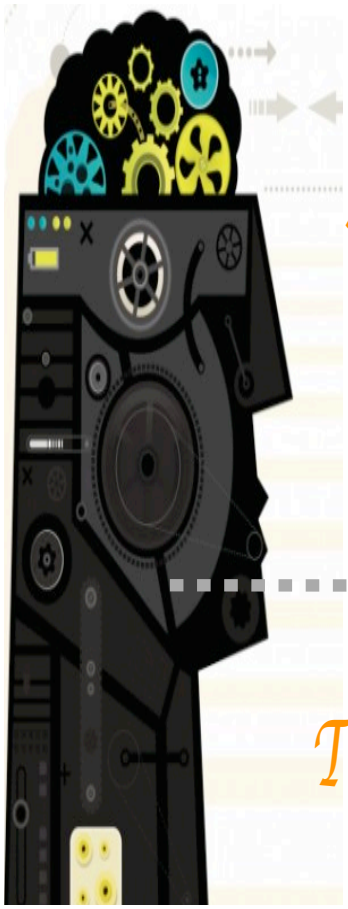

How does teacher Language, Questioning & Discourse in Cultures of Thinking classrooms shift and change over time?

THE LANGUAGE OF THE CLASSROOM

- The Language of Community (vs. Distance)
  - Pronoun choice can communicate a sense of inclusiveness, collaboration, and community (we, us, our); or it can deliver a message of division, separateness, and control (I and you)

- Language of Identity
  - Language can bring students into new words and invite them to step into new identities as scientists, writers, authors, mathematicians, thinkers and so on. These words communicate that it is learning to *do* and *act* authentically that matters, not just learning *about* the subject.

- Language of Personal Agency (vs. Rescuing)
  - Through verbal interactions with students experiencing difficulty, teachers can convey to students that they are active, decision-making agents in the learning process: "How are you planning on…" "What are you wondering about?" "What did you decide about that?" or they can step in and rescue students by making these decisions for them: "What you need to do next is…"

- Language of Noticing & Naming
  - As the more knowledgeable adult, teachers have the power to name and notice the thinking that students are doing, providing them with more sophisticated language for their thinking: "That's an interesting *connection*." "You've really *generated* some new ideas." "That's a new *theory*."

- Language of Knowing (Conditional versus the Absolute)
  - Language frames ideas and information as set, fixed, and absolute ("It is…" "What's the answer?"), or as evolving, complex, and conditional ("What's another perspective on that?" "It might be." "One way is…")

- Language of Feedback & Praise
  - Teachers use language to direct feedback and praise either on behavior or on learning. Effective learning feedback aims to guide future learning and is specific, descriptive, informative, sincere, and action-oriented as opposed to global, judgmental, reflexive, and purely evaluative.

SEE THINK WONDER
LISA VERKERK, FIFTH GRADE

LISA: The children are studying human rights at the moment. And the reason that I wanted to use the routine of "I See and I Wonder" is that I wanted to give the children the opportunity to look at a situations were children didn't have their rights.

The beauty of this routine, is that it forces the children to slow down. And to really look at pictures, and focus on what is it that they really see. And then they can wonder about what that might mean. It stops them from drawing conclusions too quickly.

Yesterday we looked at the Convention of the Right of the Child (holding up photocopy of Rights), and today we're going to carry on looking at that. The way I want to do it, is I want to give you some photographs to look at. And I want you to use a routine. I want you to use a routine we've used before, I See and I Wonder.

I've got a picture here, and it's not one that actually anybody's going to use, it's just one that I'm going to show you now. So, if we were to say, 'what do you see,' what are the kinds of things that you might say about this. Alex?

ALEX: Children saluting.

LISA: Children. You can see that they've got their hands up and they're saluting. Very good.

HUNG-JOON: I see a blackboard.

LISA: Okay. You see a blackboard. Is there any writing on the blackboard.

STUDENTS: Yeah.

LISA: Mila?

MILA: A flag.

JIN: And I see a girl, dressed like a maid.

LISA: Okay. But look what you notice. You say 'dressed like a maid.' But what is it about the girls' dresses that you notice?

JIN: They're old.

LISA: They're old.

STUDENTS: Old-fashioned.

LISA: Old-fashioned. And what is it about them that makes you say they're old-fashioned?

JIN: Because we don't wear these kind of dresses now-a-days, we wear these kind of (motioning to herself) modern clothes. What do you think might be going on with those children?

STUDENTS: Singing.

STUDENTS: Uh, they're saluting.

LISA: They seem to be saluting. So that's another one of I see, isn't it? I see them saluting. So, I see a group of children. I see them saluting.

STUDENTS: Maybe they're in an assembly or something.

LISA: JIN?

JIN: I wonder if they're singing their national anthem.

LISA: Okay, and why would you say…?

JIN: Because they're looking at the flag, and they're going like this

LISA: Alright. What we're going to do, is we're going do this part. And when we all think that we've finished with this part, we're going to come together as a whole class again and we're going to discuss what we found out…

RAHUL: The girl is worried.

GIRL: How can you tell if it's a girl? I think it's a boy.

RAHUL: We see a boy or a girl who looks worried.

GIRL: (as she writes) We see kids who look worried.

RAHUL: I wonder where they're from.

GIRL: Maybe it's the second World War?

RAHUL: Yeah, that'd a good point. (GIRL writes in the table under "What do you think is going on?": "We wonder if they're jewish; we wonder if it's in Israel; we wonder if it's WW2")

LISA: (reading the student's table) You think it might be in the second World War. And what is it that's making you say that?

RAHUL: This kind of German (pointing to picture).

LISA: Oh, this is written in German, is it?

RAHUL: Yeah, it says they're not allowed, I think. And they have it against the Jewish.

LISA: What's this sign here? (pointing)

GIRL: Star of David.

LISA: That's the Star of David.

LISA: And what do you think is being said here, in this picture here?

LISA: Ok, so you're saying over here "What's going on?," "I think the kids are being forced to work." What makes you think they might be being forced rather than actually having agreed to do…?

ALEX: I mean he probably wanted to do it, but I don't think that kid would really want to be making…I don't think that's the nicest job.

LISA: Yeah.

HUNG-JOON: Yeah.

ALEX: He'd probably have another job.

LISA: Now the next one's really interesting, you've said "I wonder if they're orphans." What made you say that?

ALEX: It looks like they don't have a home, and also him (points). It kind of looks like he lives there maybe. But, I don't really know. But we just thought some of them looked a bit like they didn't have a place to go, to live. I mean, like these ones (pointing)—these five—they looked like they had somewhere to go. But these three people, they looked a bit…

LISA: nd what do you think you were basing that idea on? When you're looking at them, what is it that you can see about them that maybe thinks they have a home to go to.

Alex & HUNG-JOON: They have clothes.

LISA: You've talked about the background that you see, the rubbish everywhere, a child asking for something, a lady on her own with her baby, wearing dirty clothes. And over here (pointing to "I wonder" column) you've said: "I wonder if they are poor." "I wonder if there's been a war." "I wonder if that's why the walls have got broken." "I wonder if he's a beggar because he has a small bucket." "I wonder if that's her job, but she doesn't get much money." This is the little girl cleaning the rubbish?

ANDRE: Yeah. We didn't have enough space…

LISA: Ok, you've done a really good job of looking at those pictures. I can see you've really tried to find an explanation for what's going on. And I really like the way that you used what you already know, things that you've already seen

LISA: What we're going to do, is you're going to come with your table and your photograph, …Come and sit up at the board. And we're going to see what conclusions we can draw about the pictures,

LISA: Hung-joon and Alex, can you tell us, quite simply, what was the big idea that you got from looking at these pictures? What were the things that you were noticing and thinking might be going on.

ALEX: Quite a lot of slavery

LISA: I'm going to pull you back a little bit, Alex, and ask you, what was it that were you *seeing* in all of the pictures, then. What were you seeing before you got to the idea of slavery. What was it you were actually seeing?

HUNG-JOON: We saw all of the children working, and we wondered if they were forced to work.

LISA: Okay. And why were some of the reasons that you thought that maybe they were being forced to work rather than just doing it quite happily.

ALEX: Because some of the jobs that the people had, like the one on the top in the middle, there are two children and they have bags on their backs, and we thought they were maybe carrying garbage. And they were being forced to do that.

HUNG-JOON: Their faces are all very serious.

STUDENTS: The one on the bottom, carrying the bricks.

LISA: Drewf? (calling on student will hand raised)

DREWF: I'm sure that they don't want to work, and they would much rather go to school. So, I wonder if they're being driven by the extreme poverty.

T & students: yes.

DREWF: And maybe their parents are making them work.

T & students: yes.

LISA: Now look, everybody, you've all done a really good job on each of your different pictures, and we'll share the others. And the idea of this is that then we'll be able to look at the connections between these different photographs and what's going on in different children's lives. And be able to draw a big conclusion about the rights of the child.

LISA: I've used this routine several times during the year already. But what I was delighted to see was it was becoming easier for them to do it. They were not getting distracted and forming conclusions too quickly, they were really looking carefully and focusing

And I think that the routine—although it's getting at thinking—it's also a social skill, it's developing that social interaction—that ability to listen to each other and to think about what somebody else is saying.

And so, the thinking that happens in the classroom becomes more exciting because they're starting to build explanations and pictures, and they help each other to understand the situation better.

Reflective Toss

Jim Minstrell

The teacher first instructional goal is to "catch" the meaning of what a student is saying.

The teacher then "tosses" or "throws" responsibility for thinking back to the student or the class.

The student then elaborates and makes her thinking more visible to herself and others.

Van Zee, E and Minstrell, J. (1997). Using questioning to guide student thinking. *The Journal of the Learning Sciences.* 6(2), 227-269.

A Typology of Classroom Questions

- **Review**: Recalling and reviewing of Knowledge and information
  - Terminology
  - Procedures
  - Content
  - Events and context
- **Procedural**: Directing the work of the class
  - Going over directions and assignments
  - Clarifying
  - Checking for attention, agreement.
  - Task completion
  - Organizational and management related
- **Generative**: Exploring the topic
  - Authentic questions or wonders that teacher doesn't know the answer to.
  - Essential questions that initiate exploration of a topic
- **Constructive**: Building New Understanding
  - Extending & Interpreting
  - Connecting & Linking
  - Orienting and focusing on big ideas, central concepts, or purpose
  - Evaluating
- **Facilitative**: Promotes the learner's own thinking & understanding
  - Requesting elaboration, reasons, evidence, justification
  - Generating discussion among the class to hear different perspectives
  - Clarifying and Uncovering

Connected Mathematics Project: Looking for Squares
Content Strand: Number
Teacher: Lisa Brown
School: Kealing Middle School, TX, Grade 8

LISA BROWN: Okay, good morning. Today our goal is to focus on finding squares. We found some squares a few days ago, but today I want to focus your attention on some squares that only will fit on what I'm going to call a 5 x 5 dot grid, I'll show you what I'm talking about. So the first square that I could draw would just be one small square right in the corner. Can someone tell me the dimensions of this square? Ashley?

Ashley: 1 by 1?

LB: And Ashley, do you know the area of the square?

Ashley: 1.

LB: So it's a 1 by 1 square and its area is equal to 1. Okay, so that would be 1 square unit. Can someone tell me another square that would fit on a dot by dot grid, another square that would fit? Dominic?

Dominic: 2 x 2.

LB: Great, thank you. And do you know the area of that square?

Dominic: 4.

LB: Dominic, can you tell me why you knew that the area of this square was 4?

Dominic: Because I took 2 x 2 and I got 4.

LB: How else can I know that the area of this square is 4? Christina?

Christina: Because you could cut it into 4 squares?

LB: 4 square units. I want you to find as many more squares as you can that would fit on a 5 x 5 dot grid. Label the area of each square that you find. Using some of the strategies that we've used in the past few days for finding areas of squares. I want you to work with a person right next to you. We're going to be looking for squares, labeling their areas, I'm listening for conversations about how you guys are finding these squares and how you are finding the areas.

Student: 3, 6, 9, the area would be 9.

Student: All the way down -

LB: Francisco, you had a question, what was your question?

Francisco: I wonder if you can a slanted square?

LB: A slanted square? Yes, you can make a slanted square. You guys remember the investigation we did where we were trying to find those parks for the city of Euclid?

So think back to the strategies that you guys were using then and see if you can some of those same strategies, so that like I said, some slanted ones would fit on here.

Student: When you figure out the area (?)

Student: Yeah, make a whole. So that's 5 altogether.

Student: And this is half and another half.

Student: 6.

Student: And it will be 8. So the area will be 8.

Student: How are we going to find the area of this (?).

Student: Well this one looks like 4 times larger than this one.

Student: Okay -

Student: So 4 times -

Student: We know the one in the middle is going to be.

Student: 2 -

Student: Square units, right?

Student: 1, 2.

Student: You can box this, we can put 4 of those in here, so 4 of these, each one is to be worth 2, we've got 4, it's going to be 8.

Student: 2, 4, 6, 8.

Student: This is going to have to be 8 square units.

LB: So how did you know like that this had an area of 2?

LB: We've done squares with area of 1, squares with area of 4, and so I wanted you guys to share other squares that you found and which group wants to go first? Tambricia?

Tambricia: We did a square of 4 by 4, and an area of it is 6 square units.

LB: Okay, great job, thank you.

Student: The dimension of our square is 3 x 3 and the area is 9 square units.

LB: How did you find that square that wasn't up right?

Student: We started connecting two dots together.

LB: I think you were able to (?) two (?).

Student: Yes.

LB: And also, how did you find that area?

Student: Because every single one of these triangles is half a square and we added 2 of them to equal 1 square and there is 4. So it's 2 square -

LB: Okay, great job.

Student: We found the area by, first we divided the parts of into little sections and then we just added like another part right here and it equaled 3 and we just halved it and it equaled 1.5. So then we just counted each little section on each side, and it came out to 6. Then we just counted the whole squares in the middle, and then it came up to 10 and that's how we got the area.

LB: Great! Can you also talk about how you found the square in the first place? Because I bet not everybody in here has that square. How many of you guys have that square? Some of you do? Okay, great! That was a pretty tricky one.

Student: How I found it was I tilted the paper over and I was just looking at it because there's other tilted squares so I tilted it and I just saw this where when I tilted the grid paper, I saw the square and then I just drew the lines and then divided it to the inside.

Student: How did y'all get that, because I don't understand. Can you explain it again, please?

Student: I'm going to draw it so it can be kind of easier for you to see. Okay? On my number 3 dots, 1, 2, 3, and that's the 4th dot, 1, 2, 3, 4 and then (here?) and then they go over, then come down and then I drew this line down over here, because all the sides have to be even.

Student: Okay, great, but Guanita, does that answer your question, because you still have like a question mark in your head.

Guanita: No, not really. It's weird. It's just like I don't see how you could just automatically see that, Veronica.

Veronica: All right, which part do you not understand, Guanita?

Guanita: Well, not only do I not understand how you like got that little tilted thing going on, but I don't understand the insides on how y'all did the 1.5's all around. Like, just connecting this part right here, and making it like a whole piece, this little section right here and then we just have to first, the squares equal 3 so we just halved it right it and it equaled 1.5. And all the other ones right here are the same as that one, so they all equal 1.5. So we just added those up. Then it came out to 6. And we just counted the whole pieces right here and it came out to 10.

LB: Guanita, do you see how we're getting the 1.5 now?

Guanita: Yes.

LB: Okay.

Student: The area was 8.

LB: Okay, so we've had several groups share and, let's see, I'm going to put them all up here and I want to ask you, do we have them all?

LB:I want to talk about side lengths, and how I can find the length of the side of a square. Now, if I know a side length of a square, like if I gave you a side length of a square, could you tell me its area of even one that's not on here? For example, this square with 9 square units has a side length of 3. And 3 times 3 is 9. But what if I gave you another side length that's not up there, like 5. What would the area of that square be? Kevin?

Kevin: 25.

LB: Yeah, excellent, good job. Okay, how about if I had a side length of 8, Casey?

Casey: 64.

LB: 64. Good, you guys get the idea? Now what if I wanted to go backwards though. And I have areas, because that's what I've got up here, right? I don't have side lengths listed up here anymore. I've just got areas. So what if I'm telling you area, could you go backwards and give me that side length? You think you could? Okay, all right, let's try one. What if the area was 100? 100? Brian?

Brian: That will be 25.

LB: 25, how did you get that?

Brian: Because 25 times 4, a square has 4 equal sides, so I multiplied 25 times 1 is 100.

LB: Okay, what do you guys think? Would it be 25 on one side? I've got some yes's, I've got some no's.

Student: (?) said that if there was one side that was 8 and then it equals 54, you are just timesing 8 by another 8. So if you are timesing 25 by 25, it's not going to be 100.

LB: Brian, what do you think about that?

Brian: That's right.

LB: Can you correct yours? So my original question was, I've got 10 square units, what would the length of one side have to be?

Brian: 10.

LB: Great. Good job. Serisa, you're ready for one? My area is 36 square units, could you give me the length of one side?

Serisa: It will be 6.

LB: And how did you know?

Serisa: Because 6 times 6 is 36.

LB: Great! Okay, Serisa, I'm going to write down what you said? 6 times 6 equals 36, that's, you said that that's how you knew what the side length was, right? So when we have an area and we're trying to figure out, what is the length of the side of a square with that area, we've got to look for, what number can I multiply by itself to give me my area. For example, in these, if I had a side length of 1 on each side, all I had to do to find area was take 1 times 1 and that would give me my area of 1 square unit. And if I have an area of 4 my side lengths are 2, because 2 times 2 is equal to 4. So I've got some new vocabulary for you. I've had a special word that I call that length of one side. Kind of a new word. I call it the square root of the area. So the square root of 4 is equal to 2, because 2 times 2 will give me 4.

Student: Ms. Brown, I have a question. I know that 2 times 2 equals 4, because this is kind of like square roots, but what if you got like 5 or something like that.

LB: Right, and why is 5 a problem for you?

Student: Now, 5 times 5 equals 25, but there's nothing to equal it. Because it's an unequal number, that's why.

LB: So we're going to talk about those kind of cases in a little while and see if we can solve them, see if we can figure them out. Okay? But let's talk a little bit more about the ones that I can do for sure. If I know that an area is 9, you've got that one on your paper, right? What's the length of 1 side, Ernest?

Ernest: It would be 3.

LB: It would be 3. And how do you know it's 3?

Ernest: Because 3 times 3 is 9.

LB: How do you know it's 3 by looking at the picture? Daisy?

Daisy: You can count the squares, like up and down.

LB: Yes, so I can count on the size. So on this one I've got 3 on one side. I can clearly see that that is the length of that side. So this side length is 3. And the length of this other side over here, because this is a square is also 3. I know its area is 9. And again, I'm going to use our new vocabulary so that I can say that the square root of 9 is equal to 3. Because 3 times 3 is equal to 9. Could you guys tell me the square root of 16? Could someone tell me the square root of 16? Okay, so Guanita you are with us. Good.

Guanita: Okay, the square root of 16 is 4.

LB: Why?

Guanita: Because 4 times 4 equals 16.

LB: Okay, and what else can you tell me about the relationship between the 16 and the 4. Dominic do you think you can tie it into the picture.Would you want to come up &show us?

Dominic: I'm not sure, but I think that it's because like if you look at it, it's like 4 going like across and going up as 4.

LB: So the 4 represents -

Dominic: The square root of 16.

LB: Okay, so Guanita, I want to go back to your earlier questions. She brought up a really good point and that is what about these? I think what she said is, I can't find anything to equal up to 5, is that what she said? Well let's take a look at that square that has an area of 5. I'm looking for the square root of 5, which happens to be the length of one side of this thing. What is the length of one side of a square with area 5?

Dominic: Isn't it 2.5?

LB: Why 2.5?

Dominic: Because you have to divide 5 x 2 and 2 x 2 is 4. So you have to add half.

LB: Okay, let's test it. If I know the length of a side, I can take the side length and multiply it times itself, that will give me the area. Let's test Stephanie's idea. If I take 2.5 times 2.5 will I get 5. Check it out. Serisa says yes. Casey says --- no.

Students: (?).

LB: All right. Serisa you had a question?

Serisa: You multiply?

LB: Yes, because if I've got the length of one side, which Stephanie thinks might be 2.5

Stephanie: That's not the right answer.

LB: Okay, so can you guys find it for me? How about if we measure it. Just to get a starting point. You've got rulers in your boxes. You guys can work together on this, it's okay. See if you can figure it out. Try measuring it, and test your ideas.

Student: (?) because look, because I got 2.3.

Student: You start from right here, don't you?

Student: Yes.

Student: Okay, you come right here. At least 2.4.

Student: I don't know. My grade's 2.4 plus 3.

Student: That's what I got.

Student: I don't know.

Student: 2.4.

Student: 7.

LB: You found it? How do you know you got it?

Student: I tried a 25 and I got 5.

LB: Did you get it to come out to exactly 5? What did you get? Let me look.

Student: 5.062, you are so close.

LB: And I've got 5.25.

Student: And this one was 4.9. Okay, so what does that tell you about the number that you are looking for?

LB: (?) 20, 25.

Student: 24.

LB: You're talking about in this part of it? So it's between 2.23 and 2.25? See if you can still find it?

Student: What did you get?

Student: 5.022.

Student: (?).

Student: Ms. Brown, I did 2.2 x 2.2.

LB: How come? How come you did this though?

Student: Because the 2.3, I measure it first -

Student: 2.3 is in the 5's.

Student: And it was like close to it.

Student: And 2.2 is close, 2.2 is like, it's not enough and then 2.3 goes over it.

Student: It goes over.

Student: How did it get to 2.23, because I don't know where you got this.

Student: Okay, when we measured it, it was 2.4 and now we've got 2.4 times 2.4, it was too much, it was like 5 and 7 something so we tried 2 because it's like, lower the number down. We didn't try 3, but we've tried 2.2 and then that wasn't, because it was, I think it was less, so we put an extra number at the end. We didn't put a 1 or 2 because that probably wouldn't work so we put a 3.

Student: My (?) is 2.4.

Student: Yeah, but that didn't work, so we have to try something else and then we when we picked the root number, we put the whole number, even with the numbers behind the decimal, we put that and then we got 5.0000002. So that's the closest one. So you got the closest (?). The measurement was 2.4.

Student: I know.

Student: Okay, so then you times 2.23, right, times 2.23, and what's the (?).

Student: We got 4.9729.

Student: Okay, then you multiply 2.23 times what?

Student: Because you put 2.233 times 2.233, and you got 4.9.

Student: I was just seeing. I was just trying to see what, if will get closer if I added another number behind it, but it didn't, because it's still a 9 and an 8. So we took all of the numbers behind the number when we got the root of 5 and we got all the numbers that we multiply that and we got it closer, because it's 5.0000002.

LB: Okay, now, I'd like to talk about this, I'd like for people to share their process about how it is that they first started to tackle this problem, Davie?

Davie: First, I measure it and it was like between 2.3 or 2.2. So I first multiplied 2.2 times 2.2 and it's 4.84. So that's like not enough, so I multiplied 2.3 times 2.3 and it's 5.29, so it's like over it. So it's like between those two numbers, 2.2. or 2.3.

LB: Did some of the rest of you notice that same relationship? Anybody else try it that way? Some of you tried it that way? Okay, and I know, I came around and I heard a lot of other strategies too. I want to talk one thing about Daisy's strategy, where the number she said, she figured out right away, it was somewhere between 2.2 and 2.3, she could even see that by measuring it with her centimeter ruler.

It turns out our dot paper, the spaces or the distance between the dots is one centimeter, so I kind of made a little number line here where I've numbered my dots, zero through 9. So I take my square with area 5, I'm going to put it right on my number line, and what do you notice? Alison?

Alison: That the square is going over the number 2?

LB: Anybody notice anything else about it? What do you notice, Daisy, I mean you were the one that kind of started us off on this track?

Daisy: It's like barely going over it, so it's like 2.2 that I measured.

LB: Does it seem like it could be 2.2?

Daisy: Yes, sort of.

LB: Yes, the same that you measured? Okay, Casey(?), how close were you able to get?

Casey: To 6, I forgot, I think million.

LB: Down into the millionth's place, or something like that? Anybody else get closer? Somebody thinks they got closer? Did anybody get it exactly on 5? It's 5.0000000, did anybody get it? Why do you think that is?

Casey: Because 5 is a prime number?

LB: It could be. We're going to talk about this more later. So Syresa I want you to hang onto that idea, because we'll probably be coming back to that, if not today, in a couple of days. What I'm looking for is exactly 5. Did anybody get it exact? You were able to get it? Guanita?

Guanita: The square root of 5 times the square root of 5 equals 5.

LB: How did you do that?

Guanita: I figured it out in my calculator.

LB: Can you show us that? That's the overhead calculator?

Guanita: I put square root 5 times the square root of 5 and it equals 5.

LB: I'm so glad you brought that up, because Guanita's just discovered a new key on her calculator. Some of you may have noticed it and what do you think that key is called? What do you think it's called? Brian?

Brian: The square root key.

LB: Excellent, good. For now though we're going to leave that behind because we're going to talk about the square root key and how to use it a little bit more either later today or in a couple of days. What I want you to do now though is I want you to use some of the same process that you use on the square with the area of 5 and see if you can find out the side lengths of the rest of the squares on your sheet and label them.

Student: 9, 30, 16, 4.

LB: I want us to talk a little bit more about how we, our process that we use to find the side lengths of some of these tilted squares, I'm noticing that you guys are having a little trouble with the tilted squares. And Stephanie volunteered to come up and show us her process.

Stephanie: I was trying to find the side length for the one that equaled 8. I took the square root of 8, times the square root of 8 and that gave me 8 with nothing left over. But when I took the square root of 8 again and I took it and I timesed the number he gave me, times the number he gave me again, he gave me one with left over. He gave me 8.0001, which wasn't exactly even like when I took the square root of 8 times the square root of 8.

LB: There were actually more zeroes there than you mentioned.

Stephanie: Right.

LB: Kind of hard to say all those zeroes all at once. So I noticed a lot of you are having that same sort of a problem. I don't understand why it won't work if I take the number that the calculator spits out and timesed it by that same number, it's not coming out. But you know, the deal is here, that what we're trying to find is an approximation and that's really all we've gotten so far. Our calculators can't seem to give us the exact thing that we're looking for here. The square root of 8 is about what? Ashley?

Ashley: I would probably say, 2.82.

LB: Okay, so what I want to do is I want to go back to the number line with that 8 squares units. What we were saying is that if I'm actually measuring the side of a square, then approximation is about all I can get. In fact, if I'm measuring with a centimeter ruler, the nearest 10th of a centimeter is probably good enough, and I can hold this one

up to my number line, I've got my 8 square units one that we've been working on here, I'm just going to slide that right up onto this number line and I can see that it's not quite 3, it's really close to 3, in fact, if it was on 3, what would I have?

Student: 9.

LB: A square with the area of 9. If it went all the way over to 3 I'd actually have a square with 9 square units. How about the 10 square units? Where would it fit in this picture? Angela?

Angela: Since it's (?) it can be like bigger and so it's going to be a little more than 3.

LB: Okay great and I can even check it by sliding it up on my number line and I can see that Angela's correct, it is greater than 3, the length of one side of a square with area 10 is greater 3. Okay, so I'm going to use some notation to talk about this approximation and one thing, I've got my square with the area of 8 square units, the square root of 8 is approximately equal and I'm not going to write and equal sign, because I know it's not exactly equal to this, but it's very close to 2.8.

LB: So I can say that the square root of 8 is proximately equal to 2.8 units. And the next one I looked at was the square with area of 9 and we know that the square root of 9 is actually equal to 3. The square root of 20 is approximately equal to 3.2 units. And tonight, for your homework, I've got a challenge for you. We're going to talk more about this kind of stuff in the next few days, but tonight I'm going to give you a segment, a different segment you haven't seen yet, and I want you guys to take a look at this segment on page 21, problem number 2. And see if you can apply some of the things that we've learned to date and figure out, what is the length of this side, approximately for that side and how it relates to what we've worked on this afternoon. The second piece of your homework is what I want you to start last now in the last few minutes that we have before we leave today. What I'd like you to start on is a summary for me in your binders. So I want you to summarize for me what you know so far about square root. I don't want you to look in your glossaries, I don't want you to look in a dictionary, I want you to tell me what you think, in your mind, so far about square root. For example, if you had to go home this evening and you had to describe to a younger brother or sister, well we talked about square roots today and here's what I know so far. Go ahead and start on that, if you will please.

Find the side lengths of some of these tilted squares.

Discourse Routines

The following routines and protocols can be of particular use in fostering discussion and promoting discourse around ideas.

Structures for small groups and pair work

- **Think-Pair-Share**. Simple structure in which students are ask to think individually about an issue or topic, pair with a partner, and share their thinking.
- **Micro Lab Protocol**. Small group (3 or 4) structure to encourage equal participation from all. Each person gets 2 min. uninterrupted airtime followed by 20 sec. of silence. After all have shared their initiall thoughts/reactions there is an open discussion period for the group of 5-15 min.

Questioning strategies/techniques

- **What makes you say that?** Question to ask in follow up to a students' response that will push him/her to give evidence or reasons.
- **Reflective Toss**. Pattern of discourse in which the teacher strives to first catch students' meaning and then tosses back a follow-up question that will prompt students to elaborate or expand on his/her initial response and take it further.

Discussing a text

- **Leaderless Discussion**. Structure for small group discussion in which everyone shares responsibility for moving the group's discussion forward. Group members prepare questions in advance that will encourage group discussion and then must listen to and encourage one another to speak.
- **Word-Phrase-Sentence**. Method of responding to a text by identifying a single word, a phrase, and a sentence from the text that stands out for them and then giving reasons for their choice.
- **What Comes Up? Protocol**. General response to a text using the prompt: "What came up for you when you read this?" All responses are collected and then the discussion ensues.
- **Final Word Protocol**. Each individual identifies a powerful passage from the text. The first person's selected passage is shared, and each member of the group responds to the passage, saying what it means to them. The originator gets the 'final word' by saying why he/she found it powerful.

Debating and exploring issues

- **4 Corner Debate**. A provocative statement is shared and individuals decide if they strongly agree, agree, disagree, or strongly disagree with the statement. Individuals go to the respective corners to discuss their choice and prepare an argument to convince others to move to their corner.
- **Tug of War**. The class identifies the pulls or tugs for both sides of an issue and then debates the strength of those pulls in order to place them appropriately on the tug-of-war line.
- **Claim-Support-Question**. Claims or assertions are made and then debated in terms of the evidence that supports the claim or the evidence or reasons why one might doubt or question the claim.

Analyzing a group's discussion and learning about what makes a good discussion

- **Inner-Outer Circles/Fishbowl**. A small group engages in a discussion while the rest of the class observes (in an outer circle) the discussion and makes notes of participation structures, effective questioning, use of evidence, listening, etc. The observers then feedback their findings to the group.
- **Leaderless Discussion**. Structure for small group discussion in which everyone shares responsibility for moving the group's discussion forward. Group members need to prepare questions that will encourage discussion and then must listen to and encourage one another to speak.