Professional Development Programs: Cognitively Guided Instruction (CGI) and Math As Text (MAT)

Many people feel mathematics education in the U.S. is in need of improvement. Fennema and Franke (1992) note that teachers' knowledge (or lack thereof) is often associated with poor instruction and thus, low student achievement on instruments which measure mathematical aptitude. For this reason, universities across the country have become mathematical and pedagogical (re)-training grounds for future, novice, and even experienced teachers. Fennema et al. (1996) indicate that the object of many professional development programs is to instill in teachers the kind of knowledge which will enable them to modify their own teaching so that students understand mathematics in a more meaningful way. But these authors also note that there is little agreement and even less evidence pointing to what specific knowledge is actually needed by teachers in order for them to better facilitate mathematical understanding among their students. Is it merely more formal mathematical knowledge? Is it exposure to reformed style classroom environments? Is it more pedagogical knowledge? If so, is it a matter of becoming better trained in certain instructional strategies? Or is it understanding how young people normally think about mathematical ideas, their misconceptions, their innate abilities? Several professional development programs are currently being used in an attempt to explore and answer these questions (Ball, 1995). I will be outlining two approaches to professional development in the following essay. The first is Cognitively Guided Instruction (CGI) and the second is Math As Text (MAT). I will begin by briefly outlining how the program is implemented. I will also include information on the benefits it has shown for elementary teachers (and in the case of CGI, student benefits as well). I will finish by describing which approach I would use, and how I would implement my approach.

The CGI program, as described by Fennema et al. (1992), is an attempt to attune teachers to their own students' current mathematical understandings. The assumption underlying CGI is that students already have informal or intuitive mathematical knowledge and are relatively adept problem solvers as long as they can act out the situation. Teachers are encouraged to build off of their students' prior knowledge and experience in modeling problem situations by introducing abstract notation (+, - , x, etc) as a way to represent the concrete situations students are already familiar with. This contrasts with the more traditional approach of teaching symbolic computations first, and then trying to get students to apply this knowledge to problem solving situations.

Teachers in Fennema et al.'s (1996) CGI program met once a week in a workshop setting. During this time, they were exposed to a research-based model of children's mathematical thinking. The five themes which were emphasized in this model were: (1) Children who are exposed to a variety of problems can learn important mathematical ideas, (2) individuals and groups of children will come up with a variety of solutions to the same problem, (3) talking and writing about mathematics is important for student learning, (4) teachers need to know what students are thinking, and (5) what students currently know and understand should affect the way instruction is delivered in the classroom. Video tapes of students solving problems and classroom discussion were two main strategies used in the workshop to convey these five ideas to teachers.

As the participants viewed video clips of students as they solved problems, they were told to focus on the thinking of students. After the clip, the participants talked about what they saw. The types of items discussed might be: (a) how the student saw the problem, (b) what approach this student took in solving the problem and what that meant in terms of the child's conceptual abilities, (c) why the solution worked and how it was different from other solutions, (d) how might this student solve other types of problems, and (d) how this student's solution might indicate the student's overall understanding of different concepts. The goal of watching the videos and sharing their ideas with the class was to have the participant teachers construct a more organized and expansive model of student capabilities and understandings surrounding basic mathematical concepts which are typical in the grade levels they teach. Teachers are even encouraged to attempt the same problems seen on the video with their own students during the week, and validate their own model of student understanding. Some teachers did this and reported their experiences to the rest of the group the following week. These workshops were by design, participant led. It was assumed by the facilitators that the teachers needed to construct their own knowledge at their own pace and in a way meaningful to them. Many teachers asked direct questions of the facilitators, hoping for explicit, prescriptive ideas for classroom organization, how to respond to student thinking, curriculum matters, and the like. But the facilitators conveyed to the teachers that they had no way of knowing what would work in their particular classrooms, that the teachers themselves needed to find the answers throughout the course of the workshop.

After the workshops were concluded, the program staff followed the participants into their schools. A CGI staff member and a mentor teacher were assigned to each school which had a participant in the workshop. These two persons had the responsibility of meeting with the participants throughout the school year (on more or less a weekly basis). Their main role, in the same spirit as the workshops, was to provide participants an opportunity to discuss what was happening in their classroom in terms of student thinking and instructional choices.

The benefits of this particular professional development program were in two areas. First, several teachers were found to have changed their teaching beliefs and teaching strategies. Originally, they thought of teaching as a process of demonstrating procedures which students were to then imitate. After four years in the CGI program, these teachers now saw teaching as helping students build on their own knowledge through solving meaningful problems. Students also benefited from the CGI program. The participant's classroom achievement was higher on concepts and problem solving items at the end of the four years. One might assume the student's computational scores fell because they were in classrooms where there was less emphasis on drill-like procedures. However, there was no overall change in student achievement on computational items.

The CGI program helps participants develop a unified, coherent, and adaptable model of student thinking by examining student activity (via videotape and classroom examples) and exploring student thinking and mathematical principles through discussions. The MAT approach to professional development, as described by Farmer, Garretson, and Lassak (2003), begins by having participants take part in reform-oriented mathematical learning experiences. These experiences include solving interesting problems in small groups, discussing ambiguities and assumptions in problems, considering multiple representations of mathematical ideas, and engaging in writing. This is followed by pedagogical discussions in which traditional ways of teaching a concept are contrasted with more reform-based strategies. As in CGI, the MAT program was often participant centered, with the direction and focus of the sessions driven by the participants themselves. The workshops appeared to be held once a week during the school year, or for two week blocks during the summer.

A typical activity completed by participants in the MAT program involved measures of central tendency. At first, the entire group reviewed definitions for mean, median, and mode—the definitions themselves were elicited from the memories of participants and discussed until everyone was satisfied with the definitions. The class then broke up into small groups and each group was given six problems to solve. These problems were not simple computational problems involving central tendency, but were open ended problems with many possible solutions. After awhile, each group demonstrated their solution to the class, with class-wide discussion surrounding similarities and differences in the various solutions. The MAT facilitators did not give participants answers or declare things right or wrong. They tried to convey to the teachers that they themselves were learning from the activity as much as the teachers were. In some activities, a two person dyad was used in which teachers took turns expressing their ideas to each other without interruption. Additionally, participants were given extensive time during the program to write in journals. One thing they were encouraged to write about was how they would implement some of the ideas learned that day in their own classrooms.

The MAT program goal is to have teachers teach in a way consistent with reform. Farmer, Garretson, and Lassak (2003) report on three teachers who participated in the MAT program. They found that these teachers, varying in experience level and initial mathematical perspectives, were impacted by their experiences in the program, and became more reform-oriented in their teaching strategies and beliefs about teaching. This was seen in follow up interviews and observations in which each teacher's beliefs and instructional strategies were ranked on different levels. These levels were stages in a teacher's transformation into an ideal teacher based on reformed standards.

Another benefit they found was that the teachers developed an "inquiry stance" toward their teaching; that is, they learned how to evaluate their own teaching on a continual basis, which produced a personal, self-staining professional development atmosphere within their own classrooms. Their classrooms became teaching laboratories were the teacher was continually modifying and expanding their model of student thinking and continually discovering which teaching strategies best compliment this ever increasing knowledge. It is also suggested in the results of the study that as participants had reform-based instructional strategies and problems modeled to them in the workshops, that this allowed them to more easily transfer this same kind of teaching into their own classrooms.

If I were in a position where I was to administer professional development to elementary teachers, and I could choose the program, I would use the CGI approach. I like this approach because teacher's entry point into the program is student work and what can be learned from it. Every teacher is flooded with student work, student conversations, and student ideas, and it is easy to accumulate ideas about what students know and how they think about mathematics. The CGI program takes this knowledge teachers already have, formalizes it, expands it, and modifies different aspects of it, so that it becomes a coherent whole. The CGI philosophy encourages teachers to build off of students’ prior knowledge and the program itself is building off what teachers already know about students. The program seems very philosophically consistent.

If I were to use the CGI program, I would also explore with the participants the difference between students’ personal understanding and their ability to communicate this understanding in the culture of a mathematics classroom. Using Yackel’s (1999) theoretical framework as a guide, I would emphasis that in many ways, student solutions are an indicator of how well they can translate their personal understanding into forms which are acceptable to teachers. That often times, students can understand a mathematical concept, but have the “wrong” solution, because they are not what forms will be understood by classmates and teachers.

I also liked how the CGI program followed up with their participants by sending mentors into the school on a weekly basis. This appealed to me because it would be easy for these teachers to lose sight of what they learned in the workshops if they had no one to talk to during the school year. Also, effective professional development allows teachers the time they need to develop, change, and mature (Ball & Cohn, 1999).

The CGI and MAT programs are only two kinds of professional development. The CGI revolves around student work and what can be learned from it. The MAT program centers on mathematics content in a reformed setting. Both programs can benefit new, novice, and experienced teachers by providing them the knowledge and experience needed to change their own teaching. I, myself, would like to conduct a CGI program, because of its emphasis on student thinking. I think this will work well with teachers because teachers already have so many ideas about how students think and they use these ideas already when they interact with students. Thus, helping them articulate these individual ideas and expanding these ideas into a coherent whole will give them a more powerful tool to use in their teaching.

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