Cognitively Guided Instruction

Research Expertise Presentation

EDCI 855

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Abstract #1


Research Questions

What do teachers know about the distinctions between different addition and subtraction problem types? What do teachers know about the strategies that children use to solve different problems? How successful are teachers in predicting their own students’ success in solving different types of problems and in identifying the strategies used by children to solve problems of different types? What is the relation between different measures of teachers’ pedagogical content knowledge and their students’ achievement?

Participants

The subjects of the study were 40 first-grade teachers in 27 schools located in and around Madison, Wisconsin. The mean number of years of teaching experience was 10.9. Teachers participated in a 4-week CGI workshop during the summer.

Procedures/Data Collection Methods

Researchers collected data on teachers’ knowledge of problem types and relative problem difficulty, general knowledge of strategies, and knowledge of their own students. Teacher knowledge was assessed through written tests, and interviews. Student performance was measured by a timed number fact test and a problem-solving test.

Analysis

Writing Word Problems and Relative Problem Difficulty tests were analyzed according to the number of correct responses and teachers’ explanations of the distinctions between problems. Teachers’ general knowledge of strategies was assessed by how well teachers could describe and model strategies that videotaped children had used. Teachers’ knowledge of their own students was based on a match between a teacher’s prediction of success and strategy and a student’s actual performance.

Results

Most teachers could classify problem types and identify children’s strategies, but they could not organize that knowledge into a coherent network that allowed them to make distinctions between problems, children’s solutions, and problem difficulty. The teachers’ ability to predict students’ success in solving problems was significantly correlated with student performance.

Synthesis of How the Studies Confirm or Refute the Others

Confirms other studies that suggest that teachers can learn the CGI framework and use it to guide their instruction, but found that most teachers do not have explicit and in-depth knowledge of the research. Also found that teachers’ knowledge of their own students’ ability to solve different addition and subtraction problems was one of the best predictors of students’ achievement on both computation and problem-solving tests.
Abstract #2


**Research Questions**
How is teachers’ knowledge about their students’ knowledge related to students’ mathematics outcomes? How is teachers’ knowledge of problem-solving abilities related to their beliefs about mathematics and about the learner and to their knowledge of their students’ use of number fact and problem-solving strategies? How do teachers obtain and use this knowledge of their students’ knowledge and cognitions? What distinguishes teachers who are effective in facilitating their students’ mathematics problem solving from those who are less effective?

**Participants**
The subjects were 20 first-grade teachers and their students in 12 schools in and around Madison, Wisconsin. The mean number of years of teaching experience was 8.2. Teachers participated in a 4-week CGI workshop during the summer.

**Procedures/Data Collection Methods**
Teachers were observed for 16 days throughout the school year by trained observers using a coding system. Observers coded the strategy that the teacher expected the students to use in solving problems. Teachers’ knowledge of their students was measured by asking the teachers to predict how individual students would solve specific problems. Predictions were matched to student performance. Teachers were also interviewed and completed questionnaires. Students were interviewed and given written pre/posttests.

**Analysis**
Correlational analyses were used to answer the first three research questions. The fourth question was addressed by analyzing the cases of the most effective and least effective teacher.

**Results**
There were significant positive relationships between teachers’ knowledge of students’ knowledge and students’ problem-solving achievement. More knowledgeable teachers questioned students about strategies and solutions and listened to their responses. Less knowledgeable teachers explained how to solve the problem to the students.

**Synthesis of How the Studies Confirm or Refute the Others**
The 20 teachers who participated in this study were a subgroup of those who participated in the study for abstract #1. This study went further than study #1 in that it compared a knowledgeable teacher with a less knowledgeable one. It confirms the results of other studies. It is the only study I read that compared an effective teacher to a less effective teacher.
Abstract #3


**Research Question**
Does providing research based knowledge concerning students’ problem solving in arithmetic to first-grade teachers in urban schools influence their instruction and the achievement of their students?

**Participants**
CGI and comparison groups consisted of teachers and their students from 12 schools in a large midwestern urban school district. There were 12 classrooms in each group. School populations were comparable in terms of minority populations.

**Procedures/Data Collection Methods**
Experimental teachers participated in a CGI staff development program. Teachers from the comparison group participated in a staff development program that did not include CGI research. Eighty-two classroom observations were conducted. Twelve randomly selected students from each class were interviewed and given written problem-solving tests.

**Analysis**
Student interviews were analyzed in terms of correct responses and the number of times students used an advanced strategy. Classroom observers used an observation instrument to gather information on the content and instruction of mathematics lessons.

**Results**
CGI students scored significantly better on number fact and problem solving tests. CGI students used advanced strategies significantly more often than non-CGI students did. CGI teachers were observed reading word problems to students and asking students to explain their solution strategies. They did not teach specific strategies. Non-CGI teachers demonstrated procedures to students. They seldom asked students to explain their thinking. Non-CGI students spent more time completing worksheets than CGI students did.

**Synthesis of How the Studies Confirm or Refute the Others**
This study is the only one I read that used a control group. It also is the only one that studied children from a large urban district with significant minority populations. The study looked at how CGI will work with disadvantaged minorities. Researchers found that students need not master computational and other lower-order skills before they can develop their problem-solving skills. Even though non-CGI students spent more time completing number fact worksheets, CGI students scored significantly better on the number facts tests. This evidence confirms and extends the findings about computational performance reviewed in Abstract #7.
Abstract #4


**Research Questions**
Can kindergarten children solve addition, subtraction, multiplication, division, multistep, and nonroutine problems? What problem-solving processes do they use?

**Participants**
The subjects were 70 children in six kindergarten classes in two schools. The schools served diverse populations. The six classes were taught by four teachers. The teachers participated in a yearlong CGI course.

**Procedures/Data Collection Methods**
Researchers collected data through classroom observations, teacher reports, and student interviews. Three of the teachers were observed seven or more times and one was observed four times. The teachers were asked to describe the types of problems that were included in instruction. Children were interviewed in May by trained interviewers. Each child was asked to solve nine problems. Interviewers coded the children’s responses according to the strategy used and whether the answer was correct.

**Analysis**
Researchers counted the kinds of valid strategies used and the number of correct answers. Observations and descriptions of classroom instruction were not analyzed, but only used to give researchers background knowledge.

**Results**
Thirty-two children used a valid strategy for all nine problems and 44 correctly answered seven or more problems. Only five children were not able to answer any problems correctly. Children’s strategies could be characterized as directly modeling the actions or relationships described in the problems.

**Synthesis of How the Studies Confirm or Refute the Others**
This study suggests that children can solve a wide range of problems, including problems involving multiplication and division situations, much earlier than generally has been presumed. It confirms findings about student performance reviewed in Abstracts #5 and #7.
Abstract #5


Research Questions
Can knowledge gained by research be used in classrooms? Can teachers’ understandings of children’s thinking be used to make instructional decisions?

Participants
This study is a case study of one teacher, Ms. J. She taught first- and second-grade in Madison, Wisconsin. She participated in many CGI studies over a four year period. Researchers compiled data from the other studies to conduct this case study.

Procedures/Data Collection Methods
Researchers collected information about Ms. J over a period of 4 years. Year 1 (pre-CGI workshop) – structured and semistructured interviews, CGI belief instrument. Year 2 (after CGI workshop) – Classroom observations, interviews, CGI belief instrument. Year 3 – Group discussions, individual interviews, classroom observations, interviews with students. Year 4 – interviews, CGI knowledge assessment.

Analysis
Researchers analyzed the data to generate descriptions of Ms. J., her classrooms and teaching, and what her students learned. At the end of Year 2, Ms. J. ranked near the top of the experimental group on knowledge of the CGI addition/subtraction framework. Her score on the CGI Belief Instrument was 1.5 standard deviations above the mean of the experimental group. Observation of Ms. J’s teaching showed that she frequently questioned children about their thinking, and she listened to her students more than other teachers. Student interviews showed that the student’s in Ms. J’s class had learned mathematics to a level that was unusually high for first-grade children.

Results
Data analysis showed that Ms. J. had research-based knowledge of children’s thinking and was able to use it to make instructional decisions. Students had a strong sense of number. They felt comfortable manipulating numbers and solving problems. They developed positive attitudes about themselves and mathematics.

Synthesis of How the Studies Confirm or Refute the Others
This study confirms the others. It shows evidence that teachers can use CGI research to inform their instruction and increase learning of children. It also confirmed studies that suggest that teachers will not make permanent modifications in their teaching until they see that the modifications result in benefit to their students.
Abstract #6


Research Questions
What do teacher think about CGI 3 or 4 years after participating in the summer workshop? Did teachers’ practices indicate that they were currently using CGI? Would noticeable variations exist in the ways teachers described their development and use of CGI? What beliefs did they now espouse about mathematics teaching and learning and how were these beliefs related to their practices? Had CGI principles influence their teaching in other subject areas?

Participants
Participants were 20 of the original 40 CGI participants, 10 who took the workshop in July 1986 and 10 who took it in July 1987. All were first or second grade teachers in or around Madison, Wisconsin. All 40 teachers were contacted by mail and asked to participate in the study. Researchers believe that teachers who found CGI not particularly useful are underrepresented.

Procedures/Data Collection Methods
Each teacher was interviewed by phone for at least 1 hour. Interviewers had a checklist of topics to discuss. Teachers gave interviewers detailed descriptions of their teaching practices.

Analysis
Interviews were recorded and transcribed verbatim. Thirteen analytic questions were developed to guide the analyses. An overall portrait of each teacher was constructed based upon the questions. Researchers rated teachers’ ideas about what it means to know mathematics and how children learn mathematics on Likert-type scales.

Results
Teachers varied widely in degree of CGI use and in beliefs relating what it means to know mathematics and how children learn mathematics. Three groups of teachers emerged: (1) ten teachers used CGI as the main basis for their teaching, (2) four teachers had never used CGI more than supplementally, and (3) six teachers had used CGI more extensively in earlier years but now were using it only occasionally.

Synthesis of How the Studies Confirm or Refute the Others
The study confirms others in that it found evidence that teachers’ knowledge of the CGI framework can inform and change their instructional practices. The positive effects of CGI intervention seem to have been most pervasive and long lasting in teachers who constructed for themselves more conceptual and flexible meanings for CGI rather than adopting meanings that were tied to specific procedures or from the CGI training.
Abstract #7


**Research Question**
What is the long-term impact on teachers’ instruction and beliefs of learning about children’s thinking? Is there a relationship between teachers’ growth in understanding their students’ thinking and their students’ learning?

**Participants**
Data were collected from 21 first-, second-, and third-grade teachers and their students.

**Procedures/Data Collection Methods**
Data were collected over a 4-year period starting with base-line data in Year 0. Formal classroom observations were conducted during the spring of each year. Observations were tape-recorded and transcribed. Observers also took notes. Postobservation interviews were conducted after each formal observation. Each teacher was formally interviewed each spring. The CGI Belief Scale, a Likert-type instrument was administered to teachers. Students were given problem-solving tests which were read to them. They had test booklets and scratch paper but no manipulatives. Second and third grade students were also given a computation test.

**Analysis**
Researchers developed four levels of instruction and four levels of beliefs through an intensive process over a two-year period. Data sets from each of the 21 teachers were assigned to research staff who had participated in the definition of the levels and had common conceptions of what was considered evidence for each level. Staff members assigned an instructional level and a belief level for each year for each teacher. Because a different set of students was tested each year for each teacher, researchers measured changes in class means from Year 0.

**Results**
There were changes in beliefs and instruction of 18 of the 21 teachers over the four-year period. Student achievement in problem solving was higher at the end of the study than at the beginning. There was no change in computational performance.

**Synthesis of How the Studies Confirm or Refute the Others**
Gains in students’ concepts and problem-solving performance appeared to be directly related to changes in teachers’ instruction. The shift in emphasis from skills to problem solving did not result in a decline of students’ computational performance. This confirms the study reviewed in Abstract #4. This study confirms other studies and makes a strong argument that one major way to improve mathematics instruction and learning is to help teachers understand the mathematical thought processes of their students.
Abstract #8


**Research Question**
How have teachers changed from participating in a four-year CGI project?

**Participants**
Three teachers were drawn from 21 first-, second-, and third-grade teachers that were involved in a four-year CGI project. The three teachers were chosen because they represented different levels of engagement in practical inquiry and in their patterns of self-sustaining, generative change.

**Procedures/Data Collection Methods**
All 21 teachers participated in CGI workshops. Each teacher also received support from a mentor teacher and research staff. Information was collected through interviews, informal interactions, and formal and informal observations. Data was collected in Year 0 (prior to teachers’ involvement), Year 1, Year 2, and Year 3. Two types of interviews were conducted: general belief interviews and post-observation interviews. Each teacher was observed five times by trained observers. Researchers created verbatim transcripts of the observations.

**Analysis**
Analysis involved developing a coding scheme that elaborated teacher change within CGI. Researchers examined teacher development in terms of the teachers’ beliefs, knowledge, and classroom practices. After completing initial analysis on all teachers, three cases were chosen for further analysis.

**Results**
The three teachers differed fundamentally in their engagement in practical inquiry. Two of the teachers showed sustained change, but only one showed self-sustaining, generative change. By struggling to understand her students, the teacher’s knowledge of children’s thinking continued to grow, and her practice continued to evolve.

**Synthesis of How the Studies Confirm or Refute the Others**
This study confirms and extends others that I read that give evidence that teachers’ knowledge of the CGI framework can impact their instruction. It suggests that professional development focused on children’s mathematical thinking provides a basis for teachers to engage in ongoing practical inquiry directed at understanding their own students’ thinking and provides a basis for teachers to engage in self-sustaining, generative growth.
Abstract #9


**Research Questions**
What are preservice teachers’ beliefs about mathematics instruction? What is the effect of introducing preservice teachers to Cognitively Guided Instruction (CGI)?

**Participants**
Thirty-four members of an undergraduate cohort of preservice teachers at the University of North Carolina at Greensboro took part in the study. At the beginning of the study, they were starting their 2-year sequence of professional course work in elementary education. Additionally, two of the preservice teachers (Helen and Andrea) were selected as cases for in-depth study. Helen worked with a CGI teacher during student teaching. Andrea did not.

**Procedures/Data Collection Methods**
The preservice teachers participated in a 3-credit mathematics methods course. CGI was introduced through a five-session module during the course. Researchers administered the CGI Belief Scale to the 34 preservice teachers four times: beginning of the professional course work, beginning of the mathematics methods course, beginning of student teaching, and end of student teaching. Researchers made eight on-site observations of each preservice teacher. In addition, Helen and Andrea wrote reflective journals, were videotaped four times during student teaching, and participated in three open-ended interviews.

**Analysis**
Researchers compared preservice teachers’ mean scores on the Belief Scale over the four administrations. They analyzed Helen’s and Andrea’s Belief Scale scores by category. Observation, interview, and journal data were used to determine the Helen and Andrea’s CGI level of instruction. (See Fennema et al., 1996).

**Results**
The preservice teachers’ Belief Scale scores changed little during the first year of the program, increased significantly during the mathematics methods course, and continued to increase significantly across the student-teaching experience. Helen and Andrea’s belief scores increased across the two years, but the changes varied. Helen’s belief scores increased substantially during the methods course and during student teaching. Andrea’s belief scores increased considerably during the first three semesters of the program, but stayed constant during student teaching. At the conclusion of the program, Helen’s mathematics instruction was categorized as level 3. Andrea was considered to be in transition between level 2 and level 3.

**Synthesis of How the Studies Confirm or Refute the Others**
This study was different than the others because it looked at preservice teachers. The preservice teachers changed beliefs and perceptions about mathematics instruction over the two-year period. The extent to which they are able to incorporate these beliefs in their instruction varied.
Abstract #10


**Research Questions**
How do teachers acquire knowledge of individual children’s thinking about mathematics? How do teachers use information about individual children’s thinking to make instructional decisions?

**Participants**
This study was a case study of one kindergarten teacher in a midwestern school district. The teacher had previously participated in Cognitively Guided Instruction (CGI) workshops. She had ten years of teaching experience. At the time of the study, she was beginning her sixth year as a CGI teacher.

**Procedures/Data Collection Methods**
The researcher collected three types of data: notes on classroom observations, notes on informal interviews with the teacher, and audiotapes of formal interviews with the teacher. The teacher was observed teaching 32 math lessons and nine calendar activities during the first semester of the school year. Informal interviews were conducted before and after each observed lesson. Formal interviews were conducted seven times during the school year. Interviewers asked about the teachers’ knowledge of specific children’s learning and about instructional decisions.

**Analysis**
Data were coded using three categories: beliefs, knowledge, and instruction. Instruction codes were subdivided into: tasks, teacher interactions with students, and assessment of students. Categories were examined to determine if there were common themes. The study focused on the teacher’s knowledge of her students’ mathematical thinking and on her instruction.

**Results**
The teacher learned about children’s mathematical thinking by having them solve word problems and explain their solution strategies. Questioning played an important role in determining what she learned. She demonstrated detailed knowledge of the types of word problems the children could solve and the solution strategies they could use. She used this knowledge to help her select appropriate classroom activities, to group children for instruction, and to select problems and numbers to use with each group.

**Synthesis of How the Studies Confirm or Refute the Others**
This study is evidence that teachers can use a CGI framework to learn about individual children’s mathematical thinking and use that knowledge to make instructional decisions. It confirms the other studies that I read.