Using Student Interviews to Guide Classroom Instruction: An Action Research Project

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During the 1999–2000 school year, the teaching staff, including teachers and instructional assistants, at Jefferson Elementary School, Jefferson, Oregon, engaged in an action research project to investigate how student interviews would influence the way that teachers present mathematics in the classroom. For the purpose of this article, *action research* is defined as the process of asking a worthwhile research question, collecting credible evidence to answer the question, and using the evidence to guide further improvement in a school. Action research is similar to traditional research in that it embodies a desire to inquire and understand and a commitment to use data to guide improvement efforts. Unlike traditional research, which is usually conducted by university researchers to construct general theories, action research is conducted by school personnel to build local knowledge. Although action research can yield results that can be generalized outside the local school setting, the outcomes of action research are primarily directed toward meeting the needs of children in a school through changes made by the school's teacher-researchers.

The Problem

Several teachers of kindergarten through fourth-grade classes at Jefferson Elementary School were struggling to implement problem solving in their mathematics classrooms. They found that problem solving is often hard to teach and even harder for children to learn. In addition, the entire staff was working hard to develop effective questioning strategies to use when students experienced difficulty in solving mathematics problems. The teachers realized that they lacked sufficient knowledge about the mathematical understanding of individual students. Large class sizes and an ever-increasing number of special needs children in the school prevented the teachers from regularly spending time with individual children and limited the teachers' efforts to uncover the children's level of understanding of the full array of mathematics topics that must be addressed each school year.

We chose to investigate the following two questions:

- Do student interviews provide teachers with a more detailed, accurate, and complete picture of children's mathematical understanding?

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- Does this knowledge help teachers improve the way that they teach mathematics?

Action Research Plan

The major components of our research project included professional development workshops for all team members; data collection from student interviews, teacher self-assessment, and reflection journals; and sessions for sharing results with other team members. The project was conducted as follows:

- Team members interviewed individual children while the rest of the class participated in a program of extended activities (see **fig. 1**).
- During the interviews, team members used a variety of problem types identified in *Children's Mathematics: Cognitively Guided Instruction* (Carpenter et al. 1999) (see **fig. 2**). In addition, the teachers used both probing and leading questions to gain additional insight into children's thinking (see **fig. 3**). Finally, some team members videotaped each interview.
- The team members conducted two sets of interviews, one during the fall and one during the spring of the 1999–2000 school year.
- The team members shared the results of their interviews with the rest of the team and described the impact of these interviews on their classroom instruction. These insights and results were summarized using qualitative data-collection techniques.

Because the primary goal of this action research project was to examine the effect of the interviews on the ways that teachers teach mathematics, changes in student performance were not measured. A follow-up analysis will be conducted over the next five years, however, to examine changes in student performance related to differences in teacher classroom practices.

Findings and Implications

Do student interviews give teachers a more detailed, accurate, and complete picture of children's levels of mathematical understanding?

Student interviews directly supported two of the approaches to teaching mathematics that are used at Jefferson Elementary School. Although none of the teachers uses these two approaches exclusively,

FIGURE 1

Scheduling times and activities for the interviews

We realized that most teachers could not conduct the interviews as part of their regular classroom activities because other children would constantly interrupt. We joined together, therefore, to set aside time specifically for teachers to conduct interviews without the presence of other children in the classroom.

Every Friday, all regular physical education, computer lab, and resource room (Title I) classes were canceled. We used the Title I staff (one teacher and five instructional assistants) to supervise an activities program. A sample schedule of the program is shown below. This schedule gave each classroom teacher two hours every other week for interviews with individual children while the rest of the class participated in the activities program. Other schools have used similar schedules but have included four activities instead of three or have used different instructional staff, such as the principal, counselor, librarian, or music teacher, to supervise the program. At the beginning of the school year, we prepared a list of activities for this program, which included mathematics and language games, computer activities, dance classes, art projects, and so on.

Sample Schedule for Activities Program

Week 1	8:30–9:10	9:10–9:50	9:50–10:30	12:30–1:10	1:10–1:50	1:50–2:30
Gym	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6
Computer Lab	Room 3	Room 1	Room 2	Room 6	Room 4	Room 5
Resource Rm.	Room 2	Room 3	Room 1	Room 5	Room 6	Room 4
Week 2						
Gym	Room 7	Room 8	Room 9	Room 10	Room 11	Room 12
Computer Lab	Room 8	Room 9	Room 7	Room 11	Room 12	Room 10
Resource Rm.	Room 9	Room 7	Room 8	Room 12	Room 10	Room 11

FIGURE 2

Problem types used in Cognitively Guided Instruction (Carpenter et al. 1999)

Join	**Result Unknown** Jason has 4 cookies. A friend gives him 2 more cookies. How many cookies does he have?	**Change Unknown** Jason has 4 cookies. How many more does he need to buy to have 1/2 dozen in all?	**Start Unknown** Jason has some cookies. He gets 2 more from the cookie jar. Now he has 6 cookies. How many did he have to start with?
Separate	**Result Unknown** Jason had 6 cookies. He gave 2 cookies to a friend. How many does he have left?	**Change Unknown** Jason has 8 cookies. Some of them are frosted. If 3 cookies are frosted, how many are not frosted?	**Start Unknown** Jason bought a package of cookies. He put 3 cookies in his lunch box. There are 5 left in the package. How many cookies were in the package he bought?
Part-part-whole	**Whole Unknown** Jason has 6 oatmeal and 3 chocolate cookies. How many cookies does he have?	**Part Unknown** Jason has 9 cookies. 3 are oatmeal cookies and the rest are chocolate. How many are chocolate?	
Compare	**Difference Unknown** Jason has 8 oatmeal and 5 chocolate cookies. How many more oatmeal than chocolate cookies does he have?	**Compare Quantity Unknown** Jason has 3 oatmeal cookies. He has 5 more chocolate than oatmeal cookies. How many chocolate cookies does he have?	**Reference Set Unknown** Jason has 8 cookies. He has 3 more oatmeal than chocolate cookies. How many oatmeal and how many chocolate cookies does he have?
Grouping	**Multiplication** Jason has 3 packages of cookies. Each package has 5 cookies. How many cookies does he have in all?	**Measurement Division** Jason has 1 dozen cookies. He puts 3 cookies on each plate. How many plates does he use?	**Partitive Division** Jason has 1 dozen cookies. He shares them with 4 friends so they each get the same number of cookies. How many cookies does each person get?

Note: Problems used with older children can contain larger, fractional, or decimal quantities. Also, older children can be asked to solve additional problems that require them to use a scale, balance, thermometer, and so on. For example, show children a 1-ounce ball of clay, and ask them to use a balance to make a 1/2-ounce ball from some loose pieces of clay.

they do form the basis for most classroom mathematics instruction. The first approach is cognitively guided instruction. A major tenet of this approach is that learning occurs as new knowledge is linked to existing knowledge, and teaching is most effective when instruction directly builds on what children already know. Our interviews supported and enhanced Cognitively Guided Instruction by making teachers more aware of what individual children knew and what tasks they could perform with their knowledge.

The second approach is based on the theory of constructivism. A major tenet of this approach is that understanding is personally constructed. Our interviews helped teachers understand how children learn mathematics. The interviews gave teachers the opportunity to observe children's attempts at solving problems in ways that made sense to the student.

Do student interviews influence the way teachers teach mathematics?

Student interviews changed instructional practices in some classrooms and influenced instruction in all classrooms. All teachers reported that after the interviews, they increased their focus on meeting the needs of individual students. Other results reported by teachers included the following:

- The teachers noted that they were able to identify students who were ready for the next level of conceptual understanding and gave them problems that were challenging yet not overwhelming. At the same time, teachers helped students who were not ready for the next level of concept development by giving them additional opportunities to solve developmentally appropriate problems.
- The teachers commented that they were able to write better problems for use in the classroom, focusing on students' misconceptions that were revealed during the interviews. The teachers found that children did not interpret the meanings of some words used in problems in the same manner as adults. They noted that changing one word could make a problem more or less understandable and that the placement of words in a problem could affect a child's ability to solve it successfully.
- The teachers reported that they tried to make the classroom setting more conducive to discussing the children's solutions to problems. Teachers became aware of the need to ensure that children share many different ways of solving problems to reveal a variety of strategies typical of the wide range of development of the children in the classroom.
- The teachers recognized the need for a learning environment in which children could solve problems cooperatively with others. The interviews dramatically revealed which children relied heavily on others for networking and scaffolding.
- The teachers gained a sense of confidence in the natural abilities of children as problem solvers. As a result, they felt more comfortable giving children more classroom time to work through their own strategies for solving problems. Teachers found that children could create their own strategies for solving problems, especially in the privacy of the interview environment, and given sufficient time, could solve challenging problems that teachers would not have previously used with their students.

Conclusions

Teachers benefit directly from the interview process by gaining a more accurate and complete view of what children know and can do. With this information, they can match instruction to the individual needs and abilities of children. Also, teachers grow professionally because they experience a gradual shift in their beliefs about how children learn to think mathematically and how they can support and facilitate children's thinking.

FIGURE 3

Problem and leading questions for interviews

Probing question to be used at the beginning of an interview:
- That answer is very interesting; can you tell me what you did?
- Please show me what you did and tell me about it.
- How did you find the answer?
- How did you figure this problem out?
- Please tell me more about what you did to help me understand you better.
- I never thought about solving the problem that way; can you tell me more?
- Why did you do that?
- Why did you say that?

Leading questions to be used later in an interview:
- Why did you use a key or labels with your drawing?
- How did you check your answer to see whether it is correct?
- Why did you use the word *estimate* when describing your solution?
- Explain your drawing to me.
- What do these lines mean?
- What did you think in your head when you were doing this part of the problem?
- How did you find the answer so quickly?
- What do you mean when you say, "This number is more"?
- Why did you use a number sentence for this part of the problem?

Children benefit directly from the interview process by spending one-on-one time with the teacher, a rare and valued opportunity in the fast-paced world of a standards-driven classroom. Children can receive immediate and specific feedback on their performance from the teacher; and this feedback, in turn, helps them correct misunderstandings and improve skills. Finally, children have the opportunity to ask clarifying questions about mathematical concepts or ideas that they do not fully understand and to explore conjectures or hypotheses about problem-solving strategies or procedures in the safety and privacy of the interview environment.

Summary

Traditional forms of evaluation, such as tests and quizzes, can measure improvement in children's acquisition of specific skills and can compare children's performance levels. However, "over reliance on [tests and quizzes] may give an incomplete and perhaps distorted picture of students' performance" (NCTM 2000, p. 23) because tests in general do not tell teachers how children learn to think mathematically, how children reason and why they make errors, or what kind of feedback will help children become better problem solvers. In contrast, "the assessment of students' understanding

FIGURE 4

Guidelines for planning and conducting student interviews

- Try to ensure that you and the children will not be interrupted during the interviews.
- Choose a private location where distractions can be minimized.
- Have available a broad range of problem-solving tools for children to use, including manipulatives, rulers, graph paper, Judy clocks, play money, calculators, and so on.
- Pose a problem that will challenge children.
- Assume that what a child says and does is a real attempt to make sense of the problem and to solve it in a meaningful way. Focus on the child's thinking, not on the misuse of mathematical terms, symbols, or computation algorithms.
- Start with open-ended questions, then proceed to more specific questions as you gain insight into the reasons behind children's thinking.
- Try to search for the child's point of view. Extending or expanding a child's thinking is difficult until you first determine how a child approaches the problem. Most children also think differently than adults do, which means that seeing the problem from a child's point of view can be challenging.
- Try to listen closely to what children say, not to what you expect to hear. We have found that to be successful interviewers, teachers must be good listeners and skilled questioners.

can be enhanced by the use of multiple forms of assessment" (NCTM 2000, p. 372), such as interviews. These conversations can give children useful and usable feedback while providing teachers with valuable diagnostic information on children's performance. Interviews can foster insight into how children think and reason, how children demonstrate their creative abilities and talents, and how they apply and use problem-solving strategies in mathematics.

Our reasons for concluding that interviews are a more appropriate assessment tool than tests are to examine the performance of children engaged in mathematical problem solving include the following:

- Teachers can use interviews to construct a more comprehensive portrait of how children think when solving a problem and can thus promote and facilitate this kind of thinking in the classroom.
- Teachers can use interviews to give children feedback that is more useful and usable for improving future performance because the feedback is specific and individualized.
- Interviews can help teachers create a more comfortable problem-solving environment for children. During our interviews, many children seemed more willing to take risks, such as using strategies or manipulatives that they had not previously used in the classroom. This willingness may have resulted from the fact that the children perceived the interview to be a more private setting compared with the public setting of the classroom, where their actions would have been constantly scrutinized by their peers. In addition, many children found the interview to be more "user-friendly" because they could explain their solutions out loud instead of having to record them in writing. Because most children can explain what they have done orally with far greater ease and clarity than in writing, the interview gave children a chance to demonstrate a deeper understanding of mathematical concepts than they had previously revealed through their written solutions to problems.
- Interviews help teachers gauge children's breadth and depth of understanding of the major mathematical concepts embedded in problems. Our interviews frequently gave teachers insight into which children used a particular problem-solving strategy, which children could solve a problem but did not really understand the procedure that they used, and which children the teacher had mistakenly assumed to possess certain understandings.
- Interviews can prompt teachers to examine aspects of children's performance that traditional forms of evaluation do not measure, such as problem-solving attitudes; behaviors; and dispositions, such as patience, perseverance, and a positive outlook.
- Finally, during interviews, teachers can examine how children perceive the difficulties that they experience when solving problems and how they attempt to resolve these difficulties.

From our experiences, we have developed some general guidelines that others might find helpful in planning and conducting student interviews (see **fig. 4**), as well as some questions that teachers might want to answer for themselves during interviews (see **fig. 5**). We believe that the results of our action research project affirmatively answered our two questions: Do student interviews provide teachers with a more detailed, accurate, and complete overview of children's levels of mathematical understanding? and Do student interviews change the way that teachers teach mathematics?

Next Steps

Our research team members will examine changes in student performance before and after the implementation of this action research project. Data collection methods will include classroom

FIGURE 5

Reflection questions for teachers during interviews

- Do children use manipulatives or other tools to solve the problem? If so, what tools do they use and how do they use them?
- Do children display problem-solving dispositions, such as patience, perseverance, positive attitudes, flexibility, and fluency?
- Do children take risks, such as using an invented algorithm or an unfamiliar manipulative?
- Do children ask questions of the interviewer? What kind of questions do they ask?
- Do children monitor their solution processes while working on a problem, and how do they verify their solution processes when they are finished?
- Do children present their solutions in ways that the interviewer can understand? Are the solutions clear and complete?
- Do children recognize major mathematical concepts and ideas embedded in the problem, and can they express these ideas in a generalized form?
- Do children see their errors in logic or computation, and are they able to correct them?
- Do children respond positively to feedback, and are they able to extend their level of understanding by answering leading questions posed by the interviewer?
- Do children learn something new from the interview, and can they tell the interviewer about their new knowledge?

observations, interviews, scoring guides, portfolios, and statewide tests. In addition, the team members will continue to conduct annual student interviews with all the students in the school and revise existing questions or write new questions to be used during the interviews. The teachers will continue to explore effective questioning strategies and reflect on changes in their beliefs about how children learn to think mathematically. They will also continue to assess how these changes influence their classroom instruction.

Final Thought

Traditional research works from the outside to inform teachers inside the classroom by extending what they know. Action research works to inform teachers from the inside by expanding what teachers understand. Action research has the potential to change what teachers believe, and these beliefs have the greatest influence on the way that teachers present mathematics. Teachers need to stop looking for the one correct way to teach mathematics; that search will be fruitless because every classroom is different, every child is different, and every moment of teaching is different. However, teachers should never stop looking for practices that empower themselves and their students as learners. Just as children are empowered by investigating their own solutions to mathematical problems, so too are teachers empowered by investigating their own solutions to the challenges that they face in the classroom.

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