Designing a Video Library and a Web Environment for Learning about Early Childhood Mathematics Education

Janet Eisenband Sorkin
Teachers College, Columbia University
jge2004@columbia.edu

Michael D. Preston
Teachers College, Columbia University
Columbia Center for New Media Teaching and Learning
mdpreston@columbia.edu

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This paper provides an overview of the VITAL web-based video analysis system on which our various research projects and this symposium are based. VITAL, short for "Video Interactions for Teaching and Learning," was designed and developed by the Columbia Center for New Media Teaching and Learning (CCNMTL) and Prof. Herbert P. Ginsburg of Teachers College, Columbia University, to support his course in early childhood mathematics education. With a library of course-related video and tools for editing, annotating and communicating with video, VITAL is designed to help students connect the theoretical material in assigned readings with real examples of children's behavior, which helps them practice and refine their skills of close viewing and interpretation in order to help them prepare for classroom teaching and assessment.

The paper focuses on two aspects of the development of the system: (1) the creation of a "video library" on a wide range of topics related to young children's mathematical thinking and learning, and (2) the design of the web environment itself, which was informed by an existing classroom-based method of teaching psychology with video and refined as new discoveries were made about its potential uses. VITAL combines video content and instructional design in a space that complements and enhances, rather than displaces, learning in the classroom and the field.

Overview of the VITAL project

VITAL was originally created for "The Development of Mathematical Thinking," a graduate-level course in early childhood mathematics education taught by Prof. Ginsburg at Teachers College. The students in this course are typically masters-level education students working toward certification in early childhood education (birth through age 8). The course covers topics recommended by NCTM, including number and operations, geometry, measurement, algebra (including patterns), and data analysis (NCTM, 2000). Beyond the mathematics education content, an important goal of the

course is to prepare teachers to use multiple sources of knowledge to make valid professional judgments and decisions regarding early mathematics education in their classrooms—what to teach, when to teach it, and how best to teach it (Ginsburg, Jang, Preston, VanEsselstyn, & Appel, 2004). Students in the course use VITAL regularly to view videotaped examples of children engaging in mathematical activities, and to complete analytical assignments that require them to interpret the videos and develop and defend hypotheses about children's mathematical thinking and learning.

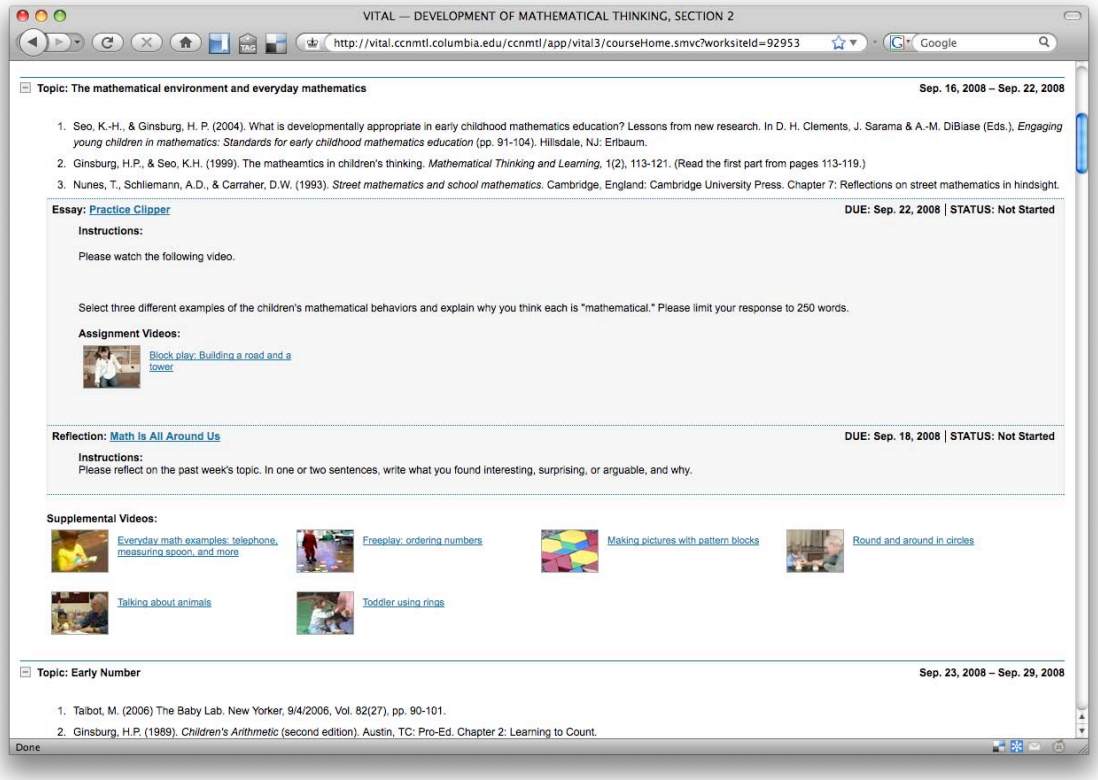

Figure 1: The syllabus page in VITAL for the Development of Mathematical Thinking course, with weekly topics that contain a list of readings, activities for students, and required and recommended video content.

VITAL was developed to help students learn to observe, make hypotheses, and evaluate interpretations about early childhood learning in the light of evidence. Students are given short essay assignments that require them to view videos of children in the classroom, develop their own hypotheses, and select and present specific evidence from the videos to support their arguments. By providing students with opportunities to apply their developing skills of observation and interpretation to the analysis of videotaped examples of children's behavior, VITAL creates the possibility for students to develop personally meaningful working theories of student behavior, to learn to observe behavior through the enlightened eye, to investigate thinking with the clinical interview, and finally, to apply these working theories and investigative techniques to issues of instruction.

VITAL video library

The VITAL video library began with the digitization of about 50 archival clips that span the range of topics covered in the course, including counting, arithmetic, geometry, and pattern. Funding from the National Science Foundation enabled us to create a much more ambitious and comprehensive collection of video, which now contains more than 500 clips of classroom lessons, clinical interviews, and free play, with a more diversified range of topics and tasks as well as ages and demographics of children (see Figure 2).

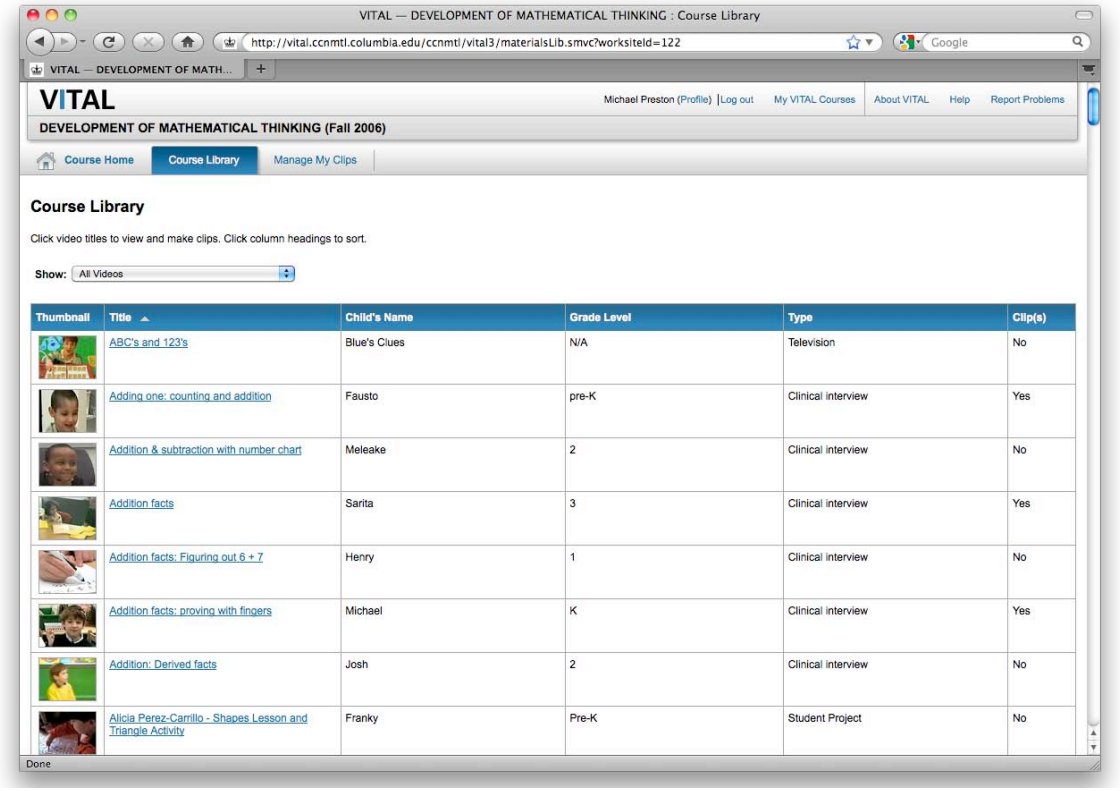

Figure 2: The Course Library or video index page from the Development of Mathematical Thinking course in VITAL, which contains more than 150 clips that can be sorted by title, child's first name, grade level, and type of clip.

In strategizing for video collection, we first reviewed old clips that had proved valuable in previous versions of the course, and created protocols so as to capture new versions of similar events. We supplemented this with protocols for new situations that might illustrate different ideas and would cover more content areas, drawing from the mathematics education literature. We then worked with schools to plan video shoots that would incorporate as much of our "wish list" as possible. A typical visit to a school for video shooting lasted 2 to 5 days, in which we captured 3 to 6 classroom lessons, 5 to 10 interviews, and 2 or 3 sessions of free play.

The taping sessions yielded a mass of raw footage that needed to be reviewed carefully. The first step was to partition the footage into short clips that could be

examined more efficiently. Some clips were obvious choices for illustrating points; others were promising, but needed to be edited or field-tested. To facilitate the reviewing process we created a database with a record for each short clip (see Figure 3). The database served as a way to store metadata (e.g., date of taping, age of the children, mathematical content covered) and to share notes on the videos, both about ideas for editing and possibilities for use in the course.

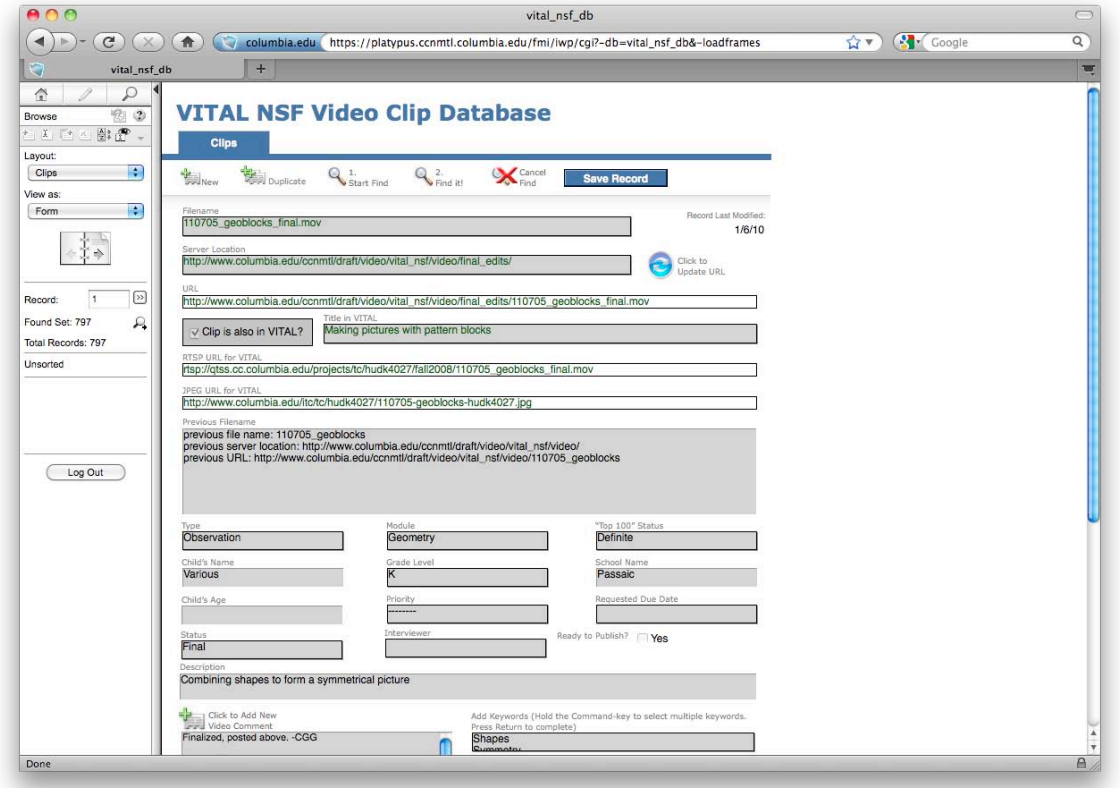

Figure 3: An entry from the VITAL video database in FileMaker Pro. Fields include formal metadata about the clip as well as notes on editing the content for publishing and commentary on applications for teaching.

In the winnowing process, we observed that there are different types of clips that work for different purposes. Some are excellent for quickly illustrating a common behavior, and are in the range of 20 seconds to a minute long. Others are richer and serve to provide windows into children's understanding of mathematical concepts, an interviewer's techniques, and/or a teacher's pedagogy. These are the most common type of clip and are typically 2 to 5 minutes long. Finally, we have found that it is sometimes helpful for students to view substantial portions of videos that may even last up to 30 minutes. These are often clips of classroom lessons, free play, or interviews in which it took a while for the interviewer to uncover a child's thinking.

Over the years, we have honed our collection through reviews, field-testing, re-edits, and plans for new video shoots. We have arrived at a "Top 100" list for use in the course (see appendix for complete list of Top 100 video titles), although we continue to dip into other videos from the database when needed. Clips were chosen for the Top 100

list to cover the range of material addressed in the course, and selections among similar clips were based on effectiveness in illustrating an idea, video quality, and sheer drama (we have found that a surprise element or a humorous moment is very helpful in engaging students). The library continues to be updated to keep up with needs of the course as well as the developing field of early mathematics education.

VITAL software

The VITAL web environment serves as a central repository of videos for the course and an analysis space where students can browse the videos embedded in a course syllabus. The VITAL video viewer engages students in a process of close viewing and analysis by using editing tools to bookmark or "clip" important moments from the videos, take notes, and save the clips in a personal workspace. Students then write "multimedia essays" in which they can embed their clips to support their written arguments, and publish these essays to be reviewed by the instructor and shared with peers. Students complete their VITAL assignments before class so the instructor can use class time more productively for discussion and debate.

The VITAL software was designed specifically to enable students to manipulate, annotate, and save clips of video. Students watch videos inside a special viewer equipped with editing tools for clipping pieces of videos and attaching notes to the clips to help them remember the significance of the content (see Figure 4). These clips and notes are saved in a personal workspace, where they can be accessed later and used to support an essay.

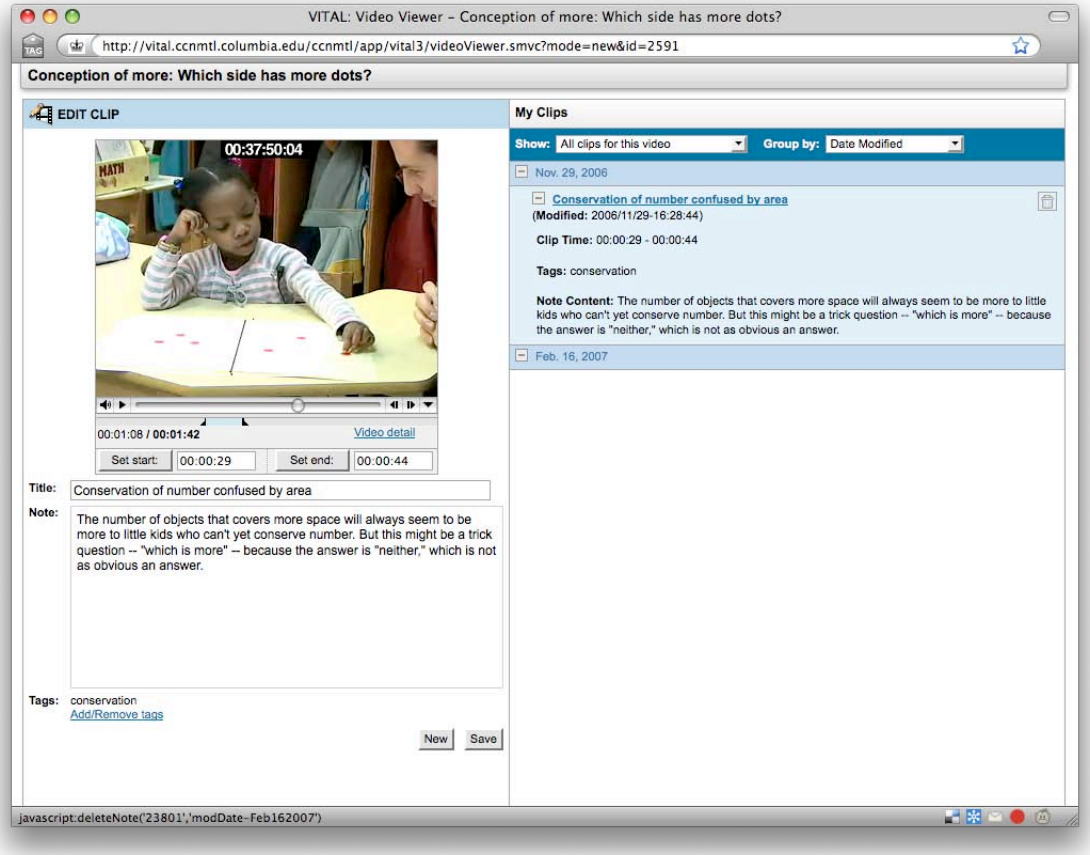

Figure 4: The VITAL video viewer, with editing tools and an annotation space beneath the video, and clips with notes collected in the right-hand column.

Students embed their selected video clips into the text they type in a "multimedia essay" space (see Figure 5). In the course, students are asked to write essays of 350 words or fewer in response to questions such as, "What do the children know about number? Please cite from the videos and the readings." By directly citing their video clips, students avoid transcribing the content of the videos and proceed directly to analysis, at minimum providing the same context they would to a quotation from a journal article or book. Completed essays are then "published" within the VITAL environment to be read by the instructor and other students, and the instructor can leave feedback for the student.

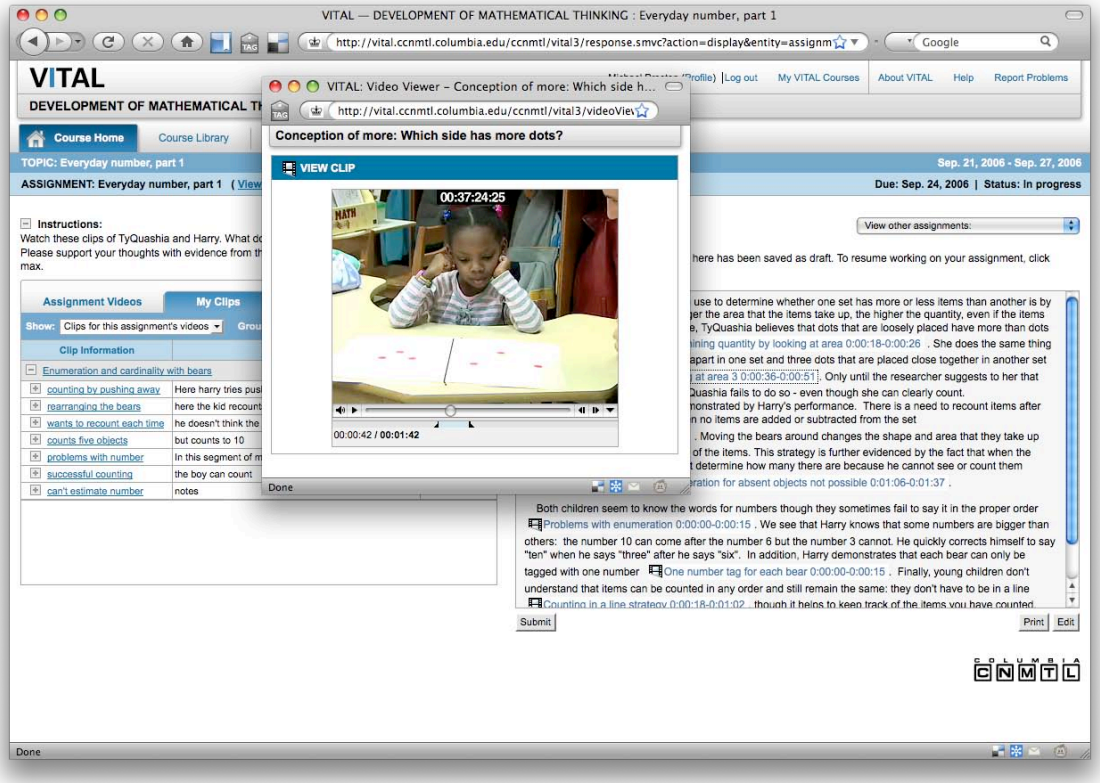

Figure 5: The multimedia essay, with the student's collected video clips on the left side of the screen, and a writing space incorporating text and video on the right. Students click or drag their video clips to add them to their essay.

In addition to essays, students complete a series of "guided lessons" in clinical interviewing inside the VITAL environment. These assignments are designed to simulate an interview by stepping students linearly through videotaped interviews and prompting them to interpret the child's behavior and the interviewer's technique, to anticipate what the child will do next, and to make recommendations for subsequent questions or alternative tasks.

In the final month of the course, students complete a project that involves designing a mathematical lesson or activity, trying it out with a child, and interviewing the child beforehand and afterwards to find out what he or she learned as a result of the lesson. The student records these events on videotape, submits the tape for inclusion in the VITAL library, and writes a research paper in the form of an extended multimedia essay that details the literature, methods employed, and results obtained. The final project integrates the mathematics content learned in the course with the assessment skills associated with clinical interviewing. The final project report submitted in VITAL also serves as a demonstration of the students' ability to think critically—even scientifically—about the work they are doing as teachers and what a child might be learning as a result.

In brief, VITAL introduces a sequence of activities—essays, lessons, reflections, an interview, and a final project—that are designed to help students learn to observe, make hypotheses, evaluate interpretations in the light of evidence, use a clinical interview to investigate student thinking, and apply their ideas and skills to teaching.

References

Ginsburg, H. P., Jang, S., Preston, M. D., VanEsselstyn, D., & Appel, A. (2004). Learning to think about early childhood mathematics education: A course. In C. Greenes & J. Tsankova (Eds.), *Challenging young children mathematically* (pp. 40-56). Boston: National Council of Supervisors of Mathematics.

NCTM. (2000). Principles and Standards for School Mathematics. Reston, VA: National Council of Teachers of Mathematics.

APPENDIX: LIST OF TOP 100 VIDEOS

Module	Topic	Video Title	Child/School Name
1	Introduction	Dogs & mud pies	N/A
1	Introduction	Adding bears: invisible to visible	Olivia
1	Introduction	Counting and pointing to numbers in chart	Corpus Christi
1	Introduction	Carrot math-- moving pictures of carrots across mind	Rachel
2	Everyday math	Guided free play with cubes	Corpus Christi
2	Everyday math	Building a block structure	Armando & Keithly
2	Everyday math	Bigger Garage	Eduardo & David
2	Everyday math	Emily clapping/ calendar	Emily
2	Everyday math	Infant playing with rings	Hope
3	Early concepts	Cardinality and conservation with bears	Harry
3	Early concepts	Conservation of number with bears	Vienna
3	Early concepts	Which side has more dots?	Tyquasha
3	Early concepts	Conservation of equivalence	Kristin
3	Early concepts	Conservation of number with green cubes	Tyquasha
3	Early concepts	Which side has more dots?	Vienna
4	Counting/number sequence	Counting: indicating mistakes	Little Josh
4	Counting/number sequence	Counting with fingers	Lateek
4	Counting/number sequence	Counting & figuring out decades	Michael
5	Enumeration & cardinality	Counting a line of hot dogs	Alexander
5	Enumeration & cardinality	Where is the winner?	Danny
5	Enumeration & cardinality	Counting: configurations	Victoria
5	Enumeration & cardinality	Counting & enumeration with elephants	Ben
5	Enumeration & cardinality	Dice movement game	PS 112
5	Enumeration & cardinality	Enumeration & production of an amount	Chidera
6	Informal operations	Addition strategy: counting all	Talulah
6	Informal operations	Taking away 1 and 2 blocks from box	Santiago

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6	Informal operations	Adding one: counting and addition	Fausto
6	Informal operations	Where is the winner?	Julia
6	Informal operations	Inverse addition / subtraction	Rachel
6	Informal operations	Harry fruit commutativity	Harry
6	Informal operations	Non-verbal task	Genisis
6	Informal operations	Missing addends with broccoli/ spinach	Santiago
6	Informal operations	Prediction game: Zur Gelman activity	Julia
6	Informal operations	Paper towel subtraction	Corpus Christi
7	Assessment	Explaining 8+7=15	Henry
7	Assessment	Whole interview of Tammy	Tammy
7	Assessment	Whole interview of Michael	Michael
7	Assessment	Interview in classroom	Harrison/ Ramaz
8	Representation/Symbols	Representing teacup problem	Gabriel
8	Representation/Symbols	Ordering written numerals	Aiden
8	Representation/Symbols	Matching tallies to chips	Ben
8	Representation/Symbols	Writing multi-digit numbers	Raul
8	Representation/Symbols	Representing and operating with tallies	Kenny
8	Representation/Symbols	Representing operation with picture	Santiago
8	Representation/Symbols	Understanding 3+1 with and without symbols	Kevin
8	Representation/Symbols	Connecting equation to manipulatives	Tammy
8	Representation/Symbols	Tammy equals	Tammy
8	Representation/Symbols	Two meanings of equals sign	Jordan
8	Representation/Symbols	Introducing kindergartners to formal equations	Ramaz
9	Number facts	Original Beth number facts anxiety	Beth
9	Number facts	Reciting number facts in preschool	Santiago
9	Number facts	Cheating: number fact vs. manipulatives	Eddie
9	Number facts	Explaining 2 x 4	Zelda

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9	Number facts	Reversibility-- even with mistakes	Rachel
9	Number facts	Julia Zoo game	Julia
9	Number facts	Henry derived fact 8 + 7	Henry
9	Number facts	Ian 7 x 3	Ian/ Irwin
10	Written Procedures	Understanding of place value	Shania
10	Written Procedures	Partial sums method	Molly
10	Written Procedures	Bug in double digit addition	Julia
10	Written Procedures	Doing addition two different ways	Diane
10	Written Procedures	Invented Strategy for double digit addition	Tara
10	Written Procedures	Mental addition double digits	Zoe
10	Written procedures	Adding 37 and 26 with paper and with blocks	Rain
10	Written Procedures	Blackboard Math	N/A
10	Written Procedures	Fraction blackboard math	The School
11	Understanding	Working with number line	Zelbo kids
11	Understanding	Comparing sums	Conrad
11	Understanding	Representing 4 x 15 with stars	Akiko
11	Understanding	Different ways of representing multiplication	Ami
11	Understanding	Tammy connect chips equation	Tammy
11	Understanding	Zoe explaining 10+3 vs 3+10	Zoe
11	Understanding	Nicholas proving 5 + 5 = 10	Nicholas
11	Understanding	Rufus solving division problems:	Rufus
11	Understanding	Six pack problem	Various
12	Geometry	Coloring in triangles	Dillon
12	Geometry	Sorting shapes with vehicles	Jayden
12	Geometry	Sorting shapes with princesses	Sarah Kate
12	Geometry	Identifying shapes	Chidera
12	Geometry	Grid task	Ben

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12	Geometry	Symmetry Pegboard	Shauna
12	Geometry	Making pictures with geoblocks	Various
12	Geometry	Making shapes with toothpicks and clay	N/A
12	Geometry	Identifying shapes tactilely	N/A
13	Pattern/Algebra	Difficulty extending pattern	Ben
13	Pattern/Algebra	Filling gaps in patterns	Vienna
13	Pattern/Algebra	Growing patterns	Owen
13	Pattern/Algebra	A pattern is a list of colors, extension	Vienna
13	Pattern/Algebra	AB vs. ABB pattern	Ben
13	Pattern/Algebra	Pattern lesson: Do re mi	CC
13	Pattern/Algebra	Doubling cubes pattern	Henry
14	Measurement/Data	Block king	Jordan
14	Measurement/Data	Talking about animals	Julia
14	Measurement/Data	Graphing hearts activity	Various
14	Measurement/Data	Seriation	Lizbeth
14	Measurement/Data	Liquid volume lesson	CC
15	Pedagogy & Manipulatives	4 takeaway 4 = 4	Tanya
15	Pedagogy & Manipulatives	Multiplying by nines	Ramaz
15	Pedagogy & Manipulatives	Reviewing base ten homework	The School