Seeing Math Special Edition
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Seeing Math through Multimedia Case Studies

Kelly Goorevich works with her fourth grade students at the Hosmer School in Watertown, MA, on the "Broken Calculator."

By Joanna Lu and Raymond Rose

The case method is a powerful learning model. For years, schools of business, law and medicine have used case studies through which students explore real-life principles. By examining critical moments in a case, students enter vividly into the events and can carry the lessons learned into their professional lives.

The Seeing Math Telecommunications Project has added the force of audio, video, and interactive computer tools to the already powerful case study method. Seeing Math is developing nine Web-based video case studies that provide mathematics professional development for elementary and middle school teachers. These case studies use both real-life video narratives and guided inquiry to craft a unique learning experience. By going into real teachers' classrooms and presenting the problems they face and the solutions that grow from imperfect situations, Seeing Math provides a rich source of insight that all teachers can use to develop their own practice.

Creating the Cases

Each Seeing Math case study focuses on specific math content that is widely recognized as difficult to teach. Several months before taping, case developers from the Concord Consortium and Teachscape identified a teacher and class of students planning to study the math concept. Producers and math specialists talked with the teacher to understand the curriculum goals. The day before the lesson, the production team interviewed the teacher to understand her strategies and expectations.

Over the course of two or three taped class sessions, pre- and post-lesson interviews with the teacher, and a collection of student work, a number of stories emerged. The team decided what strands were most relevant, determined the storyline, edited the video, and shaped the Web-based materials.

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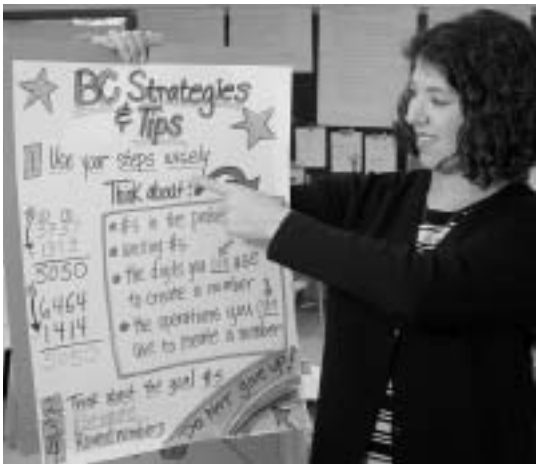
The storyline always integrates two essential elements – a math content strand that is aligned with NCTM standards, and a classroom pedagogy strand (see "Seeing Math Video Case Studies" on page 5). This integrated approach helps participants use the case as both a window into another's practice, and a mirror for reflection on their own teaching of math. Watching and analyzing the way teachers make decisions about their teaching leads participants to make better analyses and decisions about their own teaching.



The Broken Calculator case study encourages alternative problem-solving strategies.

Commentary Spurs Reflection

Video commentaries augment each case with views of the featured classroom from different perspectives – that of the teacher reflecting on the lesson she has taught, and that of a math content specialist offering additional insight. In the teacher commentary, the case teacher describes her expectations of the lesson as she envisioned it before taping. Following that, she may share her reflections about the classroom experience as it actually unfolds. Did the students "get it"? What worked and what would she change next time? Listening to a fellow teacher reflect on her practice offers a way for teachers to identify with another professional encountering the same problems and modeling a path to solutions.

Specialists from the field provide expert commentary on the case study teacher's classroom management skills, and help participants see beyond this single experience to understand other mathematical approaches to the same problem.

Inquiry-Based Professional Development

While the video narrative is the starting point, there is also a rich surround of supporting materials. The support materials answer questions about the school location, demographics, and how the featured lesson fits into the curriculum. There are examples of student work with guidelines for assessment, as well as the teacher's lesson plan. A math "diving in" activity – often using an interactive tool – helps participants understand the mathematics from the students' point of view. Teachers thus must wrestle with the same problem with which their students wrestle.

In addition, User Guides for both the course facilitator and the participants lay out a path for the course and pose activities to guide reflection on the case.

Open-Ended Presentations

Often student thought is highly original, but in real time, in a classroom, it may be difficult to understand. A video case offers the luxury of multiple chances to listen, review, and even study transcripts of what a student says. Read the transcript below and see if you can figure out what the student is talking about as he tries to explain why he concluded that 5/18 is closer to 1/4 than 1/3.

Teacher: So, how did ... tell me about the tally marks. How did you use those tally marks? How did you come about 1/4?

Student: Because first from five, you have to multiply three and it's fifteen, and then we try four ... five times four, which is twenty. So, um, twenty, is, um, two above from eighteen and fifteen is three less than eighteen so we decided 1/4...

Teacher: Oh, all right.

From Number and Operations: Fractions
Jennifer Bradley's 4th grade class
Timmerman Elementary School, Pflugerville, Texas

What was the student's strategy? Did it lead to the correct answer? Why would it work … or not work?

As any good storyteller knows, sometimes the greatest impact on learning comes not from what is told, but what is not told. Sometimes the strongest way to encourage reflection is not to resolve a problem shown in the case. Therefore, sometimes a video episode ends without a tidy resolution, and the participant is asked in the surrounding materials to reflect on how, in a similar situation, she might encourage her own students to move to a deeper understanding. In these cases, the video is a starting point for the teacher to think "what if this were my class and these were my students, what would I do?" @

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ARTICLE LINKS & NOTES

Seeing Math Telecommunications Project – http://seeingmath.concord.org

Teachscape – http://www.teachscape.com

Seeing Math Video Case Studies

Numbers and Operations

Division with Remainders

For 4th and 5th graders, division with remainders and the inverse nature of division and multiplication are key ideas. Nancy Horowitz and Mary Beth O'Connor present the same lesson. Students in each class build understanding about the nature of the division by creating and solving their own story problems.

Content: Division with remainders, problem solving, inverse nature of division and multiplication, division as sharing or partitioning
Pedagogy: Using effective questioning strategies, encouraging students to graphically represent abstract ideas
Location: Springfield, MA

Fractions

Jennifer Bradley's 4th grade students expand their understanding of fractions as parts of a whole to understanding fractions as numbers. They use multi-link blocks, folded number strips, and number lines to compare magnitudes of "familiar fractions" with fractions they generate from data about the classroom.

Content: Number sense, fractions, part/whole relationships, comparing fractions
Pedagogy: Using linear models of fractions to build understanding of fractions as a quantity, understanding different meanings of fractions
Location: Pflugerville, TX

Broken Calculator

Stacy Riggle's 3rd grade class explores division of large numbers using a "broken calculator" strategy: students must use handheld calculators that are limited by a division key that does not work. Kelly Goorevich's 4th grade class uses the Broken Calculator program – with various keys and operations disabled in the software – to explore addition and multiplication problems.

Content: Number sense, grouping, relationship of multiplication and division, relationship of addition and multiplication, place value
Pedagogy: Alternative problem solving strategies, communicating mathematical ideas, using technology to support learning in mathematics
Locations: Pittsburgh, PA; Watertown, MA

Geometry

2D and 3D Figures

Students in Jeanine Airesman's 4th grade class build rectangular prisms using straws and connectors, then describe and compare their constructions. They use a workbook, along with wooden polyhedral solids and other shapes, to solve riddles about faces and vertices. Students also draw 2D representations of their 3D shapes.

Content: Geometry, 3D description, 3D to 2D representation, reasoning and proof
Pedagogy: Using models to support close interpretation of text, building understanding by translating 3D models to 2D representation
Location: Pittsburgh, PA

Calculating the Area of a Triangle

Traditionally students learn to find the area of geometric shapes by using formulas. Noreen Winningham guides her 5th grade students as they build a foundation for understanding the area of a triangle and methods to calculate it before learning the standard formula.

Content: Geometry, measurement, symmetry, representation, reasoning and proof
Pedagogy: Using personal experience to inform a concept of area, applying multiple strategies to solve problems, student writing in mathematics
Location: Evanston, IL

Fourth graders Denzel, Eddie and Stephanie use alternative strategies for solving a problem with the Broken Calculator.

Pre-Algebra

Pan Balance Equations

Audrey Soglin's 5th grade class manipulates concrete representations of equivalence, using pan balances to understand the nature of equations and operations on equations.

Content: Algebra, equivalence, operations on equations
Pedagogy: Using 2D and 3D models to represent abstract processes, value of a challenging problem
Location: Evanston, IL

Functions

Leyani von Rotz's 4th grade students develop their ideas about functions, patterns and predictions by exploring linear growth patterns of tile arrangements. Using T-charts, students compare stages of growth with the number of tiles used at each stage. They generate rules that permit them to make predictions.

Content: Early algebra, functions, patterns, graphing, prediction, generalization
Pedagogy: Using patterns to support inference, understanding the difference between deductive and inductive inference
Location: Emeryville, CA

Data Analysis and Probability

Using Data to Make Predictions

This case presents ways to support NCTM standards for grades 3-5 that invite students to collect, analyze, and make predictions from data. The video shows two lessons from Rhonda Singleton's 5th grade class. The first explores mathematical fairness. The second shows the relationship between sample size and accuracy of predictions about a population.

Content: Collecting data, making graphs, data analysis, making predictions, probability
Pedagogy: Collaborative learning, games to support learning, addressing misconceptions
Location: Myrtle Beach, SC

Data Sets and Measures of Center

Students collect, organize and analyze data to determine maximum, minimum, range, mode, median, and mean. Thirty percent of Lala Sahakian's 4th grade students have arrived in the U.S. during the past 18 months. Teaching in an ESL class presents unique challenges. Not only must a teacher ensure students understand math content, but she must also assess understanding when students lack strong language skills for communicating their ideas.

Content: Data sets, data analysis, measurement, representation
Pedagogy: Teaching mathematics to ESL and ELL students, using concrete experiences to ground terminology
Location: Glendale, CA

Video Case Studies:

Grounded Dialogue Matters Most

By Alvaro Galvis and Ricardo Nemirovsky

How do teachers engage with professional development video case studies and what do they learn from them? These have been some of the driving research questions of the Seeing Math Telecommunications Project (see also "Seeing Math through Multimedia Case Studies" on page 1).

Using spring and fall 2002 data from teachers in South Dakota, Vermont, Washington, D.C., and Massachusetts, we have identified two critical aspects that make a significant difference in the depth and quality of the professional development outcomes:

- Grounding the discussion in the specifics of the video case.
- Integrating the events of the video case with actual ongoing events in the classrooms of the participating teachers.

To illustrate these points we selected the following excerpts from online postings in the Seeing Math professional development courses. We start with a facilitator's "seed" and two responses.

Facilitator: How can the questioning strategies in this case study serve all the students, not just those in the middle but the strongest and the weakest ones as well? Do the strategies offer a way to strengthen teaching and learning for all these students simultaneously?

Teacher: I think that the questioning strategies and students' responses allow the higher level thinkers to rethink their process and allows the lower level students to gather more information on different processes that were used.

Teacher: I think that using a variety of questioning strategies strengthens all students. Students need to hear the way other students think and understand the processes. When a variety of ways are discussed, all students reap the benefits.

Notably, these messages are devoid of specific references to the video case. Rather, the teachers respond with general statements reflecting their already held beliefs about the value of "questioning strategies" whose nature is not spelled out. The video cases play only a marginal or superfluous role in the exchanges. Further, we could not identify instances in which the teachers had changed or enriched their views.

In order to deepen the discussions and the rich potential of the video cases for teacher professional development, we realized the need to "ground" the discussions in the particulars of the video case and the actual experiences of the teachers in their classrooms. This shift of facilitator strategies was apparent during the fall 2002 course.

Facilitator: What statements did you hear in the introduction that caused you to begin reflecting on the traditional method of teaching division? Did anything Mary Beth or Nancy said "ring a bell" with you?

Teacher: When they presented the arrays for division facts and then discussed using manipulatives, I realized that I had really reinforced the notion that mastering the algorithm for division was the be-all and end-all of division, rather than to help my students to develop a solid numerical understanding of what it means to divide and how to fluently describe division with language.

Teacher: Now I am starting to utilize the ideas presented with arrays – manipulatives and writing of problems. I am teaching multiplication now and will have the kids write their stories tomorrow.

Here, the facilitator requests commentaries on particular utterances included in the video case. Teachers respond to examples in the video case with reference to the practices in their own classroom, regarding their own teaching.

The Seeing Math project has learned that sustaining rich, grounded discussions – grounded in the video case as well as in actual ongoing stories from the participants' classrooms – is the facilitator's major role. This role needs to be made explicit and actively supported. @

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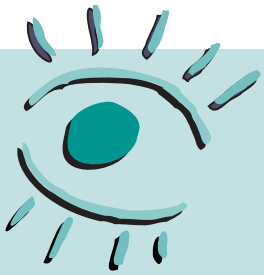
Seeing Math's Vision



Video cases should:

- Be analyzed, not imitated
- Initiate shared inquiry about the object of study, rather than transmit a given teaching model
- Be authored by a professional group of producers and educators
- Adhere to a production standard, while allowing flexibility for the uniqueness of each case
- Exhibit a clearly defined pedagogy, as chosen by the creator of the video case

Teacher Professional Development using video case studies should have the following characteristics:

- Facilitator moderates from the side, not from the center – in either face-to-face or Web dialogue
- Discussions are driven by both professional and personal interests and needs
- Discussions are focused around both local and shared, "supralocal" issues
- Participants are both intrinsically and extrinsically motivated and rewarded
- Discussions are grounded in video and classroom experience – not merely in participants' ideas and opinions
- Video case study and classroom practices are integrated