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Teachers and University Researchers as Co-Investigators:

A Case Study of the Collaborative Process

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Cognitive science has made great strides in the study of human learning the past three decades, yet many have noted that these advances have not made as much of an impact on classroom teaching as might be expected (e.g., Sowder, 2000). Among the factors that could be responsible for this lack of translation of cognitive theories and research findings into classroom practices may be a split between the world of teachers and the world of researchers. This split results in a lack of conversation in two directions: The writing of teachers rarely appears in research journals and books on instructional practices; instead, contributions are made primarily by university-based researchers. Moving in the other direction, we find that teachers rarely look to research as an important guide to their everyday decision making (Gitlin, 2000). Sowder (2000) also recently noted that many mathematics teachers have little regard for research in mathematics education and believe that it is irrelevant for their practice. Whereas university-based researchers invent, develop, and sometimes field-test innovations in educational practice with the intent that, when complete, teachers will eagerly seize upon the innovations and implement them, all too often this fails to occur. Instead, innovations in instructional methods often remain known to a small circle of university-based researchers and become implemented in only a few schools. In this sense, we find little mutual respect between teachers and university researchers for the work and potential contributions that each can make to improving educational practice.

Wineburg and Grossman (2001) have commented that, ironically, although researchers of cognitive science often make the case that the competency of the young child has been underestimated, somehow these brilliant youngsters mature into teachers who are portrayed as "not so smart"–in other words, "kids are smart but teachers are dumb." A further spin on this subtle bias is the notion that only university-based researchers are capable of inventing curricula based on principles of cognitive science whereas teachers merely implement what these researchers have developed. Those few teachers who have become both generators and implementers of educational innovations (e.g., Magdalene Lampert, Jim Minstrell[1]) seem to be viewed as anomalies and not representative of most teachers. It is suggested here that these assumptions need to be identified and put to the test empirically. It is quite possible that many teachers, given supportive circumstances (which may not be typical of those found in their jobs), can do a very good job of developing as well as implementing curricula. Further, they may bring considerations to this task that the university researcher is unable to, just as the university researcher brings insights that teachers may not.

The main goal of this exploratory study was to investigate the creative, generative processes that both a classroom teacher and a university researcher engaged in when designing new curriculum. The product of these planning processes was a method for teaching a topic in elementary mathematics, and a formal study (referred to hereafter as the "mathematics study") evaluating this method was carried out at the end of the planning phase. This paper, however, focuses only on the collaborative processes involved in planning the curriculum (referred to hereafter as the "collaboration study") and not on the formal study of the efficacy of the curriculum that resulted from the planning phase.

A second purpose of this study was to find out what processes occur between these co-investigators as new lessons are developed and implemented. Of particular interest was how different ways of

1. See, for example, Minstrell, 1999; Hunt & Minstrell, 1994; Lampert, 1990; Lampert, 1998.

thinking might complement each other during the planning phase of lesson design. Huberman (2000) describes such collaboration as engaging in “interactive thinking” (from Habermas, 1987), capable of producing "understandings that allow for reciprocally understood experiences and work" (p. 293).

Background of the Collaboration

At the time the collaboration study that is the subject of this paper began, a grant had been obtained to fund a study on teaching measurement estimation to third grade students (mathematics study). The overarching goal of the mathematics study was to compare two methods of instruction for teaching measurement estimation: a new method using a numberline concept/personal benchmarks (*experimental*) versus a traditional method (*control*). The design of the instruction was based on a comprehensive review of the literature and a model of the measurement estimation process (Joram, Subrahmanyam, & Gelman, 1998). The general features of the new method of instruction are consistent with the principles for effective mathematics instruction specified by the National Council of Teachers of Mathematics (2000), such as teaching for conceptual understanding.

Previous research we have carried out (Joram, Gabriele, Gelman, & Subrahmanyam, 1996) indicates that third graders lack number sense in the domain of linear measurement as reflected by their difficulties representing standard units of measurement (e.g., an inch, a foot). In the mathematics study, our experimental instructional unit was designed to help students represent standard units by working with “child-friendly” benchmarks, such as pieces of bubble gum for inches, and to understand how these units are part of a linear measurement system and are thus interrelated. Students worked with benchmarks for inches and feet, practiced imagining them, and used them for estimating the lengths, widths, and height of objects in their classroom. They also made a class chart that showed benchmarks for different measurements (e.g., a packet of ketchup was taped to the chart to indicate “3 inches” and a dollar bill to represent “6 inches”). This chart was designed to help students develop their own mental numberlines for measurement (for further details, see Joram, Bertheau, Gabriele, Gelman, & Subrahmanyam, 2001).

At the beginning of the collaboration study, the instructional unit for the mathematics study had been sketched out in only very general terms; for example, the use of benchmarks had been proposed, but specific lesson plans and methods of teaching had not yet been developed. The product of the collaboration study, and the focus of this paper, is the collaborative processes that the teacher and university researcher engaged in as we designed the instructional materials that would be used in the mathematics study.

Beginning in the late summer and continuing throughout the fall semester, E.J., the university researcher, and M.B., the teacher, began to meet regularly to design a series of lesson plans to teach the estimation of linear measurements. This paper focuses primarily on these meetings during which the actual creation of lesson plans occurred; however, there is some discussion of how lesson plans were revised during the implementation phase. The lessons were then pilot tested in M.B.’s school with a third grade class near the end of the fall semester. They were revised and subsequently taught to third-grade students in the spring semester in an urban school attended mainly by students coming from low-income families. M.B. taught all the lessons, with E.J. serving as an “assistant.”

The Collaborators

E.J. had approached the leader of a reform-based professional development project in elementary mathematics, headed by several faculty members at her university. She had asked him to suggest a teacher who might be interested in working with her on the mathematics study. The leader suggested M.B. because of her expertise in mathematics teaching and her openness and eagerness for continued professional development. When E.J. invited M.B. to collaborate on the mathematics study, M.B. enthusiastically agreed to become involved.

At the beginning of the collaboration study, M.B. had been teaching elementary school for approximately 20 years. She currently teaches fifth grade in a small Midwest city and has previously taught other elementary grades, including third. M.B. has been involved in the Primary Mathematics Project for over five years and has won several awards for mathematics and science teaching. During the time the collaboration study occurred, M.B. taught a mathematics methods class for prospective elementary teachers several evenings a week at the same university in which E.J. taught. At the inception of the study, M.B. had not authored any of her own curricula but had made extensive use of, and had embellished, curricula designed by others.

E.J. was teaching educational psychology to preservice teachers at the time of the collaboration and had previously carried out numerous research projects on mathematics education at the elementary and middle school level. When the study began, E.J. had some experience designing lessons and teaching lessons for research projects with which she was previously involved; however, she had not worked as a K-12 teacher.

Data Gathering for Collaboration Study

E.J. and M.B. met approximately 10 times during late summer and through the fall semester, either weekly or bimonthly. Typically, these meetings occurred in M.B.'s classroom after her students had left for the day and were one to two hours long. During several of these planning meetings, E.J. asked M.B. to “think out loud” and articulate what she was thinking as she was coming up with ideas. All meetings devoted to planning the instruction were tape recorded and later transcribed.

In addition to transcriptions of planning meetings, E.J. kept a journal in which she wrote after each planning meeting. She described the content of the meetings as well as her interpretations and feelings. Further, during the spring semester while the instruction was delivered, E.J. made observations and reflections in her journal after each lesson.

Transcripts of the planning meetings and journal entries form the data on which the collaboration study is based. During the actual delivery of the final version of the instruction, much revision and subsequent planning occurred on-the-fly, often in the few minutes before the lesson began and sometimes during the lessons themselves. It was not possible to record all of these last minute and on-line changes due to the exigencies of the teaching situation. The material on which this analysis is based occurred primarily during the planning meetings.

Results and Discussion

Generating Lessons

Goals. At the inception of the study, E.J. had the overarching goal of creating a new instructional unit for teaching measurement estimation that would represent an advance over previous methods. This goal was not arrived at collaboratively with M.B., but when asked if she would like to participate in fulfilling this goal, M.B. agreed. Both collaborators agreed that although the control group in the mathematics study would receive traditional instruction, for ethical reasons it was important that this instruction benefit the students and not waste their time.

Despite the shared overarching goal described above, it became apparent very early on in the collaboration study that M.B. and E.J. had very different specific goals that formed the basis for their planning. Just as expert writers filter content (“what do I mean?”) through their rhetorical goals and concerns for audience (“how do I say it?”) (Scardamalia, Bereiter, & Steinbach, 1984), both the university researcher and teacher were observed to fine tune lesson content in light of different “rhetorical” goals. The transcript excerpt below illustrates some of the teacher's goals when discussing the plan for the first lesson.

> MB: Maybe I talked to you before about the poem *An Inch* by Shel Silverstein. I'm thinking

> about that as an introduction to get the feel of the kids, for them to get the feel of me, to do something that's kind of fun, instead of going into an unknown class and not having any rapport built up with them. It would probably take about 15 minutes, but I think it would be worthwhile and you'd get more authentic results.
>
> EJ: What would you do with that book?
>
> MB: Just read the poem to them and maybe go around the room and say one thing that would be different for them in their lives if they were only one inch tall. The whole premise of the poem is that if you were one inch tall, life would sure be different.

This excerpt illustrates M.B.'s concern with establishing rapport with the students and her ability to generate appropriate lesson content to fulfill that goal. E.J.'s goals, on the other hand, had primarily to do with the conceptual principles of teaching measurement in this project: using imagery to help students develop accurate mental representations of standard units, developing number line representations for measurement units, etc. This translated into the content goal for the first lesson of introducing the standard unit "inch," having students imagine the extent of this unit, and having students work with benchmarks. E.J.'s more general, overarching goals were to develop an original curriculum unit that would help to advance children's thinking and make a contribution to the field of mathematics education.

Generating content to satisfy goals. M.B.'s goals in the example above were to establish rapport and maintain student interest, and she was able to generate an activity to achieve this purpose. Her ability to do so required an in-depth knowledge of the mind of a student—not just any student, but a third-grade student. She needed to be able to predict what would be comprehensible and what would captivate the interest of that level of student. It also required a large repertoire of activities that M.B. could refer to mentally–she had used the Silverstein poem many times previously in her teaching. The activity, although seemingly simple, is a meaningful way to introduce the unit; it helps students to begin thinking about representations of standard units and also introduces the idea of scale (e.g., "If I am only an inch tall, how long will my pants be?"). Further, by calling on each student, M.B. would allow each one to express her or his own thinking and give the teacher an opportunity to appreciate this thinking. Thus, the repertoire of activities that M.B. "consults" in order to satisfy her goals for teaching is a rich one that she can dip into with some assuredness of the effects. E.J.'s reaction to M.B.'s suggestion to use the Silverstein poem, as recorded in a journal entry, is presented below:

> I could immediately visualize this classroom and how it would have the potential to engage even the most unruly children. The task had all the elements I tell my students to strive for: it allows the kids to connect to the material, it shows an acknowledgement and respect for their individuality and their thinking, and by calling on each one, it would have the effect of enhancing management. Further, by beginning with a poem, the material may be more engaging to some.

E.J. later noted that M.B. was able to enter the "child's world" while at the same time keeping full awareness of and implementing her pedagogical goals. It was as if M.B. could filter previously used teaching activities, rules and principles for generating new activities, and her knowledge of mathematics through her familiarity with children's thinking, what tends to be effective with this level of student, and what tends to hold their interest. Thus we find, like an expert writer who creates text by filtering what he or she means through concerns for an imagined audience (Scardamalia et al., 1984), M.B. created teaching activities in light of her imagined students' thinking. Further, although M.B. did not articulate content goals, it is clear from the activity she generated that on some level content goals were operative; if not, it would be unlikely she would have generated such a meaningful activity for teaching measurement estimation.

Because M.B. was not focused on developing original curricula that would advance what we know about teaching measurement estimation, she often suggested activities from books or curriculum guides that she had read about. She also frequently suggested what seemed like good ideas for teaching measurement estimation, but which were unrelated to using the mental numberline or benchmarks. E.J. thus often took on the role of an "editor" of the ideas M.B. generated–asking her where an activity had originated or asking M.B. to articulate how a particular activity related to the instructional goals they had agreed upon. In the example below, an activity M.B. suggested did not qualify for inclusion in the instructional unit because it was taken directly from a book. The journal excerpt below shows how E.J.'s goals to develop original instruction guided and constrained the form that the instruction took:

> She (M.B.) explained a little activity which turned out to be from a book. Part of the activity consists of riddles dealing with length measurement that pertained to some ribbons and pieces of yarn hanging down from a card that the kids make. I (E.J.) caught on to the riddle idea and suggested that we have a series of these things (e.g., "What is greater than 1 inch but shorter than 5 inches") which we would use for a treasure hunt. M. liked that idea.

Just as M.B. was familiar with a repertoire of mathematics activities for elementary level students, E.J. possessed an extensive mental catalogue of the techniques used to teach measurement estimation that had been researched and published. It was, therefore, easy for E.J. to identify novel instructional methods that had not yet been researched. One example was "flash math," which M.B. described as showing an object and quickly taking it away while students generated estimates of magnitude. These estimates would later be compared to the actual measurement of the object. E.J. noted that this is essentially the instructional method known as "guess and check" which has been studied extensively in the mathematics education literature (see Joram et al., 1998). Although the method M.B. suggested added a timed element in that students only see the object for a short time, E.J. felt that flash math was too similar to guess and check and did not reflect the instructional principles of promoting accurate representations of standard units and their relationships. Thus, "flash math" was not ultimately included in the instructional unit developed as a result of the collaboration study.

E.J. often suggested activities for the third-graders, and typically, when incorporated into the lesson plans, they were embellished by M.B., usually as they were being tried in the classroom. An example is what came to be called the "pick up an inch" activity. E.J. originally proposed that the students use their thumb and index finger to show the length of an inch. The point of this activity was to help students develop more accurate representations of the standard inch unit. M.B.'s slight change to this activity made it more motivating for the students: "Let's pick up an inch," she would call out to the class. This became a favorite routine the class did together. Another example was a variation on an activity E.J. had suggested, which was to have students individually draw lines of specified lengths on pieces of paper. M.B. drew a line on a white board with a marker, and the class had to call out "stop" together when she had reached one inch–she would then stop drawing. After that, M.B. would take a vote as to whether the line was shorter, longer, or one inch long. The point of this activity was to hone students' representations of standard units, and the line stopping activity retained this goal but took on a different and more engaging format.

As mentioned above, some of the planning and refining of activities took place "on-line," as lessons were being delivered. E.J. noted in a journal entry: "I can see her during the lesson, clicking, clicking, clicking–I'll see it in her eyes and hear it in her voice that she is inventing the instruction as she goes along." E.J. would often add to changes that M.B. made during the lessons, either by pointing out a misconception she had noticed while students were working that needed to be addressed in the lesson or by cautioning M.B. to discontinue with a line of teaching, because it was off-track in terms of instructional goals or the activity was running over the time allocated or because of a need to make the treatment and control instruction equivalent. An example of a misconception that E.J. noticed was that as students were working on an estimating activity some were leaving spaces between benchmarks as they lined them up alongside an object–E.J. communicated her observation to M.B. during the lesson and M.B. quickly addressed it by cautioning students to completely cover their objects with units and not leave any spaces.

As well as modifying and embellishing E.J.'s suggestions for instructional activities, M.B. developed several of her own. For example, she suggested using a dollar bill as a 6-inch benchmark for students, and then showed them how it could be folded and used to estimate 3 inches. This came to be known between the collaborators as the "benchmark halving" strategy, and it seemed particularly powerful for teaching the students to use benchmarks flexibly. That is, a single favorite benchmark could be doubled (two dollar bills touching equal one foot in length) or halved, as described above, to estimate objects longer or shorter than six inches.

<u>Need for Experimental Control: Thinking About Populations and Samples</u>

Because the mathematics study was set up in a quasi-experimental format, with one class of students receiving an experimental curriculum and the other class receiving a traditional curriculum, there was a need to have tight control over lesson content. For example, the intention was that the control group would not work with benchmarks, and that the two groups would be treated identically in terms of the effect expressed by the teacher. Although this was relatively straightforward in the planning phase of the study, it proved much more challenging when the lessons actually were being delivered. The lessons had been carefully scripted, but M.B.'s main goal seemed to be to teach both groups of children about measurement estimation in the best way she knew possible, and it ran against her grain (as a good teacher) to deliberately <u>not</u> do something with the control group that she believed could be effective. For M.B. it was an end in itself to teach the two groups of students, whereas for E.J. these students represented part of a larger population. E.J. felt that even if the control group did not receive certain elements of instruction that M.B. found appealing, this would be justified by the fruits of the investigation and the subsequent contribution to a larger population of students.

E.J. felt a considerable amount of tension when some of the control over the two groups was relinquished or M.B. had to change an aspect of one of the lesson plans in order to maintain experimental control. This was clearly an area in which E.J. and M.B. had very different values. E.J. closely monitored what went on in the lessons and between lessons for the treatment and control groups and communicated to M.B. if anything should be added or subtracted. For example, M.B. began a lesson for the control group by reading a book on length that proved to be entertaining for the class–this book was not in the lesson plan. E.J. then made the suggestion during the 15-minute break between the control and treatment lessons that M.B. also read this book to the experimental group.

At times, E.J. found that M.B.'s loosening of experimental control revealed interesting patterns that she had not anticipated. An example was a task that M.B. asked her undergraduate students to complete the evening prior to one of the first planning meetings. Below are notes from E.J.'s journal describing this task:

> Our meeting began with M. pulling out this fascinating data she had spontaneously collected from her undergrads that night–she had asked them to draw a 6-inch long line and to write what they were thinking about or how they had done it. When she first pulled out the papers I thought (and said aloud), "Oh no, they did it on 8 1/2 x 11 sheets, so if they know the measurement of the paper they can figure it out from there." [The sheets were also lined.] Her response was that she didn't think most of them

would have used that, and we agreed we would go through the data together to see. The first one definitely did and then I was sure all the data was garbage. But as we went through them, I was amazed at the fact that most of them didn't and that M. actually elicited some interesting (and documented) strategies in a paper and pencil format (I previously used interviews to get people to articulate their strategies). Some of them talked about using 3 lines as an estimate of one inch and then counting–I don't know what this strategy would be called but it's a lot like the one that Hildreth identified as *decomposition*. So maybe M. had even identified a new strategy.

Summary and Conclusions

This informal case study of the collaborative processes of lesson design (collaboration study) suggests that primary points of difference between one university researcher and a classroom teacher exist in the kinds of goals they hold and the knowledge that becomes mobilized to serve those goals. Whereas E.J.'s goals were to invent a novel instructional method that would represent an improvement on existing methods and that would employ the conceptual tools of the mental number line and benchmarks, M.B.'s goals were to teach measurement estimation in a way that would push the thinking forward of all the students in both groups. Her goals were oriented toward the particular–teaching a given group of individuals in the most effective way she knew how. Although E.J. also had the students' interests at heart, she believed that it was necessary to teach the control group via a traditional way so that the benefits of the experimental curriculum would become evident–in other words, she was willing to subvert the immediate goals of teaching particular children for the more abstract distant goal of better teaching of all children.

How one interprets the different priorities described above reflects the value system of the observer. For example, in medical research, the same issue arises–how can one ethically withhold a treatment that might work from someone who is ill so that he or she can be a member of the control group of a study? Some individuals would argue that because this practice has the potential to ultimately benefit many individuals, it is justified. In the mathematics study, E.J. and M.B. dealt with this problem by making sure that the traditional instruction benefited the control group. Their intentions were born out by the results of the study–although the experimental group improved more than the control group on achievement tests, both groups improved in their understanding of measurement estimation relative to where they began.

The two approaches described above derive from different epistemological commitments–on the one hand, a scientific perspective with its origins in a Greek Platonic/Aristotelian intellectual tradition that values abstract principles and theoretical concepts (Leinhardt, McCarthy-Young, & Merriman, 1995), and on the other hand, professional knowledge that focuses on specific situations and procedures. Professional knowledge seems to result from pressure to act in the moment, as characteristic of classroom situations (McAninch, 1993). McAninch (1993) notes that when practitioners operate under conditions that create a high demand for immediate action, they tend to rely on firsthand experience as a source of knowledge because they do not have time to consult books or colleagues or to gather data. Educational researchers, who are not classroom teachers, are subject to fewer pressures to reach for immediate solutions to classroom problems and, under these conditions, research as a source of knowledge may become more viable and more attractive.

Leinhardt et al. (1995) note that university educators and researchers, with a greater focus on abstract, declarative knowledge, tend to devalue or simply ignore the "uncodified knowledge of practice." This study reveals that this knowledge of practice can be invaluable for designing effective instructional interventions. One conjecture we can make is that if more university researchers involved teachers in the planning phases of their studies there would be a greater likelihood that the teachers would make use of the curricula; it would bear the legitimizing "stamp" of practicing teachers' thinking. Further, those teachers in whose classrooms we worked seemed to be more receptive to continuing to implement the unit because of M.B.'s perceived involvement as an "author" of the lessons. The collaboration study, described above, demonstrates that teachers can be successful co-developers of a "lived mathematics, not just a recipient of or a conduit for a predecided curriculum" (Kieren, 1997, pp. 32-33).

Returning to the Wineburg and Grossman (2001) observation discussed in the introduction, that "kids are smart but teachers are dumb," one goal of this study was to investigate how "smart" a teacher could be when assessed by the university researcher's measuring stick (which is obviously just one of many standards). The analysis presented above showed that when another individual provided a knowledge base of instructional methods that had been researched, and when goals were negotiated to include developing an original instructional method, the teacher in this study was very good at generating meaningful and novel mathematics activities. She was able to draw on a vast repertoire of experiences and knowledge of children's thinking to mentally determine what would be effective. Cognition, in this sense, was truly distributed across individuals in that each member of the collaborative team "held" some of the knowledge necessary to design the curriculum unit—this allowed for productive "interactive thinking" during the collaborative conversations that generated new knowledge.

<u>Limitations of the Case Study</u>

One caveat here is that the university researcher had initiated the study and had already chosen the topic and focal points of the instruction when the teacher was invited on board. A scientific perspective dominated in that the teacher and university researcher collaborated on a study that followed a fairly rigid and controlled format. This required M.B. to subvert her natural professional goals of teaching each student in the best way she knew how. Although she did not comment on this, it is possible that she also felt a degree of discomfort at having to work within someone else's value system. In Huberman's (2000) terms, the power or authority in this collaboration was not symmetrical. Research on this topic in which both collaborators enjoyed a symmetrical power relationship might reveal different collaborative processes.

A second consideration is that M.B. is not a typical teacher in that she had been involved in a mathematics reform program for a long time and had won several awards for teaching. The focus on student thinking that clearly emerged in M.B.'s lesson planning and teaching was likely influenced by her long-time involvement with the reform program. Thus, we can draw the conclusion, which remains speculative given that this was a case study, that a very effective teacher who is well versed in new advances in her subject area will be highly capable of generating meaningful, novel lesson activities under supportive conditions. Notwithstanding these limitations, several important aspects of the teacher/university researcher collaboration were revealed by the exploratory case study described above.

References

Gitlin, A. (2000). The double bind of teacher education. *Teaching Education, 11*, 25-30.

Habermas, J. (1987). *Theorie de l'agir communicational: Tome 1*. Paris: Fayard.

Huberman, M. (2000). The mind is its own place: The influence of sustained interactivity with practitioners on educational researchers. *Harvard Educational Review, 69*, 289-319.

Hunt, E., & Minstrell, J. (1994). A cognitive approach to the teaching of physics. In K. McGilly (Ed.), *Classroom lessons: Integrating cognitive theory and classroom practice* (pp. 51-74). Cambridge, MA: MIT Press.

Joram, E., Gabriele, A., Gelman, R., & Subrahmanyam, K. (1996, April). *Building meaning for units of measurement: A "Personal Anchors" approach*. (Paper presented at the Annual Meeting of the American Educational Research Association, New York, NY.)

Joram, E., Subrahmanyam, K., & Gelman, R. (1998). Measurement estimation: Learning to map the route from number to quantity and back. *Review of Educational Research, 68,* 413-444.

Joram, E., Bertheau, M., Gabriele, A. J., Gelman, R., & Subrahmanyam, K. (2001). *Building conceptual scales: Learning to use reference points and the mental number line for measurement estimation*. (Manuscript submitted for publication.)

Kieren, T. E. (1997). Theories for the classroom: Connections between research and practice. *For the Learning of Mathematics, 2*, 22-29.

Lampert, M. (1990). When the problem is not the question and the solution is not the answer: Mathematical knowing and teaching. *American Educational Research Journal, 27*, 29-63.

Lampert, M. (1998). Studying teaching as a thinking practice. In J. Greeno & S. V. Goldman (Eds.), *Thinking practices in mathematics and science learning* (pp. 53-78). Mahwah, NJ: Erlbaum.

Leinhardt, G., McCarthy-Young, K., & Merriman, J. (1995). Integrating professional knowledge: The theory of practice and the practice of theory. *Learning & Instruction, 5,* 401-408.

McAninch, A. R. (1993). *Teacher thinking and the case method: Theory and future directions.* New York: Teachers College Press.

Minstrell, J. (1999). Expertise in teaching. In R. J. Sternberg & J. A. Horvath (Eds.), *Tacit knowledge in professional practice: Researcher and practitioner perspectives* (pp. 215-230). Mahwah, NJ: Erlbaum.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

Scardamalia, M., Bereiter, C., & Steinbach, R. (1984). Teachability of reflective processes in written composition. *Cognitive Science, 8,* 173-190.

Sowder, J. (2000). Relating research and practice. NCTM Presession 2000, Chicago. http://public.sdsu.edu/CRMSE/js_nctm_pre.html.

Wineburg, S., & Grossman, P. (2001). Affect and effect in cognitive approaches to instruction. In S. M. Carver & D. Klahr (Eds.), *Cognition and instruction: Twenty-five years of progress* (pp. 479-492). Mahwah, NJ: Erlbaum.

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