# Learning to Enter the Child's Mind On-Line: A Web-based Video Analysis Lesson in an Early Childhood Mathematics Education Graduate Course

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# Introduction

The essence of teaching is understanding how and what children think, believe, and feel and what they know or fail to know. In mathematics, as in any subject matters, young children come to school with intuitive ways of thinking and reasoning about doing it, although their ways may not always be the same as those of adults. As children enter school, their mathematical understanding and abilities continue to develop quickly and broadly, in and out of school, with much individual variation (Clements & Sarama, 2007). Thus, as recommended in the joint position statement of NAEYC and NCTM, it is essential for teachers to "support children's learning by thoughtfully and continually assessing all children's mathematical knowledge, skills, and strategies." (NAEYC & NCTM, 2002).

In order to understand students' learning and dispositions, teachers, regardless of the grade level, must use a variety of assessment tools and approaches. Yet, the field of early childhood education has traditionally favored observation as the primary method for understanding young children. Observation is not enough. As Piaget (1976) pointed out many years ago, "... how many inexpressible thoughts must remain unknown so long as we restrict ourselves to observing the child without talking to him?" (pp. 6-7). Thus, Piaget developed the clinical interview method to learn about what is hidden in their minds. As Piaget (1952) explains,

> I engaged my subjects in conversations patterned after psychiatric questioning, with the aim of discovering something about the reasoning process underlying their right, but especially their wrong answers. I noticed with amazement that the simplest reasoning task… presented for normal children… difficulties unsuspected by the adult (p. 244)

Clinical interview, when done well, can uncover children's conceptual understanding and strategies behind their answers whether correct or incorrect, and thus, their often hidden abilities and learning potential. Clinical interviewing is a powerful assessment tool that can assist teachers to gain a deeper insight into the child's thinking or "enter the child's mind" (Ginsburg, 1998).

So, how can we prepare our teacher candidates effectively to conduct clinical interviews with young children? In this paper, I describe and discuss the experiences of the prospective early childhood teachers learning, specifically clinical interviewing, in the early childhood mathematics education course which incorporated an innovative web-based video system, Video Interactions for Teaching and Learning (VITAL).

## The Overarching Context of the Study: The VITAL Project

With the support from the National Science Foundation (NSF), Dr. Herbert P. Ginsburg at Teachers College, Columbia University has partnered with the Columbia Center for New Media Teaching and Learning (CCNMTL) to develop an online learning environment, called "Video Interactions for Teaching and Learning (VITAL)," based on his courses on mathematics education (Ginsburg, Jang, Preston, VanEsselstyn, & Appel, 2004). One of the special features of his courses was the extensive use of videos to illustrate key ideas and stimulate teacher candidates' thinking (Ginsburg, Cami, & Schlegel, 2008). VITAL aims to enhance and expand this video-based learning experience to an online environment, which teacher candidates can access outside of the college classrooms. As a part of an ongoing collaboration between Columbia University and Hunter College of The City University of New York, VITAL has been integrated into the graduate course on early childhood mathematics education taught by the author at Hunter College and is currently undergoing pilot testing and refinement (Lee, Ginsburg, & Preston, 2007).

## The Course Context: Early Childhood Mathematics-Birth through Grade 2

This was a 3 credit, 15 session-course required for M.S. students in the Early Childhood Education Program who were working on their certification in early childhood education birth through age 8. The course content was centered around educational and psychological research

concerning the development of young children's mathematical thinking as well as the teaching and learning of school mathematics in terms of contents (i.e., numbers and operations, algebra, geometry, measurement, and data analysis and proof) and processes (i.e., problem solving, reasoning and proof, communication, connections, and representation).

In the 9th session, the topic of assessment was dealt with. By this time, the teacher candidates were already familiar with clinical interviewing since they had watched various video clips of children engaged in clinical interviews dealing with a range of mathematical concepts. However, in this session, clinical interviewing was specifically introduced as one of the assessment methods. The teacher candidates were assigned to complete a VITAL video analysis lesson developed specifically to enhance teacher candidates' ability to conduct clinical interviews with young children. During the lesson, they were guided through a series of video clips of Dr. Ginsburg interviewing an individual child on simple arithmetic problems. The candidates were prompted to view a segment, stop the video, answer a guided question, and then repeat this same process with additional video footage, simulating the experience of interviewing the child. Through these processes, the teacher candidates were expected to study closely the clinical interview with a careful and critical eye.

## Method

### Participants

The participants of the study were the 34 graduate students who were enrolled in the Early Childhood Mathematics-Birth through Grade 2 course and completed all the questions in the VITAL guided lessons.

Materials and Procedures

Participants were asked to complete the VITAL guided lesson individually at places and times of their convenience and also at their own pace. They were allowed to view and review the relevant video footage as many times as they wanted before they answered the questions. Yet, once they submitted the answer for each step, they were not allowed to return to the previous step. The participants were guided through four steps. (For a more detailed description of the guided lesson, please refer to Appendix 1).

| | |
|---|---|
| Step 1 | The participants were prompted to view a video clip of a first grader, Rachel, solving a subtraction word problem correctly, that is, 6-3=3 and were asked to form an initial and an alternative hypotheses about her mathematical thinking. |
| Step 2 | The participants were to read three experts' hypotheses and judge the plausibility of each of them. The same video clip as in Step 1 was given. |
| Step 3 | The participants were prompted to view an additional video footage, which included the child's own explanation of her solution strategy and asked to re-evaluate their previous hypothesis. |
| Step 4 | The participants viewed the child solving another question, but this time incorrectly, that is, 7-2=4. She explained her strategy, and the interviewer worked with her to reach the correct answer. The participants were asked to draw conclusions about the child's mathematical understanding. |

Data Coding and Analysis

The data coding and analysis were guided by a grounded theory approach of generating relevant codes from the collected data (Strauss & Corbin, 1990). Using N•VIVO, a software

program that facilitates the organization and analysis of qualitative data, the participants' responses to the questions in each step were grouped based on ideas expressed by them.

## Results: Content Analysis of Teacher Candidates' Responses

### Step 1: Creating Hypotheses

In response to the questions in the Step 1, the teacher candidates formed a total of 67 hypotheses (34 initial and 33 alternative hypotheses) about how and why the child in the video clip solved the word subtraction problem correctly, that is, 6-3=3.

#### Initial Hypotheses

##### Understanding the Given Problem (38%)

The most common response, generated by 38 percent of the participants, was that "Rachel has a strong early understanding of basic subtraction" without much theorizing or hypothesizing about the underlying thinking process that led to the correct answer. Even when their responses were more elaborated, they still typically included that the child "reached the answer by solving the problem in her head" as in the excerpt below.

> She has a great understanding of subtraction. In her response, she shows that she can subtract small numbers from each other, in this case, six minus three. The type of question asked also shows that Rachel can understand word problems and the context of the information, realizing that in the given situation, subtraction was necessary to reach the answer. Lastly, Rachel answered the question quickly and correctly. This immediately made me think that she had a good grasp of the topic being examined, subtraction. It appeared that she did not use any type of method (i.e., using her fingers) and reached the answer by solving the problem in her head.

Memorizing Basic Number Facts (21%)

More than 20 percent of the participants hypothesized that the child had already memorized the basic subtraction facts and used them to solve the given problem.

> Rachael may be already familiar with basic subtraction facts to the point where giving answers is rote. The equation 6-3 yields a prompt "3," indicating that it is a problem that is easy for her, and that she has memorized so that it is not necessary for her to use her fingers or any manipulatives to solve the problem.
>
> Rachael appears to retrieve the answer to 6-3 from memory, which would indicate a familiarity with basic number facts and/or an ability to abstractly manipulate small numbers. We do not see hear using her fingers or any manipulatives, and she answers the question almost immediately. While we cannot be sure that she does not mentally visualize the problem or manipulatives representing the carrots in the problem, the speed with which she answers makes such a conjecture less likely. She also seems to quite certain of her answer, revealing no hesitance in her response.

Using Mental Image (21%)

More than 20 percent of the participants hypothesized that the child imagined the story unfold in her mind and used the mental images to solve the problem.

> It looked like Rachel was looking at the squirrel and rabbit figures and imagining them with the carrots. One could hypothesize that she used this mental image to take 3 carrots away from squirrel and give them to Rabbit.
>
> As Dr. Ginsburg is telling her the story, she is picturing it in her mind, and sees the squirrel giving the rabbit three carrots. Therefore, since she was bringing the story to life as Dr. Ginsburg spoke, she was able to give her answer right away.

Lucky Coincidence (9%)

About one tenth of the participants hypothesized that the child, without actually thinking about the problem, simply repeated the number that she just heard the interviewer saying.

> The number discussed in the problem elicited Rachel's answer. By this I mean that in the problem, Dr. Ginsburg stated that the rabbit wanted to get three carrots and that the squirrel was going to give

> the rabbit three carrots. The number three was said several times and instead of solving the problem, Rachel may have answered by quickly stating a number that was said many times in the problem and was the first to pop into her head. In this case, the number most often said was three, which by chance, was also the correct number to the problem.
>
> I would say that Rachel answered three because Squirrel gave Rabbit three carrots, and perhaps she confused the question into thinking she was being asked how many carrots Rabbit would have after Squirrel's donation.

Applying Number Composition Knowledge (9%)

About one tenth of the participants hypothesized that the child used her number composition or decomposition knowledge to solve the problem.

> My initial hypothesis about her thinking in answering this problem is that Rachel has a firm number sense and might know the number six as two groups of three. She can apply those ideas to subtraction.

## Alternative Hypotheses

As alternative hypotheses, Finger Counting (16%), Understanding Given Problem (16%), and Memorizing Basic Number Facts (16%) were most frequently mentioned, followed by Lucky Coincidence (14%), Using Mental Images (11%), and Applying Number Composition Knowledge (11%). Noticeable differences between the initial and the alternative hypotheses generated are a significant decrease in the number of Understanding the Given Problem (from 38% in Initial to 16% in Alternative) and the emergence of a new category, Finger Counting.

Finger Counting (16%)

The 16 percent of the alternative hypotheses generated by the participants stated m that the child might have used her fingers to solve the problem although not in an obvious manner.

> Alternative hypothesis could be that she solved the problem by using her hands to represent six then closing three of her fingers. This could be another hypothesis because one of her hands was

> under the table, and when Dr. Ginsburg mentioned the number six she struck out her thumb in her other hand.
>
> The article also discussed how children around Rachel's age also use their fingers in order to reach a solution. I then noticed that one of Rachel's hands is under the table, which makes me question whether she used her fingers in order to reach the answer. When Dr. Ginsburg was asking Rachel the question, I noticed that one of her fingers moved slightly. This in my opinion is an indicator that Rachel was using her fingers in order to reach a solution. So I conclude that Rachel's mathematical thinking involves using her fingers in order to reach a solution that is typical for a child her age.

## Step 2: Judging the Plausibility of Expert Hypotheses

After the participants finished forming their own hypotheses, in Step 2, they were provided with three experts' different hypotheses and needed to judge their plausibility.

### Expert A: Memorization

EXPERT A: Rachel most likely has her number facts memorized. She probably learned the subtraction fact '6-3=3' in school. This question is easy to her because she has easily retrieved it from her memory. There was no counting involved in her mind.

#### Plausible (74%)

Almost three quarters of the participants agreed that the Expert A's hypothesis was plausible.

> This hypothesis seems very plausible and is supported by clear evidence. Here, the expert explains that Rachel most likely learned the mathematical equation, 6-3=3, in school. Her memorization of the problem led her to answer the question quickly by retrieving it from her memory. This supportive conclusion is illustrated in the clip, seen in Rachel's immediate response to the question. In this hypothesis, a clear explanation is offered and supported through evidence that is found in the video clip.

Implausible (26%)

Yet, one quarter of the participants disagreed with Expert A, most of them typically arguing that knowing the subtraction fact 6-3=3 is different from solving a word problem.

> The question Dr. Ginsburg asked was not '6-3=3.' Rachel had to imagine the correct number of carrots then convert it to the correct number. After completing the whole process, she would then have to subtract t he numbers. She probably could not have answered as quickly as she did.
>
> Even if she had memorized 6-3=3, I doubt she would be able to realize that was the question the math story was asking that quickly.

Expert B: Mental Images

EXPERT B: Obviously, Rachel had the carrots pictured in her mind. She mentally moved three of the carrots away from the group of six that she was picturing, and then counted out the carrots that were left. Of course, she did this rather quickly because her response was fast, but I could tell that she 'saw' them in her head because her eyes flickered a bit. She was also doing some of the visual calculating as Dr. Ginsburg was finishing the question; in this way, she was predicting the question he was about to ask.

Plausible (71%)

Almost three quarters of the participants judged that Expert B's hypothesis was plausible, even though some of them did not think his use of the child's eye flicking was sound evidence.

> I believe that it is plausible that Rachel might have visually thought about the carrots and counted what was left. I don't agree that the flickering of her eyes can tell that she could see the carrots in her mind. However, this expert's notion that she was visually thinking about the question and was able to predict what she was going to be asked could be valid. She answer this question quit fast and maybe the way Dr. Ginsburg phrased this question allowed her to think about what he was going to ask faster. This expert's

> hypothesis seems to be convincing without the flickering of the eye!
>
> Rachel might have predicted the question before it was completely asked. It is likely what when you tell a story about Rabbit wanting 3 of Squirrel's 6 carrots that the question is going to ask how many carrots Squirrel will have left. I do not agree, however, with the first part of Expert B's explanation because I did not see any "flicker" in Rachel's eyes. Sure, she might have pictured them in her mind, that's generally what happens when a story is being told, but to use an unobservable "flicker" as evidence that Rachel "saw" the carrots I is not going to convince me that she was doing elaborated calculations and not just listening to the story.

Implausible (29%)

The rest of the participants disagreed with Expert B., some of them because the facts that the child responded quickly and that the child's eyes flickered did not necessarily mean that she was imagining in her head.

> Expert B's hypothesis seems to be a complex method that a first grader would use. A first grader may solve this task quickly if he or she had actual pictures of carrots in front of him or her. However, Rachel was not provided with pictures or carrots to use to subtract. Even though she responded quickly, I do not believe that first graders are generally capable of mentally picturing particular objects and then adding or removing a certain amount of these objects this quickly.
>
> It assumes that when Rachel's eyes flicker, it is because she was seeing the carrots in her head. There could be many reasons why Rachel's eyes flickered, from a bright light, awareness of the camera in front of her, or simply her mind wandering. Also, while it is possible that she was predicting the question about to be asked, there is no clear cut evidence to support that.

Undetermined (1 response?)

> I do think that maybe she could have been picturing the carrots in her mind, but she took no time at all to come up with the answer. It would be helpful to know if she had been in the interview for a while and had been practicing these types of problems. This might help to clue in on whether she could get the answer so quickly or if she has memorized her addition and subtraction tables.

Expert C: Inversion

EXPERT C: "Rachel probably has '3+3=6' memorized, but not the related subtraction fact. However, she was able to reason about this problem enough to do the reversal in her mind, and came to the conclusion that '6-3=3'. Therefore, she had a related problem memorized that allowed her to come to the answer very quickly, with the help of a little logical thinking."

Compared to the hypotheses offered by Expert A and B, Expert C's hypothesis appeared to be controversial among the participants.

Implausible (59%)

More than half of the participants rejected Expert C's hypothesis, most often mentioning the young age of the child and/or the short time she took to answer the question.

> I feel that this type of logical thinking on the part of a first grader is a little too complex. It is unlikely that she could have used her addition skills to reverse the answer in her mind. This type of thinking could not be possible for a first grader to use in such a short time.
>
> Expert C's hypothesis seems the least plausible because the time between when the question was asked and her answer was not enough to reason the reversal in her mind of '3+3=6.'

Plausible (35%)

Yet, 35% of the participants responded that Expert C's hypothesis was plausible based on their own experiences with children. For example, the participants mentioned that all children have different ways of solving problems, and that many of them use addition facts to solve subtraction problems as seen below.

> The last Expert C's hypothesis seems to also be plausible. It could be that she related an addition problem to this problem, which helped her quickly solve it. I believe that previous understanding and memorizations can really help a person solve new problems in

> they are able to connect them to each other. These hypotheses could be plausible because all children have different ways of solving problems.
>
> I do think it is possible that Rachel may have used an addition fact rather than a subtraction fact to figure out the answer. Maybe Rachel thought of the problem as 3+_=6. I notice a lot of my students doing the same thing when figuring out subtraction problems and not even realizing it was a subtraction problem in the first place.

Undetermined (6%)

Two of the participants abstained from judging the given hypothesis explaining that they needed more information.

> It would be helpful to know if she had been in the interview for a while and hand been practicing these types of problems. This might help to clue in on whether she could get the answer so quickly or if she has memorized her addition and subtraction tables.
>
> Having 3+3=6 memorized is a common number fact because doubling facts are a tool used to teach addition. However, to assume that she was able to apply this technique of finding half the sum cannot be left to assumption. Again, she should be asked, "how did you do this?'

## Step 3: Checking the Hypotheses

After viewing the additional footage in which Rachel explains that "I know that three and three is six. And so, and so I know if I take three away from six you have three left." which was similar to Expert C's hypothesis, the participants were to explain if this changed or supported their previous hypotheses.

Change (68%)

The majority of the participants responded that they had to change their hypotheses. Many of them expressed that previously they had underestimated the child as exemplified below.

> Apparently I have underestimated Rachel; it appears that she did, in fact, use the number sentence 3+3=6 that she had already

> memorized, and then reversed the problem to become the subtraction problem 6-3=3. In my own hypothesis, I did not anticipate that Rachel would be able to problem solve so quickly, as she gave her answer without hesitating. However, it is apparent that she is conformable both with basic addition facts and with reversing what she knows to apply her knowledge to a word problem.
>
> I didn't assume that she would be able to use a previous known number fact to apply to a new math question (shame on me.) which is why it is important to ask rather than assuming, because this raises new interview questions that can be asked in addition to other number facts that she knows.

Confirm (26%)

Those who had previously proposed the possibility of the child using number composition mentioned that the child's own explanation confirmed their hypothesis.

> I proposed an alternative hypothesis that Rachel knew that two groups of three make six, which is essentially how Rachel explained her solution to the problem. My hypothesis further guessed that Rachel knew how to divide by two, but it actually remained in the addition/subtraction domain, in which Rachel was able to turn a known addition problem into a subtraction problem that applied to the story.
>
> It seems more obvious now with Rachel's response that she is used to these sort of word problems and was preparing to do this mental math in her head. This is how she got the answer so quickly. And she combined her knowledge of 3+3=6 and 6-3=3 to get the answer. This was interesting. It is as if she was double checking herself.

Resistant to Change (6%)

Two participants refused to change their hypotheses even when the additional video footage clearly showed what was essentially different from their hypothesis and continued to adhere to their own hypothesis.

> This supports my previous hypothesis that Rachel not would have been able to keep track of all that was going on in the problem and what Dr. G was asking of her, had Dr. G used a harder set of numbers that she did not have the number facts memorized. (#7)

> This supports my previous hypothesis about Rachel's thinking and understanding because she used mental math in order to come up with her answer. She was able to do all of this without touching the rabbit and squirrel and without physically having the carrots in front of her.

Step 4: Drawing Conclusions about the Child's Mathematical Thinking

The participants viewed additional video footage of Rachel solving another similar word problem. Yet, this time, she got the answer wrong, and the interviewer helped her solve the problem using blocks. The participants' conclusions about the child's mathematical thinking were grouped according to whether they focused on the strengths or the weaknesses of the child's mathematical thinking.

Child's Conceptual Understanding (59%)

The majority of the participants emphasized that the child had a conceptual understanding of addition and subtraction, despite the fact that she got one out of two questions wrong.

> Based on this process, it is apparent that Rachel may not have all of her basic addition (and in turn subtraction) facts down pat, but she understands the overall concepts behind what she is doing. Although she didn't get the right answer at first, she knows the correct tools and methods to use to help her reach the answer. Overall, it appears that Rachel has a strong mathematical understanding of what both addition and subtraction mean. (#8)

> From this I can conclude that she has a strong understanding of the procedural knowledge for addition and subtraction (even though she uses the addition to get to the subtraction.) Her mistake was only based on rote number facts, which is less important in my opinion. I can also conclude that she knows different strategies to help her solve problems, one of which is substituting something concrete for an abstract word problem. (#9)

> Based on this evidence and the information observed in the video clip, Rachel shows a clear understanding of how to use addition to solve subtraction problems. She was able to associate the word problem into a mathematical equation while also being able to form a parallel between this problem and the one posed earlier. Using the same method of addition, Rachel came to

> conclude that the answer was four. Unfortunately, because she believed that four plus two equaled seven, Rachel answered the problem incorrectly. However, it is evident that her thinking process was correct. This illustrated in her explanation, where she stated that because four plus two was seven and if you were to take two away from seven, four would result. Also evident in the video clip, one can conclude that Rachel understands the concept of subtraction. Even though she uses the process of addition in solving the problem, Rachel does seem to understand that the process of subtraction involves 'taking away'. (#5)

Child's Lack of Competence/Understanding (24%)

Yet, almost a quarter of the participants' conclusions focused on the child's limitations and incompetence in dealing with addition and subtraction problems. They failed to appreciate the child's sophisticated strategies such as using inversion relationship of addition and subtraction, and focused mainly on the addition number fact that she had memorized incorrectly and/or on the ensuing incorrect answer to the subtraction question.

> Although Rachel is in first grade she still has a problem with understanding addition of numbers. At this age children can retrieve information in order to solve problems but the information that the child retrieves has to be correct in order to be able to use the inverse principle and get the correct answer. After using concrete blocks Rachel understood that 5+2 is 7 and 7-2 is 5 there for she was able to use the inverse approach. (#1)

> Rachel relies on her memorized problems even though some may be wrong. She may not understand how addition or subtraction really works if she is only relying on her memory or previous knowledge of addition problems. (#22)

> I can conclude after watching this video that Rachel does not really understand some areas of addition and subtraction. In the earlier part of this interview, Rachel demonstrated an understanding of 6-3=3 by mentally adding 3+3 to get six and then subtracting 3. It appears that Rachel probably understands addition and subtraction of smaller numbers or duplicated numbers 3+3, 2+2, etc) because once the numbers got bigger (7-2) Rachel had some difficulty getting the correct answer (#31).

No Conclusion (18%)

18% of the participants failed to provide any conclusion about the child's mathematical thinking based on the clinical interview segment that they had viewed.

## Discussions: Effectiveness of the VITAL Guided Lesson

The VITAL lesson provided hands on and minds on learning experiences. In this section, I will discuss the effectiveness of the lesson in assisting the teacher candidates to the key features of learning clinical interviewing method.

### Strengths of the VITAL Lesson

The lesson was effective particularly in teaching the following key features of clinical interview.

#### Investigating Thoughts Underlying The Child's Answers

As one of the students commented, supported by many other classmates, "It is important to ask the children how they came to their answers." This VITAL lesson has conveyed this foremost important message effectively to our future early childhood teachers. Once the child gives an answer, the teacher should try to investigate the thinking process underlying the child's response, whether correct or incorrect. As shown in the video clips, simple questions such as "How did you know that?" "How did you figure that out?," asking the child to explain what she did, revealed her hidden strategies and, sometimes erroneous, knowledge that led to the answer. This insight gathered from the clinical interview can, in turn, guide the teacher in making decisions about teaching.

Hypothesis Forming and Testing

Clinical interviewing is a thoughtful activity in the sense that the interviewer has to continually consider hypotheses about why the child does what she does-on the spot. The VITAL lesson has effectively highlighted this aspect of the clinical interview. For example, just asking the students to form an alternative in addition to an initial hypothesis appeared to have made the students think further and deeper about the thinking processes underlying the child's answer. That is, the number of generic hypotheses such as "the child solved the problem in her head" (Understanding the Given Problem) decreased dramatically in their alternative hypotheses. Further, evaluating the three experts' hypotheses of the same phenomenon helped them reflect on and refine their own thinking, as one student commented:

> I especially liked the question that used the three experts' explanations because it shows how different perspectives and opinions may be taken on the same exact observation. It shows that a person observing it must not be closed-minded, rather they must state their initial hypothesis and then think outside the box and offer alternative explanations.

Then these hypotheses need to be tested. While in the real classroom the hypothesis forming and testing need to be done on the spot, for the students who are still in training, the VITAL technology enabled us to divide the video clips into split seconds, and thus, provide the students ample time to think and form their hypotheses before they moved on to the next step of testing them. Until then, as one student commented, "my hypothesis is not set; it's the child that will show me what they are thinking." Based on the child's response, the students refined their hypotheses again, as the interviewer in a real clinical interview setting would do.

Uniqueness of Individual Child's Thinking

Another key feature of clinical interviewing is that the interviewer must be always on the lookout for the possibility that the child may employ unique modes of thinking. The surprising

response of the child in the video clip illustrates this possibility very well. More specifically, very few students hypothesized that the child might have used her number composition or decomposition knowledge to solve the problem; even though this was given as one of the expert hypotheses, the majority of the students refuted the hypothesis claiming that the child is too young to solve the problem in such a short time using such a complex strategy. Yet, the video clip still shows a twist of the plot: the child explains that she indeed used her number composition and decomposition knowledge and inversion strategy to solve the problem. This surprise in the video clip was expected to provoke "the kind of cognitive conflict or disequilibrium" in our students' thinking that Piaget felt is so crucial to intellectual growth (Ginsburg et al., 2008). Many of those who doubted the child's sophisticated strategy wrote that they had underestimated the child and changed their hypothesis. The video clip also illustrated that even when the child's answer was wrong, it could have been the result of some erroneous knowledge that led to the wrong answer but still revealed an interesting pattern of strategies and thought. The main purpose of clinical interviewing is to gain insight into the distinctive, but sophisticated, ways in which children think about mathematics, and this message appears to have been passed on to our students effectively.

Weaknesses of the VITAL Lesson

The ineffectiveness of the VITAL lesson, I felt as the instructor, centers mainly on Step 4. When analyzed carefully, the video clip shown in this step can be divided into two segments: (1) the first part is about the interviewer responding to the child's wrong answer and (2) the second is about the interviewer teaching the child to understand that 4+2 is 6 not 7. Perhaps the video clip should be broken down into these two segments and into two steps since each of them deals with different key features of clinical interviewing.

Responding to Wrong Answers

| Video Segment Part 1: Responding to Wrong Answer | |
|---|---|
| Dr. Ginsburg: | Let's try another one. Rabbit has seven carrots and he gives two of them to squirrel. How many carrots does rabbit have left? |
| Rachel: | Four. |
| Dr. Ginsburg: | OK. How did you figure that out? |
| Rachel: | I did the same thing. |
| Dr. Ginsburg: | Same thing. Tell me about it. |
| Rachel: | Well, I knew that four and two is seven. And if rabbit has seven carrots and he wants to share them with squirrel, so he gives squirrel two. He must have four left. |
| Dr. Ginsburg: | Uh-huh. Because four and two is seven, right? |
| Rachel: | Right. |

In the video clip, despite the fact that the child gave a wrong answer, the interviewer continues to ask the fundamental question of the clinical interview: How did you figure that out? Considering that many teachers have little appreciation of the meaning of wrong answers, it would have been useful to highlight how the interviewer uncovers Rachel's sophisticated reasoning underlying her wrong answer and also identifies her faulty memory of the number fact, 4+2=7, which led to her incorrect answer.

Constructive Teaching

| Video Segment Part 2: Teaching to Understand | |
|---|---|
| Dr. Ginsburg: | Right. O.K. Very good. How could you make sure that you're really right about that? You said that seven take away two was four, right? Because four and two is seven. O.K. Could you show me with the blocks that four and two is seven? |
| Rachel: | O.K. First let me get seven blocks. |
| Dr. Ginsburg: | O.K. Good idea. |
| Rachel: | One, two, three, four, five, six, seven. O.K. So, there's two over here. |
| Dr. Ginsburg: | So, we don't need these here. So, you did take away two, right? So how many are left? |
| Rachel: | Wait. Let me count these again. |
| Dr. Ginsburg: | O.K. |
| Rachel: | O.K. So it's five. |
| Dr. Ginsburg: | So seven take away two is… |
| Rachel: | Five. |

As the interviewer identifies the child's erroneous understanding of the number fact, instead of telling the child directly that 4+2=6, but he had her figure it out by herself by using blocks. Rachel experiences a situation of conflict as her reasoning told her that 7-2=4 but working with block showed her that 7-2=5. The VITAL could be better designed so that the students could appreciate this type of constructive scaffolding.

## Appendix 1: Description of the Online Video Analysis Lesson

This is a clinical interview of Rachel, a first grader, working on subtraction problems. Dr. Ginsburg is the interviewer. He is looking at Rachel's abilities and strategies in arithmetic. Watch the associated clips on the left before answering each question. Once an answer is submitted, you cannot return to it.

### Question 1 Instruction

(A) What did you observe about Rachel and how she got the answer?

(B) What initial hypothesis can you make about her mathematical thinking?

(C) Are there any alternative hypotheses you can make about her mathematical thinking?

| Video Segment 1 (how long…?) | |
|---|---|
| Dr. Ginsburg: | Now let's make believe that the squirrel has six carrots. Strange that squirrel likes carrots. |
| Rachel: | Yeah. |
| Dr. Ginsburg: | Yeah. And rabbit wants to get three carrots. O.K. So squirrel is gonna give rabbit three carrots. How many carrots does squirrel have left? |
| Rachel: | Three. |

### Question 2 Instruction

Read three expert commentaries proposing various hypotheses on Rachel's thinking and understanding. Then answer the question below.

EXPERT A: "Rachel most likely has her number facts memorized. She probably learned the subtraction fact '6-3=3' in school. This question is easy to her because she has easily retrieved it from her memory. There was no counting involved in her mind."

EXPERT B: "Obviously, Rachel had the carrots pictured in her mind. She mentally moved three of the carrots away from the group of six that she was picturing, and then counted out the carrots that were left. Of course, she did this rather quickly

because her response was fast, but I could tell that she 'saw' them in her head because her eyes flickered a bit. She was also doing some of the visual calculating as Dr. Ginsburg was finishing the question; in this way, she was predicting the question he was about to ask."

EXPERT C: "Rachel probably has '3+3=6' memorized, but not the related subtraction fact. However, she was able to reason about this problem enough to do the reversal in her mind, and came to the conclusion that '6-3=3'. Therefore, she had a related problem memorized that allowed her to come to the answer very quickly, with the help of a little logical thinking."

Do you think that these hypotheses offered by the experts are plausible based on the evidence they used? Why or why not?

| Video Segment 1 | |
|---|---|
| Dr. Ginsburg: | Now let's make believe that the squirrel has six carrots. Strange that squirrel likes carrots. |
| Rachel: | Yeah. |
| Dr. Ginsburg: | Yeah. And rabbit wants to get three carrots. O.K. So squirrel is gonna give rabbit three carrots. How many carrots does squirrel have left? |
| Rachel: | Three. |

Question 3 Instruction

(A) What did you observe about Rachel and how she got the answer to this problem?

(B) Does this change or support your previous hypothesis about Rachel's thinking and understanding? Please explain.

| Video Segment 2 | |
|---|---|
| Dr. Ginsburg: | Three. How did you know that? |
| Rachel: | Well, I know, well, I know that three and three is six. And so, and so I know if I take three away from six you have three left. |
| Dr. Ginsburg: | Oh, very good. Very good. |

Question 4 Instructions

(A) what did you observe about the process by which Rachel finally came to the correct solution to this problem?

(B) Specifically, how did she go about resolving the conflict that Dr. Ginsburg helped her to see, and what can you conclude about Rachel's mathematical understanding based on this evidence?

| Video Segment 3 | |
|---|---|
| Dr. Ginsburg: | Let's try another one. Rabbit has seven carrots and he gives two of them to squirrel. How many carrots does rabbit have left? |
| Rachel: | Four. |
| Dr. Ginsburg: | OK. How did you figure that out? |
| Rachel: | I did the same thing. |
| Dr. Ginsburg: | Same thing. Tell me about it. |
| Rachel: | Well, I knew that four and two is seven. And if rabbit has seven carrots and he wants to share them with squirrel, so he gives squirrel two. He must have four left. |
| Dr. Ginsburg: | Uh-huh. Because four and two is seven, right? |
| Rachel: | Right. |
| Dr. Ginsburg: | Right. O.K. Very good. How could you make sure that you're really right about that? You said that seven take away two was four, right? Because four and two is seven. O.K. Could you show me with the blocks that four and two is seven? |
| Rachel: | O.K. First let me get seven blocks. |
| Dr. Ginsburg: | O.K. Good idea. |
| Rachel: | One, two, three, four, five, six, seven. O.K. So, there's two over here. |
| Dr. Ginsburg: | So, we don't need these here. So, you did take away two, right? So how many are left? |
| Rachel: | Wait. Let me count these again. |
| Dr. Ginsburg: | O.K. |
| Rachel: | O.K. So it's five. |
| Dr. Ginsburg: | So seven take away two is… |
| Rachel: | Five. |

Question 5 Instructions

Please evaluate this lesson – was it useful? What did you learn that will help you with your own clinical interviewing? After you submit this question, please take a few minutes to view other students' responses to compare to your own.

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