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ABSTRACT

This paper gives a description of a videotape used with inservice teachers as a model for demonstrating the clinical interviewing technique. It describes what is seen on the tape, as well as the child's and interviewer's comments and reactions. It also describes the plan and purpose of the interviewer's questions and outlines the process that transpires during an in-service experience in which a videotaped clinical interview is analyzed. The interview discussed in this paper is an interview with a first-grader about the meaning of equals, plus, and minus signs. The paper concludes with several interviewing tips: (1) Don't stop too soon; probe for more information; (2) Follow up an answer with a "why" question; (3) Validate your assumptions about the child's thinking; (4) Ask the child for a concrete example of what he or she has just said; (5) Do not generalize or come to conclusions too quickly; test your hypothesis with a different example; (6) Do not put words in the child's mouth; (7) Challenge answers whether they are right or wrong; (8) Try to understand how the child connects school math with informal strategies; and (9) Focus on contradictory or illogical statements. Contains 14 references. (MKR)

# Learning About Students' Mathematical Understandings from Videotape Models of Clinical Interviewing

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Learning About Students' Mathematical
Understandings from Videotape Models

Both the NCTM's Standards for Curriculum and Evaluation in School Mathematics (1989) and the Professional Standards for Teaching Mathematics (1991) highlight the importance of knowledge of students' understandings in helping teachers construct worthwhile mathematics tasks. Numerous articles have been written about children's thinking processes and how to assess them (Maher, Davis, & Alston, 1992; Maher & Martino, 1992; Sammons, Kobett, Heiss, & Fennell, 1992; Thompson & Briars, 1989) and these, of course, provide guidance for teachers who want to explore alternative approaches with their own students.

Simply reading about these assessment techniques, however, is not going to provide teachers with the competence and confidence they will need to work with their own students. Rather, in order to get a feeling for the techniques and to be comfortable enough to use them independently, teachers require a much more intense experience. This is particularly the case for subtle assessment techniques such as those involved in clinical interviewing, where teachers are asked to relate to students in ways that may seem inconsistent with their normal roles as facilitators of learning. Therefore, in order to better understand and appreciate these processes, teachers really have to ***see them in action***.

Opportunities for this type of observational learning, however, are limited by the number of "experts" available who can model the techniques for inservice programs. Most districts do not have access to such experts and even those that do, can only meet the needs of small segments of the teaching staff. One way to circumvent this limitation, however, is to utilize videotaped case studies prepared by "experts" who would otherwise be unavailable. These

specially prepared videotapes could provide the core of an inservice experience in which small groups of teachers have the opportunity to watch experts modeling questioning techniques and listen to the explanations provided by children as they are questioned by these experts.

The availability of good videotaped clinical interviews, though, is only the beginning of this inservice experience. Another critical element in the approach is the way in which the videotapes are utilized. This utilization must engage teachers actively in the interviewing and observation processes themselves. For example, for teachers to learn about effective questioning techniques and about children's thinking processes in a way that will enable them to carry out and recognize similar processes with their own students, they must be able to ***put themselves in the place of the interviewer on the tape***. Therefore, videotaped cases are not simply to be viewed, as one would view a film. Rather they are to be viewed with a small group of colleagues, guided by an inservice or peer leader, and repeatedly interrupted during the viewing. These interruptions provide teachers with opportunities to interpret the children's responses, anticipate what they think a child is going to say or do next, and suggest how they think the interviewer should proceed ***before they see it happen.*** Then after they have reflected upon the material, the teachers view the next part of the tape to confirm, compare, or modify their judgments. At the end of the vignette, teachers can make their own assessments of what they think the case study child should be learning next and how instruction should proceed. Thus, the process of viewing the entire videotaped case study consists of repeated cycles in which the teachers:

- ***view-reflect-anticipate responses***
- ***view-reflect-compare anticipated and actual responses***

and finally:

*o view-reflect-assess and plan instruction*

The following example is a description of a videotape that has be used as a model for demonstrating the clinical interviewing technique. The videotape as well as the methods of analysis described here were developed by Herbert Ginsburg, Rochelle Kaplan, and Arthur Baroody (1992) as part of their inservice teacher education program, Children's mathematical thinking: Video workshops for educators."[1]

The description in the following pages informs the reader about what is seen on the tape and includes both the child's and the interviewers comments and reactions. The description also takes the reader "behind the scenes," so to speak, in that it describes the plan and purpose of the interviewer's questions. Finally. it attempts to present some of the process and that goes on during an inservice experience in which a videotaped clinical interview is analyzed.

## The Case of a First-Grader

As the reader, assume that you are at an inservice meeting at which a videotape is being viewed by a small group of teachers. There is a leader who starts and stops the tape in order to ask pertinent questions. The teachers are about to view an interview with a child who is an end-of-the-year first grader named Brian. Brian was interviewed about his conception of the use and meaning of the *equals*, *plus* and *minus "signs."* During the interview Brian was asked to determine the "correctness" of a few examples of mathematical equations using number combinations that were expected to be familiar to him. The positions of the numbers, the plus or minus sign, and the equals sign were varied in order to assess the extent of his understanding and flexibility in using symbols in different number sentence forms.

Initially we see Brian looking at a paper on which the interviewer has written "6 = 6." The interviewer poses a direct question to see if the child understands the equivalence meaning of the "equals sign."

**Interviewer:** Tell me if it's true.

**Brian:** Six equals six (see Figure 1) (*Pauses a second to think, then shakes his head*). **No.**

At this point the leader interrupts the tape and asks the teachers to react to the short segment and to suggest where the interviewer should go from here. The discussion may reveal that Brian's response indicates that he may not be using the "equals sign" as an indicator of equivalence. However, it is not yet clear how he ***does*** use it. Therefore, the teachers might suggest that the interviewer should find out more about the child's meaning and that the tape viewing be continued to see what happened.

***Interviewing Tip: #1***

*Don't stop too soon.*

*Probe for more information.*

The leader continues showing the tape and in the next segment we see that the interviewer has taken the recommended direction, stayed with the child's viewpoint, and probed further about the child's use of the symbol by asking a simple more open-ended "why?" question which usually gets children to expound upon their thinking.

***Interviewing Tip: #2***

*Follow-up with a 'why' question after the child has given an answer.*

**Interviewer:** No? Why not?

**Brian**: Cause there isn't a problem that has six and then the equals six.

Again the tape is interrupted and the teachers are asked to consider the meaning of what the child has just said. A logical conjecture, based on the evidence so far, would be that this child may never have seen an equation in that particular form before and, therefore, made a mistake. This assumption, though, is not the only possible explanation for the child's reaction and so further viewing of the tape is needed to gather more information. The tape is continued and the teachers observe that the interviewer tested that assumption by trying to find out what the child thinks a problem is ***supposed to look like***. What kind of rule does he have in mind?

***Interviewing Tip: #3***

*Find out what the child has in mind.*

*Attempt to validate your assumptions about what you think he or she might be thinking.*

The interviewer does this by continuing the interview with what the child has already said and then asks him questions that would encourage him to expand upon his explanation and reveal more of his thinking. In particular she asks him to provide an ***example*** of what he means?

***Interviewing Tip: #4***

*Ask the child to give you a concrete example of what he or she has just said.*

**Interviewer**: It can't be done like that? What would it have to be?

**Brian**: It would have to be a different number at the end.

**Interviewer**: A different number at the end? For example, what number?

**Brian**: (*thinks*) Five. One minus five is (*pause*)... No, wait. There is one. Six minus one is... No it isn't. **Seven minus one is six.**

(*The **interviewer** writes down 7 - 1 = 6*, see Figure 2).

**Brian:** (*reading the equation with satisfaction*) **Seven minus one equals six.**

At this point the leader interrupts the tape again and the teachers are asked to reflect on how Brian comes to his conclusion. Their responses are likely to indicate that they could see the child trying to search through his memory for some known combination that would fit the form he considers acceptable. Then the leader would ask about what they think is most important to Brian's concept of an ***acceptable written 'problem'***? Their responses may focus on his requirement that he wants to find some fact to put in the beginning of the equation so that the "= 6" is true. In this case it seems that the child is concerned both with the accuracy of the statement and with the form in which it is stated. Brian's concern with these issues may or may not be characteristic of him. Since the teachers cannot tell this without further observation, the tape is continued.

As the tape continues, we see that the interviewer realizes that she needs to get more information to find out if Brian ***always*** uses the same approach.

***Interviewing Tip: #5***

*Do not generalize or come to conclusions too quickly.*

*Test your hypothesis with a different example.*

To do this, she returns to a number fact family the child had talked about earlier in the interview, the "6, 7, and 13" family. This time we see that the interviewer has set up the numbers in a non-standard form to assess Brian's use of his implied rule for writing equations.

> **Interviewer:** Before we were working with thirteen and we said, six plus seven is thirteen. (***Brian** says, "yeah."*) Can we say this (*writes down 13 = 6 + 7*, see Figure 3)? Is that correct?

**Brian**: (*reads*) Thirteen equals six plus seven (*thinks a moment*). **No!**

At this point if the tape is stopped, it might be reasonable to conclude that Brian really does not take a sensible approach to mathematics and that, in fact, it was correct to assume that he is not familiar with these kinds of "backwards" equations. Perhaps if he is not familiar with this form, they ***ought not to*** make sense to him. However, as the tape viewing continues the teachers learn that although this may be so, it is still premature to conclude with certainty that the child thinks in some particular way. Further investigation is still needed. On the tape, we see that the interviewer tries to find out more about what the child means by using a deliberately questioning tone. This serves to ***reflect Brian's opinion back to himself*** and acts as a cue to the child to continue to explain his thinking.

***Interviewing Tip: #6***

*Do not put words in the child's mouth or draw conclusions too early.*

*Reflect the child's own statements back so that the child has a chance to explain his or her own ideas.*

**Interviewer**: No?

**Brian**: The equals goes here (*points between the six and the seven*). In between the six and the seven. And the plus goes in between the thirteen and the six.

When the tape is stopped here, the teachers have heard the child's clear statement about how he believes the numbers must be ordered in a written equation. They recognize that Brian is working with a rule that says essentially the "plus" and "equals signs" have to go in a certain order, and that it is ***this order*** and ***not the mathematical meaning of the sentence***, that is the most important component in an equation. We have not found out if Brian has been exposed to

only one form of equation, but we do know that he seems to be wedded to that form. It may be a function of his educational experience or it may be an immaturity in the child's own thinking that causes him to impose this rule on the numbers.

Although this seems like it might be a good time to discuss the kinds of instructional approaches that would be helpful to Brian and children like him, continued viewing of the tape provides an opportunity for another important aspect of the clincial interviewing procedure to be demonstrated. Classroom planning, therefore, is best put on hold for a moment so that the teachers can view a bit more of the taped interview in which the interviewer highlights the importance of challenging a child's statements. In doing so, the child is given a chance to look more closely at his own response and possibly recognize his own mistake. Witnessing this recognition during the videotaped interview provides participating teachers with more accurate information about the child's capabilities as well as his shortcomings.

***Interviewing Tip: #7***

*Challenge the child's answers whether they are correct or incorrect.*

**Interviewer:** OK, let's try it that way (*writes* $13 + 6 = 7$, as shown in Figure 4). Is that OK?

**Brian:** (*immediately and confidently*) Yes!

**Interviewer:** Are you sure?

**Brian:** Yeah, yes. (*Reads*) Thirteen plus six equals seven!

Again the interview could stop here and we could say that Brian does not understand the equivalence meaning of the "equals sign," but knows it only as part of a fixed order in a number sentence. The interview, however, does not stop here because we still need to know how Brian's

school knowledge fits in with his informal mathematical knowledge. Therefore, the interviewer tries to create a situation in which the child is likely to resort to counting, a basic informal strategy used by children before they are introduced to formal mathematical procdures and symbols. When the tape is continued, we see the interviewer asking Brian about the "truth" of what he has just stated. She uses this technique as a way of trying to steer the child away from his preoccupation with form and to see if he has an underlying competing view based on his informal mathematical knowledge.

***Interviewing Tip: #8***

*Try to understand how the child connects school math to his or her informal strategies such as counting.*

**Interviewer:** Is that true (*implying, "prove" that thirteen plus six equals seven*)?

**Brian:** I'll figure it out (*counts out 13 unit cubes by ones*). Thirteen. Thirteen minus one, two (*starts to remove cubes*)...

At this point the leader can stop the tape again and ask what is learned about Brian from this sequence. Teachers can immediately observe that he is trying to subtract and this would be an accurate observation. This observation is likely to lead them to infer that the child turns the problem around because at some level he knows that the idea that $13 + 6 = 7$, just doesn't make sense. A bit more can be gleaned from this act as well and so with a little more discussion directed toward discovering the underlying meaning of the child's actions, the teachers are apt to recognize that Brian spontaneously used counting to check himself. This then can be understood as an important strength in the child because, through this act, he demonstrates that he can connect written number equations to his more intuitive counting-based number sense.

With this new information, the teachers are now likely to be anxious to continue the tape

viewing in order to better understand exactly how this counting will impact upon Brian's decision to accept or not accept the original equation. Before continuing, however, the leader asks the teachers what they would do in the interviewer's position. Would they let Brian proceed with the counting for subtraction? Would they stop him and remind him that he is modeling the wrong equation? Or would they just take over and show him how to do it correctly? Clearly the last choice is not in keeping with the non-directive style of the interview, but it does raise the issue of how difficult it is not to offer guidance when trying to assess the nature of a child's thinking.

After some discussion, the teachers have the opportunity to see what the interviewer did and to compare their intuitive reactions to those of the "model" on the tape. Continuing with the videotape, we see the interviewer challenging the child rather than letting him continue uninterrupted. She does this by simply directing the child's attention to the fact that the subtraction was not part of the original task. In doing this she is acknowledging that Brian seems to know more than his initial response suggested and at the same time attempting to find out more about how strong an influence his counting knowledge can have on his formal understanding. By returning the child to his original claim regarding the addition statement she has forced him to pit his two competing strategies (the application of formal rules and the process of informal counting) against one another.

***Interviewing Tip: #9***

*Focus on the contradictory or illogical statements made by the child.*

*Do not avoid "confrontation."*

**Interviewer:** No, wait a minute. Who said minus?

**Brian**: Oh, plus. Thirteen plus one, two, three, four, five, six (*counts out one at a time)*. Equals, one, two, three....(*counts all the cubes beginning with one)*.....18. No this isn't right (*pointing to the equation written as 13 + 6 = 7*). It's 18!

At this point this particular video segment ends and the leader moves the discussion on to the application of the case analysis to classroom teaching practices. This latter approach helps teachers see more clearly how the clinical interviewing process can be used practically by the classroom teacher.

In this particular instance, they have seen for themselves how a first grade child tended to apply a rigid rule, rather than a sensible approach, to written number sentences involving *plus, equals* and *minus "signs."* However, they could also see that while the child appears at first to be more concerned with "proper" form than meaning, his later spontaneous use of counting exerted a stronger influence on the child's thinking about accuracy than the symbolic material did. Therefore, even though Brian's specific count was slightly wrong he, nevertheless, had more confidence in counting than in reasoning abstractly about the use of mathematical symbols. This observation has strong implications for classroom instruction and sets the stage for the subsequent discussion of teaching strategies to use with Brian, strategies based on an understanding of what this particular child knows and how he reasons.

Having become actively involved in the interviewing process and the assessment of a child's understanding of some basic mathematical ideas, teachers can now focus their instructional planning on answering questions such as, "What do we know about Brian's underlying number sense that could be used in further developing his understanding?" "What counting strategies does Brian use?" "What role does counting play in Brian's understanding of symbolic expressions?" "How can his counting sense be linked to his symbolic understanding?"

These questions can lead to some interesting discussions about what kind of mathematical tasks Brian, and children like Brian, should engage in to further their understanding of meaningful number concepts. For example, teachers might suggest that Brian work on linking written equations to concrete models using materials such as balance scales and Unifix cubes. They may also suggest that the child build up his knowledge of addition and subtraction number facts by solving problems utilizing *counting-on* rather than *counting-all* strategies with and without objects. Further they may suggest that Brian work more with mental arithmetic utilizing counting strategies and concrete modeling in the context of real-world problems. Finally they may offer that the child work on writing equations that express the same basic relationships using as many different positions among the numbers and operation signs as possible.

**Concluding Remarks**

The small group analysis of videotaped clinical interviews conducted by an experienced model provides teachers with something more than a discussion of some particular child. It serves as a prototype for teachers who want to use similar questioning techniques to discover the mathematical understandings of students in their own classrooms. It also provides a stronger and clearer picture of the process than written descriptions convey and allows teachers to come into direct contact with a level of assessment expertise that may not be available within individual school settings.

By attending to the wording of the questions asked by "experts" and by speculating on how these questions lead to particular kinds of responses from children, teachers can prepare themselves to conduct their own interview-based informal assessments. Subsequently, these teachers will be able to create scenarios for "in-house" clinical interviews focusing on particular

curricular concerns and individual students. As long as the interviewer begins with some reasonable conjectures about the mathematical meanings, potential misconceptions, and common inventions that children bring to a topic, the resulting product can provide an engaging and illuminating experience for all involved. The application of these techniques to instruction are at the heart of the ***Standards*** ' (1989, 1991) call for using knowledge of students' understandings for constructing worthwhile mathematics tasks.

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1. This series consists of individual clinical interviews with elementary school children as they engage in doing mathematics activities. The particular activities selected for the tapes represent some of the typical findings of research in elementary children's mathematical thinking. These include how children use counting strategies to solve simple problems (Carpenter, Moser, & Romberg, 1982; Fuson, 1988; Gelman & Gallistel, 1986; Resnick, 1989); how children use perceptual cues to understand quantitative relationships (Binet, 1969), and how children's thinking often includes interesting misconceptions (Ginsburg, 1989; Kaplan, Burgess, & Ginsburg, 1988). While the Ginsburg, Kaplan, and Baroody case studies were specially prepared to address particular topics, the potential range of topics and issues that can be depicted in videotaped case studies is extremely wide and adaptable. The only constraint ***on the development of these videotaped vignettes*** is that they provide teachers with both an opportunity to learn about effective questioning techniques and that they reveal interesting aspects of children's mathematical thinking. Thus, "in-house" case studies can be developed for inservice training focusing on particular curricular concerns and individual students. As long as the interviewer begins with some reasonable conjectures about the mathematical meanings, potential misconceptions, and common inventions that children bring to a topic, the resulting product can provide an engaging and illuminating experience for all involved.

Figure 1. Brian's Unacceptable Equation

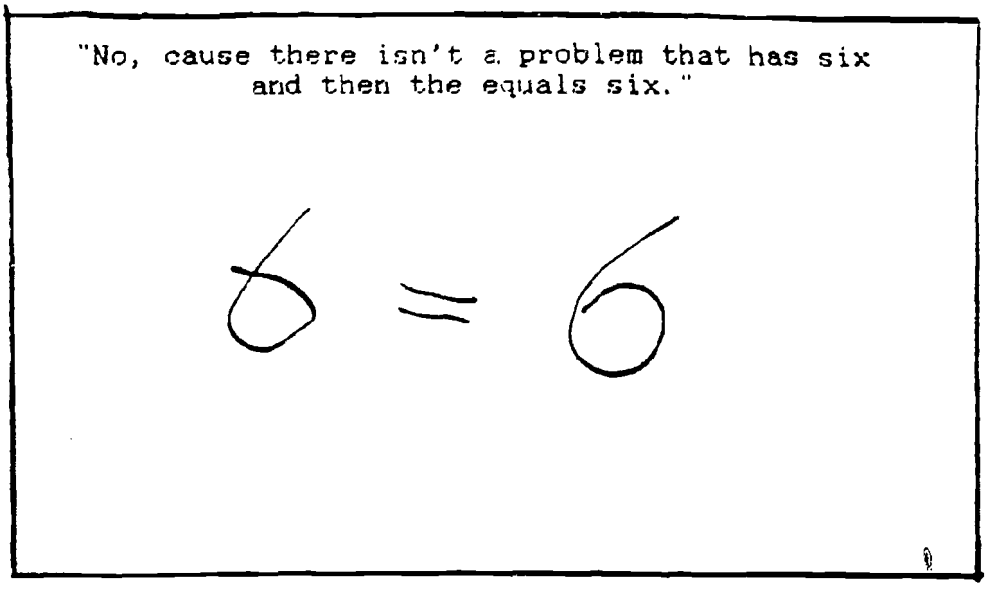


Figure 2. Brian's Acceptable Equation

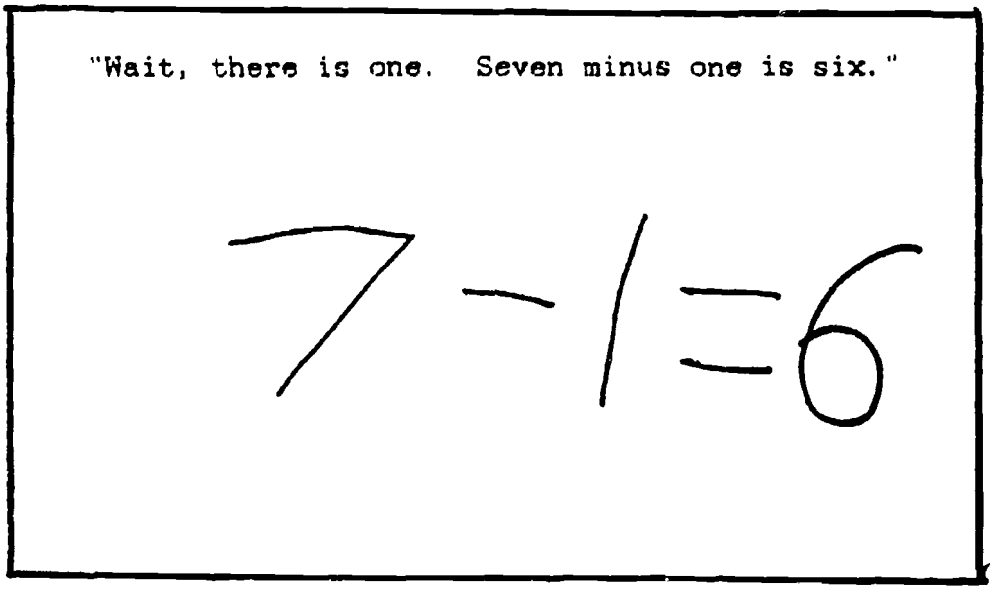

Figure 3. Brian's Wrong Way

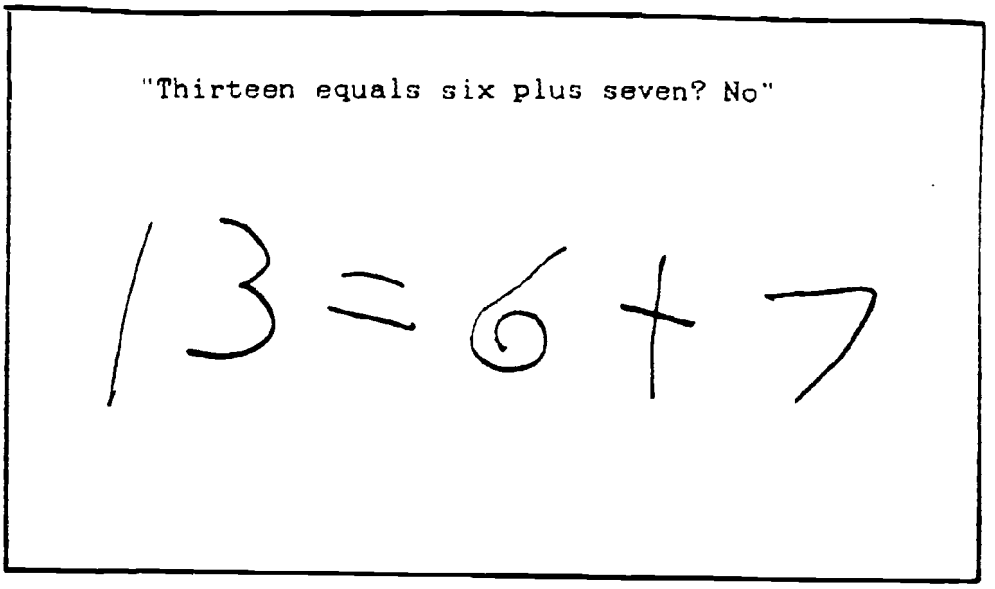


Figure 4. Brian's Correct Way