A STUDY OF THE USE OF CLINICAL INTERVIEWING WITH PROSPECTIVE TEACHERS

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The purpose of this paper is to share some of the results of a 15-week study in which pre-service teachers were provided with opportunities to learn to use the clinical interview method with children and other adults. The clinical interview is often regarded as a useful method for understanding children's thinking, and the basic hypothesis of this study was that this technique could be used to help pre-service teachers develop a deeper understanding of the ways in which children learn mathematics and devise better ways of teaching it. Results indicate that the pre-service teachers revised their ideas about the teaching and learning of mathematics, and developed a deeper understanding of the ways in which children build mathematical ideas.

Introduction and Theoretical Framework:

Providing opportunities for teachers at the pre-service and in-service levels to develop insight into their student's thinking is considered to be essential if teachers are to move away from more traditional instructional approaches which emphasize rote memorization and the execution of rules and procedures, and move toward instructional practices which provide students with the opportunity to build concepts and ideas as they are engaged in meaningful mathematical activities (Fennema, Carpenter, Franke, Levi, Jacobs, and Empson, 1996; Ginsburg, 1997; NCTM, 2000; Klein and Tirosh, 2000; Schorr and Ginsburg, 2000). The teacher who has insight into student's thinking can appreciate the sense in students' interpretations and representations of mathematical ideas, and can deal with them constructively. By contrast, the teacher who lacks understanding of student's thinking may understand a concept in a certain way, and genuinely believe that he/she is teaching that concept to his/her students. That teacher often does not realize that a student may not be learning the concept at all, or may be learning an entirely different concept from the one that the teacher has assumed. In either case, there is a wide gap between the thinking of the teacher and the thinking of the student. This can lead to problematic teaching situations, where, for example, the teacher may deal with what is seen as the student's failure to learn by redoubling efforts to teach the concept (as interpreted by the teacher)-- and remains unaware that the student is in fact attempting to learn something else entirely different.

Gaps between teachers' minds and students' minds are widespread, and occur in schools ranging from preschool through university (Schorr and Ginsburg, 2000). This is not surprising, since gaining insight into students' thinking is not easy. Piaget (1976) pointed out that it will take the psychological equivalent of the Copernican revolution for the adult to realize first that the child's thinking does not necessarily revolve around

or take a form similar to that of the adult's, and second that children's minds, although often radically different from the adult's, can nevertheless make their own kind of sense.

To better understand people's thinking Piaget, (1952) developed a technique known as "the method of clinical examination" modeled after psychiatrists' methods of diagnosis. Using this method, he pursued the investigation of thinking in the following way: "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" (Piaget, 1952, p. 244 as quoted in Ginsburg, 1997). The clinical interview, as originally developed by Piaget (1976), is a flexible and deliberately non-standardized method of questioning, which aims at providing insight into children's ways of thinking-- into their personal "constructions"-- which are often different from the adult's. In the clinical interview, the adult poses a specific task to the child, and usually begins with some predetermined questions. However, the adult is free to modify the questions as necessary, depending on the child's apparent understanding of the questions, the child's motivation, and particularly the child's response to the initial question. The interviewer has the freedom to rephrase the questions to ensure that the child understands them, to follow up on interesting remarks, to clarify responses, and even to challenge them so as to establish the child's degree of conviction. The clinical interview method has been used as the basis of a good deal of research on children's understanding of school mathematics for many years, perhaps beginning with Davis & Greenstein (1964), and is now receiving increasing recognition as a major tool for psychological research into cognitive functioning (Ginsburg, 1997).

This research focuses on one method for helping pre-service teachers reduce the gap that exists between children's thinking and teachers' thinking—namely the clinical interview. The central hypothesis is that if used effectively, the clinical interview can be a fundamental method for helping pre-service teachers better understand students thinking, and subsequently devise better ways of teaching mathematics. This research builds upon previous work which shows that it is possible for teachers to learn the clinical interview method and to develop useful forms of it for practical implementation in the classroom (Ginsburg, Jacobs, & Lopez, 1998). That research showed that elementary level teachers from very different types of schools—inner city, suburban, and private-- were able to become rather good interviewers and to develop distinctive styles of interviewing appropriate for their classrooms. For example, some teachers developed forms of interviewing individual students; others developed methods for interviewing groups of students; others integrated interviewing into their teaching; and another teacher taught her students to interview each other. Almost all teachers said that the process of learning and implementing clinical interview methods was an extremely valuable experience and indeed changed their whole approach to understanding children and teaching them. The research in this paper also builds upon prior work in a similar course where clinical interviewing was shown to be effective in

helping prospective teachers begin to develop new ideas about teaching mathematics (Schorr and Ginsburg, 2000).

Methods and Procedures:

The setting for this study was a course entitled "Methods of Teaching Mathematics for Elementary and Middle School Teachers", a mathematics methods course at an East Coast university in the USA. The course had 23 prospective teachers enrolled, who met with the researcher three hours per week, for 15 weeks. As part of the course, the prospective teachers were provided with opportunities to learn the clinical interview method, interview children, and reflect on the interviews individually and collectively during classroom sessions. They were also provided with opportunities to deepen their own understanding of the mathematics that they were expected to teach, and simultaneously consider the pedagogical implications of teaching mathematics in a thoughtful manner. For example, during weekly class sessions, the prospective teachers would investigate a particular mathematical idea by solving a problem or series of problems related to the idea, generally in a group setting. They would then share their solutions, and compare the strategies chosen, the notations that were invented or selected, and the representations built. They were always challenged to defend and justify their solutions. When appropriate, they would then watch a videotaped interview[1] involving a child or series of children grappling with the same or similar mathematical ideas. During and after viewing the videotaped interview, they would share reflections about the questions posed and the interview techniques used. They would also discuss the child's mathematical thinking, and the pedagogical implications of teaching and learning the mathematical ideas. At times, they would also watch videotaped episodes of children working on similar mathematical ideas[2] and again, discuss the mathematical ideas that emerged, and the implications for teaching. Afterwards, they were encouraged to actually interview a child about the same ideas, and share the results during the next class session. In addition, the prospective teachers were assigned selective readings on the same topics as well as readings taken from state and national standards in mathematics.

All prospective teachers had to interview a child (or in some cases, an adult) every other class session. They had to record what they considered to be significant aspects of the interview (noting the exact words of the interviewer and interviewee by using a tape recorder or videotape) and discuss the overall interview, their reflections on the questions that they asked and responses of the interviewee, and the implications for teaching. Each prospective teacher therefore conducted an interview with at least one child (or adult) every other week for a total of at least

[1] The tapes and corresponding guide are part of a series entitled "Children's Mathematical Thinking-Videotape Workshops for Educators" developed by Herbert Ginsburg, Rochelle Kaplan, and Rebecca Netley. They are distributed by the Everyday Learning Corporation.

[2] These tapes were often obtained through the Robert B. Davis Institute for Mathematics Education.

seven interviews[3]. Prospective teachers also kept a journal in which they recorded their reflections on the readings, mathematical ideas, or at times, additional reflections on their own or their peers interviews. They submitted their journals on the weeks when they did not submit an interview.

The data for this research includes the written interview logs and journals of the prospective teachers, and researcher's notes.

Results and Discussion:

There are many findings to report regarding changes in the prospective teachers' ideas about the teaching and learning of mathematics and the ways in which children build the mathematical ideas that were investigated. Space limitations permit only a subset of the results to be shared in this paper. These will be limited to three main themes that consistently emerged among the prospective teachers.

Theme 1: The prospective teachers changed their views and beliefs about the teaching of mathematics.

All prospective teachers reported that as a result of interviewing children (and adults), their conceptions about teaching and learning changed. For example, consider one Journal entry submitted by a prospective teacher who shall be referred to as Juanita:

> Before taking this course, I had a very different idea of what it meant to teach math. I thought that teaching math would be just like it was when I went to school; the teacher did a few problems in the board and we simply had to follow the steps she/he took to come up with the answers. To me this was math, until I took this course. Now I could look back and see that even though I always had good grades, it didn't mean that I knew math. Now I realize that math is more than just finding answers. Math should involve solving problems by reasoning and understanding. After doing my interviews, I was able to see the difference between knowing how to find answers by following an algorithm and finding the answers by using our knowledge and understanding of the subject.

Juanita went on to describe how she would like her classroom to look, and the types of questions and techniques that she might employ. For example, she stated the following:

> Now I realize how important and beneficial it is that we encourage students to think and come up with their own strategies. As teachers, our goal should be to challenge students by coming up with problems…good problems [that] give students the chance to solidify and extend what they know…. As teachers we should encourage students to find the reasoning behind their solutions and also be able to prove them. It's very important that students be able to defend their answers by coming up w/ proofs because this way they will have to have more in-depth understanding of the problem. We have to help our students see that their

[3] Prospective teachers often volunteered to interview additional children and/or adults about an idea that interested them, or when they sought more data about a particular idea.

statements need to be supported by evidence.

Other prospective teachers made similar comments regarding their beliefs about what it means to teach mathematics. One teacher, Maria, noted that she used to believe that using pictorial or concrete representations was not really "doing math", but now she feels differently. As documentation, she recorded these observations as she was interviewing a seventh grade student. The problem she had posed to the student, "Irene" had been similar to one that she and the other prospective teachers had solved and discussed the prior week in class. Maria was interested in seeing the mathematical ideas, strategies, notational systems and representations that would be used by this student. The problem, as recorded in Maria's interview log, was as follows: Juan has 3 pairs of pants and 5 shirts, how many different outfits can Juan wear, please show me your work. Maria recorded the following:

> Now I had a feeling the phrase "please show me your work" would be a problem [for Irene], because I knew it was for me when I was her age. Many teachers do not want to see drawings, they want a mathematical equation. Sometimes, if they don't receive that, the question is marked wrong. I wanted "Irene" to learn that drawing pictures is okay. I remember solving a problem using my head or drawings and having to come up with an equation, So, I would use any old equation that gave me the answer I was looking for, even if it didn't make sense…

Maria noted that Irene worked for a while and then handed her a piece of paper and said "it's probably wrong, but I think it makes sense". Maria included Irene's work in her written log. The work included five circles representing the shirts, and three rectangles representing the pants, along with an answer of 15. Maria continued her interview as follows:

> So I asked [Irene] how did she get that answer and if she could explain it to me. She tells me "I made circles for a the amount of shirts and squares for the amount of pants, then I just paired them up." At this point, she starts to draw lines from a circle to a square, but then she tells me that the lines got too confusing to count so she changes her format. This time she makes the shirts vertically and does something very interesting with the pants [Maria included Irene's written work which again included five circles--each with the word shirt written inside, but this time, each circle had three lines extended, each with a small square at the end and the word pants written inside each square.] She [Irene] tells me that the lines are easier this way (to count) and that it makes 15 outfits. So, I asked her how she figured it out and she tells me "well there's three pairs of pants, and five shirts, so I just paired up every single pair of pants with every shirt."

Maria went on to ask Irene if there could be any other answer, and Irene said that she didn't think so. Maria continued her interview by asking, "why did you say in the beginning that your answer is probably wrong?" Irene responded by saying "because I didn't show my work…". Maria noted that this student did not see "drawing pictures" as doing mathematics. As part of her written log, Maria also discussed the type of reasoning (additive and/or multiplicative) that she felt the student was using. In a

subsequent class discussion, Maria used this example to underscore her desire to encourage students to draw pictures. The researcher was able to use this (and other similar examples) to provide an opportunity for Maria and the other pre-service teachers to consider the type of reasoning used by the students, and how students' representations like "drawings" could be linked to spoken words, written words, numbers, symbols, etc..

Theme 2: Prospective teachers noticed that children (and adults) often invent their own strategies when solving problems.

Juanita described an aspect of one interview in which different subjects used different techniques to solve the same problem involving multiplication (one drew figures, the other used different number combinations). This, along with the other interviews and reflections of her peers prompted her to write the following:

> After doing these interviews, I was able to see for myself how everyone has their own invented techniques to solve problems. Everyone sees their own ways as being easier to understand. As teachers, we must keep this in mind because if we teach children using only one method, our method, children may not understand our techniques, to them, our ways may seem complicated, even though we find them easy.

Juanita wrote that children must be able to "make the connections between the symbols and the meaning of the mathematical process". She noted that "as teachers we should allow students to present alternative [methods]…and then lead a discussion about why a particular [method] works or doesn't. This allows the teachers to become more aware of the diversity of different approaches that are used".

Anna, another prospective teacher, decided to interview several adults about a simple mathematical problem to see whether or not they would use a traditional algorithm or an invented strategy. The problem that Anna chose was to find the age of a woman who had a son at the age of fifteen if the son was now nineteen. Anna wrote the following in her log:

> I asked my sister and aunt [and mother] to solve the problem. I was so surprised that we each ended up with a different way of coming up with the same answer. I thought that would happen more with children.

She described their methods, along with the way that she had solved the same problem. For example, she noted that her sister solved it by taking "the tens first, which came out to twenty. She then counted the ones column. She took one from the five and added it to the nine and got ten. She then added the ten to the twenty and got thirty and then added the remaining four to thirty and got the answer thirty four." Anna included these reflections in her log:

> This interview was so interesting to me because it showed me that it isn't just children who come up with different ways of solving even a simple math problem. In the video I only saw children being asked to solve problems and I was somewhat curious how adults would respond. I thought we would be more

> like-minded since we're older and have gone through a lot of similar math rules, but I was shown wrong…. This has made it even more significant to me that what may be in my mind may not be what's in another's mind, and I have to take that into much consideration!

While the prospective teachers had discussed the use of different strategies in class on numerous occasions, and indeed had even shared the many different ways in which they had solved different problems, Anna still needed to experience this for herself, and the interview provided just such an opportunity. For Anna, this interview continued what the class experience could only begin—help her to realize for herself, that people can approach the same problem quite differently.

Interviews often triggered extensive in-class discussions about why particular methods worked, when and under what circumstances they would work, and how they related to more traditional approaches. This provided an additional opportunity for the prospective teachers to deepen their own understanding of the mathematical ideas.

Theme 3: Getting the right answer does not necessarily mean that the student understands the mathematics.

Perhaps one of the most important "discoveries" that most of the prospective teachers made was that students can get the "right answer" without understanding anything about why their method worked. For example, consider the reflections of another prospective teacher, Oneda. Oneda decided to interview a friend of hers who is an accountant. Her reflections included the following comments:

> I began the interview by asking "Jim" whether he felt completely comfortable with the subject of mathematics. Jim answered the question…with an emphatic "of course…what kind of accountant would I be if I was not comfortable with mathematics." I continued the interview by asking Jim…to add 3/4 plus 1/2. Jim added the fractions and got the answer 1 and 1/4. I asked Jim to explain how he got his answer. Jim mentioned in his explanation that the first thing that he did was to find the least common denominator. I then asked why the least common denominator had to be found, and after thinking for a few seconds he laughed and stated that he did not know why. He seemed to be a little embarrassed and I assured him that many people simply did not know. We then got into a discussion of how he had learned to add and subtract fractions. Jim recalls learning to add and subtract fractions by being given the math rule by the teacher followed by numerous worksheets. He basically memorized the rules and then repeated them on similar problems on tests. He did this all through elementary school, high school, and even college with more advanced mathematics. Jim always received good grades.

Her reflections went on to include the following comments:

> The problem is not that one should not learn these algorithms or methods and rules of solving problems. The problem lies in that this is all that is presented to children. This is truly unfair and simply cannot be called teaching mathematics. As witnessed in the videos shown in class, children are capable of much more. They can grasp many concepts that many times adults don't think they can grasp…. Limited understanding of mathematical concepts cannot be blamed on the individual or his or her intelligence level. Rather, the blame must be put on the

> years of bad teaching that the individual was subjected to. Perhaps even blaming bad teaching is pretty unfair. Many of the teachers that teach in this way are simply teaching in the way that they were taught. It is basically like a bad cycle. I only hope that I can be one of those teachers that helps to break the cycle.

Another prospective teacher, Inez, interviewed a middle school student on ideas relating to fractions as well. Inez noted that while this student could add fractions with like denominators, he had no idea why he needed to have a common denominator. She noted that whenever she asked this student why the denominators had to stay the same, he responded "because it just does" or "[you] just have to". She stated

> Even though he knew the rule about keeping common denominators the same, he did not know why. I noted frustration in his voice when I tried to get him to explain to me the reason behind his answer.

Inez then posed a problem to this student where the denominators were not the same (3/8 + 1/4). She recorded this:

> When adding 3/8 plus 1/4, I could tell he was confused and frustrated for forgetting the rule to solve it. He used the rule of dividing and multiplying fractions, which involved canceling out to simplify. He admitted that he was not sure that he got the correct answer. Even though he got the answer wrong, that it was due to the fact that he was thinking about which rule to use instead of really thinking about what to do. He always got good grades in math…

While the prospective teachers had spent time in class exploring ideas relating to fractions before they conducted their interviews, the interviews provided additional opportunities for them to reconsider their own understanding of the mathematical ideas, and the implications for teaching. This occurred when the interview was shared by the student and/or the researcher, and resulted in additional discussions and explorations.

Conclusions:

The prospective teachers involved in this study felt that their views of teaching and learning had greatly changed as a result of clinical interviewing. They also gained insight into the ways in which mathematical ideas can be built and represented. It would be unwise to assume that by itself, this 15-week experience could be sufficient to dramatically change the prospective teachers' approach to teaching all areas of mathematics. Clearly, the prospective teachers will need longer and deeper experiences in order to make the transformation from perspectives that can be difficult to move beyond (see Simon, Tzur, Heinz, & Kinzel, 2000). However, this study does provide documentation that clinical interviewing can help prospective teachers to consider alternative approaches to the teaching and learning of mathematics and develop an increased awareness of the ways in which people learn mathematics. In addition, the interviews also provided the impetus for challenging and thought provoking course discussions about mathematical ideas—ideas that became more personally relevant to the prospective teachers because they emerged as a consequence of their own interviews with children and adults. Taken together, the results appear to indicate that the clinical interview method can be a

valuable tool in helping prospective teachers begin to see mathematics as a "collection of ideas and methods which a student builds up in his or her own head" (Davis, 1984, p. 92), and as a result, devise better ways of teaching it.

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