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AUTHOR	Bowman, Anita H.; Bright, George W.; Vacc, Nancy N.
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ABSTRACT

This study examined changes in 20 elementary teachers' beliefs about teaching and learning that occurred during the first 2 years of a 5-year implementation of cognitively guided instruction (CGI) as the basis of mathematics instruction. Teachers and mathematics educators from around North Carolina formed five local teams, each composed of two teacher educators and six elementary teachers. During the first 2 years, participants attended four multiple-day workshops. They also met monthly during the school year to discuss their progress. University educators visited the teachers monthly during mathematics instruction, and project staff visited the teachers once each semester. Visits were intended to support the teachers as they began implementing CGI. To assess changes in teachers' beliefs about teaching and learning mathematics, researchers administered the CGI Beliefs Scale before or after each of the workshops. The Beliefs Scale examined beliefs about the role of the learner, relationships between skills and understanding, sequencing of topics for instruction, and the role of teachers. Results indicated that during the first year, teacher's beliefs declined, though not all the way back to baseline, despite receiving extensive support. It took 2 years of implementation for teachers' beliefs to recover to the same level evidenced immediately after the initial workshops. (SM)

Teachers' Beliefs Across the First Two Years of Implementation of Cognitively Guided Instruction

Anita H. Bowman, George W. Bright, & Nancy N. Vacc
Department of Curriculum and Instruction
The University of North Carolina at Greensboro
Greensboro, NC 27402-6171

This study was designed to examine changes in teachers' beliefs about teaching and learning that occurred during the first two years of implementation of cognitively guided instruction (CGI). In implementing CGI, teachers learn to assess students' thinking primarily through listening to students explain solutions to mathematics problems, and then use that knowledge to plan instruction (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989; Fennema, Carpenter, Franke, Levi, Jacobs, & Empson, 1996).

In general, teachers' beliefs about teaching and learning mathematics significantly affect the form and type of instruction they deliver (Clark & Peterson, 1986; Richardson, Anders, Tidwell, & Lloyd, 1991), and specifically, teachers' beliefs are a critical factor in implementing CGI (Fennema, et al., 1996). Teachers' knowledge of students' thinking is a key part of implementing CGI, and it seems reasonable to expect that teachers' beliefs would influence the kinds of information that they actually gather about their students' thinking. Too, teacher-student interactions in CGI classrooms are typically different from teacher-student interactions in "typical" mathematics classrooms. In CGI classrooms, teachers ask students to solve problems and then listen carefully as students explain their solutions (Fennema, et al., 1996). Teachers who typically have not listened carefully to students are often surprised at what students say and do, so the interactions with students during initial implementation of CGI seem likely to influence the nature of changes in teachers' beliefs. Thus, understanding changes in teachers' beliefs as they implement CGI is an important area of study for determining the success for CGI inservice efforts.

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Method

Context

The study was conducted during the first two years of a five-year (1995-99) teacher enhancement project (NSF #ESI-09450518) in which elementary teachers were learning to use CGI as a basis of their mathematics instruction. Teachers and mathematics educators from different regions in the state formed five local teams; each team was initially composed of 2 teacher educators (i.e., team co-leaders) and 6 elementary teachers. Because of a variety of factors, including the use of local funds to increase the size of one team, at the end of the second year, the teams ranged in size from 5 to 9 people.

During the first two years of the project, workshops were held in May 1995 (3 days), June 1995 (10 days), July 1996 (8 days), and June 1997 (7 days). During Summer 1996, each team met for 2 days in August to plan for the 1996-97 school year. During each school year, each team met after school approximately once a month to discuss their progress, each teacher was visited approximately once a month during mathematics instruction by one of her team's co-leaders, and each teacher was visited during mathematics instruction once each semester by project staff. (Project staff included two co-principal investigators and six experienced CGI teachers.) The purpose of the visits was to support teachers as they began implementing CGI; visits were never used to "evaluate" teachers.

Instrumentation

To assess changes in teachers' beliefs about teaching and learning mathematics, the CGI Beliefs Scale (Peterson, Fennema, Carpenter, & Loef, 1989) was administered four times: on the first day of the May 1995 workshop, on the last day of the June 1995 workshop, on the first day of the July 1996 workshop, and on the first day of the June 1997 workshop.

The Beliefs Scale consists of 48 items divided among four 12-item subscales. Respondents rate each item using a 5-point Likert scale (strongly agree, agree, undecided, disagree, or strongly disagree), giving a maximum score of 60 for each subscale and 240 on the total score. Each subscale measures interrelated but separate constructs. Higher scores on these four subscales indicate the following beliefs: Role of the Learner: children are able to construct their own knowledge rather than being receivers of knowledge; Relationship Between Skills and Understanding: skills should be taught in relationship to understanding and problem solving rather than being taught in isolation; Sequencing of Topics: sequencing of topics for instruction should be based on children's natural development of mathematical ideas rather than the logical structure of formal mathematics; Role of the Teacher: mathematics instruction should facilitate children's construction of knowledge rather than the teacher's presentation of knowledge. Peterson, et al. (1989) reported that internal consistency estimates for the total score was .93 and for the subscales ranged from .57 to .86.

Subjects

Subjects were 20 teachers who completed the Beliefs Scale on all four administrations. At the beginning of the project, three teachers taught kindergarten, six teachers taught grade 1, four teachers taught grade 2, and seven teachers taught grades 3 or higher (one teacher at grade 4 and one teacher at grade 5). The 20 teachers were distributed across the five teams as follows: 2, 3, 4, 5, and 6, respectively. Thirteen teachers taught the same grade level during both years of CGI implementation; 7 teachers were assigned to different grade levels each year.

Analysis

Four subscale scores were determined for each teacher, for each administration, by summing the responses for the 12 items in each subscale (maximum possible score of 60); a total score for each teacher, for each administration, was determined by summing the responses for all 48 items (maximum possible score of 240). Overall means were determined for each subscale and total scale, across each administration.

Scores on each subscale and on the total scale were subjected to repeated measures analysis and pair-wise contrasts were run. Follow-up analyses were conducted to compare responses (a) among teachers across the five teams and (b) between groups of teachers based on whether they taught the same grade or different grades during the study.

Results

Mean scores for the Beliefs Scale are given by administration in Table 1. Results of the repeated measure analysis and pair-wise comparisons are given in Table 2. There were significant effects across the four administrations for each of the subscales and the total scale score. In addition, most of the pair-wise comparisons were also significant. The follow-up analyses indicated that there were no differences when subjects were grouped by site or by whether they taught a single grade or different grades during both of the first two years of the project.

Table 1. Means for the Beliefs Scale Subscales and Total Scale

	Administration			
Scale	First	Second	Third	Fourth
Role of Learner	43.5	51.8	49.1	51.7
Skills/Understanding	45.6	52.4	50.6	53.7
Sequencing Topics	46.5	55.2	52.2	54.9
Role of Teachers	45.9	55.6	53.4	54.4
Total Scale Score	181.5	215.0	205.3	214.7

Table 2. F-values (p-values) for Comparisons of Administrations

		Pairs of Administrations					
Scale	Overall	1st/2nd	1st/3rd	1st/4th	2nd/3rd	2nd/4th	3rd/4th
Role of Learner	19.5 (.0001)	38.0 (.0001)	17.7 (.0005)	24.7 (.0001)	12.5 (.0024)	0.0 (.8845)	5.1 (.0360)
Skills/Understanding	15.8 (.0001)	23.6 (.0001)	24.7 (0001)	47.1 (.0001)	1.5 (.2429)	0.8 (.3758)	9.0 (.0076)
Sequencing Topics	28.8 (.0001)	54.2 (.0001)	26.7 (.0001)	38.9 (.0001)	13.8 (.0016)	0.1 (.7414)	7.2 (.0149)
Role of Teacher	26.6 (.0001)	42.6 (.0001)	42.4 (.0001)	47.2 (.0001)	5.4 (.0325)	0.9 (.3426)	1.0 (.3586)
Total Scale Score	99.9 (.0001)	68.8 (.0001)	47.7 (.0001)	62.1 (.0001)	8.7 (.0087)	0.0 (.9351)	7.3 (.0146)

NOTE: For the Overall comparisons, df = 3,16; for all other comparisons, df = 1,18.

Discussion

The subscale and total scale scores on the second administration of the Beliefs Scale were higher than the scores on either the first or third administration. The scores on the fourth administration were roughly equal to the scores on the second administration. The second administration was the only administration conducted on the last day of the workshop; all other administrations were on the first day of a workshop. The scores on the second administration, then, can be thought of as representing the "first rush of enthusiasm" about use of CGI instruction. Indeed, several critical events occurred during the May and June, 1995, workshops.

First, during the May 1995 workshop, participants watched one of the experienced first-grade project-staff teachers teach a lesson, after which they immediately interviewed students in the class of one of the experienced second-grade project-staff teachers. Both the lesson and the interaction with students appeared to provide powerful exemplars of how much mathematics children in a CGI classroom can learn. Indeed, even at the end of the second year of the project, participants continued to talk about these experiences.

Second, between the May 1995 workshop and the end of the school year, participants were asked to "try out" some of the CGI problem types (Carpenter, et al., 1989) and to begin to probe students' mathematical thinking. During the June 1995 workshop, participants commented that they learned things about their students that they had not previously known, even though they had taught those students for eight months. The participants were eager, then, to learn more about CGI and about improving their mathematics instruction. It seems likely that they accepted many of the ideas and suggestions during the workshop without much critical examination. Their Beliefs Scale scores in June 1995, therefore, may have represented somewhat-too-high expectations about what would happen when they implemented CGI in an entire school year.

Changes in teachers' beliefs from the second to the fourth administrations tell quite a different story. From June 1995 to July 1996, scores declined significantly except for the subscale, Relationship Between Skills and Understanding. From July 1996 to June 1997, scores increased significantly except for the subscale, Role of Teacher. Further, there were no significant differences between the scores in June 1995 and June 1997. Our interpretation of these data is that teachers initially found the implementation more difficult than they expected and, as a result, their beliefs scale scores declined. With continued perseverance, however, they were able to find the success that they initially expected, and this more positive outlook is reflected in higher belief scale scores.

There were distinct differences among sites with respect to characteristics of the teachers, backgrounds of the team leaders, student populations in the schools, curriculum materials being used, urban versus rural characteristics of the local communities, etc. There were however no significant differences across sites in the Beliefs Scale scores or in changes in scores across time. This suggests that CGI inservice impacts teachers' beliefs fairly uniformly across a range of local differences.

There were also no significant differences in Beliefs Scale scores when teachers were grouped by whether they taught the same grade or different grades across the two years of CGI implementation. This suggests that teachers internalize beliefs similarly, independent of whether they teach children of the same or different ages or whether they teach the same or different mathematics objectives.

It is well known that changing instruction is difficult and takes considerable time and support. In particular, Fennema, et al., (1996) have shown that implementing CGI even over four years does not always result in dramatic change. In that study, Levels of Teachers' Cognitively Guided Beliefs and Levels of Cognitively Guided Instruction were defined and teacher change was measured according to these frameworks. They found that 3 of the 21 teachers showed no change in belief level, and 6 teachers showed a change of only one level in beliefs. Similarly, 3 of the 21 teachers showed no change in instruction level, and 6 teachers showed a change of only one level in instruction. Thus, it is not surprising that the subjects in this study found their initial attempts at implementing CGI less than wildly successful. The lack of immediate dramatic success may have caused them to rethink their enthusiasm about moving toward an instructional approach that builds on knowledge of children's thinking. This would help explain the drop in scores from June 1995 to July 1996. (It should be noted that the July 1996 scores were still significantly higher than the May 1995 scores.) However, the project was designed to provide long-term, consistent support for the participants through regular team meetings and regular visits to each teacher's classroom. This support helped teachers realize that change would take time and thus, provided encouragement for teachers to "stay the course." By the end of the second year of implementation, teachers were beginning to find the success that they may have expected early in their first year of implementation. This realization "played out" in the fact that the scores in June 1995 and July 1997 were essentially the same.

In an over-simplified way, we can say that during the initial stages of implementation, teachers' beliefs declined, though not all the way back to the baseline, and it took two years of implementation for teachers' beliefs to "recover" to the same level evidenced immediately after the initial workshops. During this two-year period, teachers were supported extensively, but in spite of this support, Beliefs Scale scores dropped during the first year of implementation. It seems possible that without this continuous support, teachers might have given up on CGI and abandoned it as an organizing scheme for their mathematics instruction. This suggests that implementation of mathematics reform is more complex than is often recognized. This study strongly supports the need for long-term, intensive support for teachers.

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