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ONTOLOGICAL AND EPISTEMOLOGICAL THREADS IN THE FABRIC OF
PEDAGOGICAL RESEARCH

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Abstract

Our overarching goal was to examine the ontological and epistemological threads woven throughout the research on teachers and teaching. Toward that end, we ask how the concepts of ontology and epistemology relate broadly to the research on teachers and teaching. Next, we look specifically at recent projects focused on quality teaching in reading and mathematics to uncover the ontological and epistemological threads evident in those investigations. We then turn the philosophic lens on ourselves and conduct a critical analysis of our own efforts to document quality teaching in the domains of reading and mathematics as part of the High Quality Teaching project. We close this philosophical perspective by considering the implications of this inquiry for researchers and teachers who are the principal actors in the scholarly enterprise.

Ontological and Epistemological Threads in the Fabric of Pedagogical Research

In his classic book, *The Practice of Teaching*, Philip Jackson (1986) posed two provocative questions: What is real teaching, and how can we be sure we are witnessing true (or good or effective) teaching? To reinforce his point, Jackson described a scenario where...

A visitor to a school peeks through the window of a classroom door and sees a woman with chalk in hand standing before a group of approximately twenty-five young people seated at desks. The woman is gesturing toward a mathematical formula written on the blackboard. (p. 82)

The visitor understandably reaches the conclusion that s/he was observing a class in session only to learn later that what s/he was actually witnessing was a rehearsal of a scene from *The Prime of Jean Brodie*. In effect, those in the classroom were “acting as” teacher and students—a case of pedagogical pretense. As Jackson’s scenario so nicely illustrates, there are undeniable challenges inherent in the study of teaching—challenges that we continually confront in our own investigations. Those challenges pertain to (a) ascertaining what actually constitutes teaching and (b) justifying that the events witnessed and the data collected, interpreted, and reported are honest portrayals of teaching.

It is our contention that efforts to ponder these perplexing but fundamental questions bring educators and educational researchers into the realm of philosophy and, more specifically, in touch with the areas of ontology and epistemology. Thus, our goal is to look deeply at the fabric of pedagogical research and to trace the threads of ontology and epistemology woven into the empirical literature in hopes of understanding the challenges that arise when one attempts to document teaching, or even more particularly quality teaching.

Over the past decade, there has been a philosophical renaissance of sorts within the educational research literature. An increasing number of investigations within educational psychology and teacher education have dealt with questions about students' and teachers' beliefs about the sources, simplicity, and certainty of knowledge (Hofer & Pintrich, 2002; Schommer, Crouse, & Rhodes, 1992), and to a lesser degree beliefs about the very nature of knowledge (Murphy & Mason, 2006). To date, however, such philosophical conundrums have not been directly posed in relation to the research on teaching. Thus, we feel that ongoing and future research on teacher quality, such as that undertaken in the High Quality Teaching Project (Valli & Croninger, 2000), would benefit from scrutiny afforded by such a philosophical perspective.

In particular, we have organized this philosophical perspective in five sections. First, we provide a philosophical overview of the central terms, ontology and epistemology. Within this overview, we offer brief definitions of each term as it is discussed within the discipline of philosophy. Next, we create illustrative cases of how these terms pertain to the study of teaching. Through these definitions and examples, we hope to capture basic challenges we consider inherent to pedagogical research on the nature and quality of teaching.

We continue this translation of ontology and epistemology from philosophy to pedagogy in the next section. Specifically, we ask how the concepts of ontology and epistemology emerge within the educational literature. Once this groundwork is laid, we turn our attention to the teacher education literature. Our objective in this section is to select recent projects focused on quality teaching in reading (e.g., Rowan, Camburn, & Correnti, 2004) and mathematics (e.g., Hill, Schilling, & Ball, 2004), and to examine the ontological and epistemological threads evident in those studies. One purpose of this contemporary analysis is to achieve a deeper

understanding of domain-specific investigations, including the difficulties of crossing domain boundaries.

In the subsequent section, we turn the philosophic lens on ourselves and conduct a critical analysis of our own efforts to document quality teaching in the domains of reading and mathematics as part of the High Quality Teaching or HQT project. Here again, we seek to establish the strengths and limitations of our ontological and epistemological efforts. We then close our philosophical perspective by considering the implications of this inquiry for the researchers and teachers who are the principal actors in the scholarly enterprise.

Philosophical Overview

Ontology

Within the domain of philosophy, two of the most significant branches are devoted to ontology and epistemology. The term *ontology*, which comes from the Greek (ὄντος: being and -λογία: writing about or the study of), is fundamentally the study of what exists or what is. When we name something in English (nouns; e.g., teaching or teacher), we are, to some degree, proclaiming its potential existence. Through the use of reasoning and logic, we determine whether the named entity does, in fact, exist or not, and what attributes or categories of that entity can be identified.

Although some nouns in language are references to specific physical, and observable persons, objects, or events (e.g., classroom, textbook, or mathematics worksheet), other nouns are markers for collective (e.g., school or curricula) or more abstract (e.g., teaching or quality) phenomena. Not surprisingly, it may seem easier to establish the existence or characteristics of very particular, physical objects than entities that are broad or abstract. There are certain basic questions that are often associated with ontology. Those questions include:

What is existence?

How can you establish that some entity actually exists?

What are the essential attributes, characteristics, or properties of a given entity?

What are the relations or interrelations between an entity and its attributes,
characteristics, or properties?

For instance, within the realm of educational research, learning is a particularly central construct that is often mentioned, described, targeted, or assessed. Given the manner in which learning, as an entity, is treated by researchers it would appear that most operate under the assumption that there is unquestionably this “thing” called *learning*. In effect, these researchers have seemingly made an ontological commitment to the existence of learning. However, there may be those individuals who question whether learning truly exists and could, therefore, be empirically investigated.

There have also been repeated efforts in the literature to document the attributes of learning (e.g., increased knowledge or higher achievement scores) or to uncover its underlying processes (e.g., memory or attention). Or, researchers may consider how these characteristics or processes correlate with each other or contribute to demonstrated knowledge increases or achievement gains. As with the assumption of its existence, researchers’ attempts to categorize and characterize learning or to examine correlations between and among learning factors are fundamentally ontological pursuits.

In many ways, such ontological inquiries are analogous to issues of validity in statistical analysis. When researchers ask questions about the correspondence between their observations and actual teaching practices, as Jackson described in the opening scenario, they are focusing on the validity of what they see in relation to what they believe the essence of the construct (e.g.,

teaching) to be. Researchers may succeed in securing observational, performance, or self-report data that are statistically reliable, but those data may bear little resemblance to the actual phenomenon under investigation. Just as validity supersedes reliability in statistical analysis (Phye, 1996), ontology may well supersede questions of accuracy or truthfulness to which we now turn our attention.

Epistemology

Epistemology, from the Greek words *episteme* (knowledge) and *logos* (word/speech) is the branch of philosophy that deals with the nature, source, and limits of knowledge. Within the philosophical literature, much of the epistemological discussion focuses on knowledge justification; that is, how does one establish that the information or evidence he or she gathers is true or accurate? Philosophically, without justification, an understanding or perception remains a belief rather than knowledge (i.e., a justified true belief). For instance, educational researchers may assume that the more time teachers spend on a particular skill or concept, the greater students' acquisition of that skill or concept. Yet, without justification this assumption or claim will not rise to the level of knowledge or what might be called "fact."

Other problems that fall within the realm of epistemology pertain to the sources and variety of knowledge upon which individuals draw. For instance, do researchers rely on authorities or experts as a critical source of knowledge, are primary documentations deemed informative, or do they believe that individuals' self-reports of events are suitable sources of accurate information? Is physical evidence necessary for justification or are there metaphysical sources that are deemed acceptable?

Although questions about the nature, source, and limits of knowledge are basic to philosophical examinations of epistemology, there are marked differences in the manner in

which these basics are instantiated. These differences give rise to varied epistemological frames that have corollaries within the psychological and educational literatures. According to Murphy, Alexander, Greene, and Edwards (in press), certain frames dominate in the psychological and educational literatures. Those include foundationalism, coherentism, reliabilism, and social epistemologies.

Foundationalists and coherentists share a reliance on internal beliefs as the basis for judgments on accuracy or truthfulness. The source of justification, thus, lies within. For foundationalists, justification is predicated upon a fundamental set of beliefs that underpin and gird all other beliefs (“I believe that...”). If the data correspond to one of these core beliefs, then they are judged as “true.” Perhaps an educational researcher holds to underlying beliefs in equity and social justice. Whether certain observations constitute viable evidence of effective teaching would depend on whether those observations can be reconciled with deeply-held beliefs about educational equity or social justice (e.g., “Does the practice seem to be fair to underrepresented populations?”).

Coherentists bring another dimension to bear in justification—there must be internal consistency or coherence *among* beliefs. A particular belief about teaching cannot pass the “truth” test unless it not only reconciles with a core belief but also meshes with other related beliefs. Coherentists would judge a new belief based upon how well it assimilates with other beliefs. Those that assimilate would be accepted and considered knowledge, whereas those that do not assimilate are rejected. For instance, the coherentist committed to equity and social justice beliefs would face difficulties if particular teaching practices apparently worked well with certain populations (e.g., underrepresented populations), but not others (e.g., high-SES females).

In contrast to foundationalists and coherentists, reliabilists and social epistemologists look to external sources for the justification of claims. In effect, externalists hold that beliefs must be bolstered by evidence that resides outside their own mind. That evidence is then submitted to logical or empirical test. For reliabilists, one of the tests of reasoned beliefs is whether they predict actual events or data in the world. For example, based on a detailed review of the empirical literature, a reliabilist may believe that teachers who use relevant “real-world” examples foster deeper learning in their students. To test that claim, that researcher might formulate a specific hypothesis and gather data that would either support or disconfirm the predicted relations between “real-world” examples and learning.

Finally, social epistemologists like reliabilists seek external justification for beliefs. What distinguishes these individuals, however, is that they often turn to the testimony of established authorities and or beliefs institutionalized within a given culture or community of practice as the source of that justification. “Truth,” in essence, is what the community of practice upholds as justified. Thus, decisions about effective teaching practices in reading or mathematics might be justified by comparisons to standards articulated by the community of experts within each of these academic domains.

Unpacking Teaching and Research on Teaching

Our focus on questions of ontology and epistemology in relation to research on teaching became pivotal to the High Quality Teaching (HQT) project design, instrument construction, and the data collection and analysis processes. Meanings of teaching, although often seemingly shared by educational researchers vary not only by role, perspective, and experience, but also by disciplines. In the same way, epistemologies associated with various research endeavors vary by discipline, biography, and perspective.

The complex puzzle of the representations of ontology and epistemology in relation to research on teaching becomes further complicated when one considers the range of disciplinary perspectives that shape not only what counts as research on teaching, but also the very construct of teaching. In part, any conversation about research on teaching begs two parallel and equally significant questions? What is teaching? And how do we come to know teaching? The answers to each of these questions, in part, depend on who is asking the questions and the community to which the researcher belongs:

Communication about any subject usually occurs within the boundaries of a discourse community. This community shares a sense of the meaning of the terms it uses to talk about common experiences, and it also shares standards about what is accepted as evidence for assertions. (Lampert, 1999, p. 61)

While different discourse communities may make different epistemological assumptions, and define knowledge and “reality” in different ways, the task of the educational researcher is to consider the ways in which those different discourse communities converge, and the ways in which the varied meanings and knowledges stand side-by-side.

As pedagogical researchers develop their instruments, they must not only be aware of different disciplinary lenses and communities to which they belong, but they must also acknowledge that teachers’ meanings and knowledge may differ from the representations they construct. They also need to recognize that the stories told and the perspectives that acquire a status of knowledge are impacted to some degree by who gets to tell the story (Gitlin & Russell, 1994; Sleeter, 2001). In a sense, this debate is about diverse perceptions of teaching, as well as about the seemingly uneasy relation between science and teaching. This tension is nicely captured in *Democracy and Education* where Dewey (1966) complicates the relation:

The methods of science engrained through education in habit means emancipation from rule of thumb and from the routine generated by rule of thumb procedure...It means reason operates within experience, not beyond it, to give it an intelligent or reasonable quality.

Science...changes the idea and the operation of reason. (Dewey, 1966, 225)

The relation between science and experience, while a continuing discussion among educational researchers, has especially become significant as researchers have begun to use varied methodologies to understand teaching.

The transformation of the landscape of research on teaching has produced a more complex understanding of teaching and educational contexts, particularly classroom contexts. As researchers from various disciplinary perspectives have attempted to explore teaching in classrooms, understandings of classrooms as complex, dynamic, and interactive contexts have emerged. Further, an exploration of how students inhabit classrooms has led to discussions about how the experiences and knowledge of historically marginalized communities have often been neglected in representations of classroom life (Ball, 2002).

Enhanced understandings of teaching and life in classrooms have been fueled by research methodologies that aim to uncover the complexity of cultural, social, and political dimensions of classroom life. Methodologies that have been used for such purposes include ethnography, narrative research, and more recently, a renewed interest and commitment toward action research. The presence of action research, in particular, has brought to the forefront important questions about what counts as teaching, and how one comes to know teaching. Connelly and Clandinin (1985) point to a diversity of theories of knowing and argue that “just as it is good current pedagogical theory to teach the grounds and arguments of competing theoretical views,

so too it is good pedagogical theory to case teaching and learning acts in the context of alternative epistemologies” (p. 180).

Although Connelly and Clandinin (1985) are making an argument for personal practical knowledge as a mode of knowing, they point to larger questions that are raised in the opening discussion. For the questions about what counts as evidence, or justification for knowing, and questions about the existence of certain phenomena, such as learning, have also been addressed in the fields of anthropology and sociology. Here the questions about teaching, research on teaching, and questions of truth and validity are situated within historical and social contexts— contexts in which cultural biographies are produced. So questions of whether learning exists can be coupled with whose definition of learning prevails? Who decided what counts as research, and how does experience and biography interplay with the justified meanings developed over time?

In identifying the importance of teachers’ own perspectives about their meanings of teaching, and the ways in which they come to know teaching, we are not arguing for a privileging of one epistemology over another. Rather, given recent discussions emerging about the terrain of research on teaching (Cochran Smith & Lytle, 1991), questions about valid knowledge and truth become more complicated. Historically, teachers are seen as research subjects and potential consumers of research, rather than active producers of teaching knowledge (Lagemann, 1996). Zeichner and Noffke (2001) offer further elaboration and point to an overarching assumption that

researchers do research about someone else’s practice, despite the long history in which those directly involved in educational work have done research on their own practice.

Rather than regarding practice itself as a form of systematic knowing, the practitioners' role in their view is merely to consume the research produced by others." (p. 298)

Teachers' expression of knowing in teaching and learning acts could be seen as theory-in-action. However, Connelly and Clandinin (1985) argue that teachers' modes of knowing are... narrative-in-action. It is the expression of biography and history in a particular situation...knowing a teaching and learning situation is a matter of the recollections from one's narratives that are called forth by the situation." (pp. 184-185)

Recent questions raised by postmodernist scholars about truth, validity, and the meanings of research have also led to questions about whose standards and for whose purposes is research conducted (Lather, 1991). These are two of the most perplexing questions to be pursued.

Different research traditions not only represent different epistemologies, but also are produced for different purposes. For example, phenomenology attempts to explain and understand human experiences, rather than attempting to discover patterns of generalizability in human experience. At the same time, some researchers attempt to view the world of classrooms from the vantage point of racial/ethnic communities that have often been left out of broader conversations about educational policy. Much interpretative work "locates knowledge within the social history of the knower and his or her community, regards that social history has its vantage point from which to see, and acknowledges verifiable claims as a goal to strive for" (Sleeter, 2001, p. 23). Hence research, such as narrative research and emancipatory research, tries to forward knowledge and experience that reflect many historically marginalized communities.

Discussions of the various epistemologies embedded in various traditions of educational research often center on an "either/or" stance of the quantitative-qualitative or positivist-critical-postpositivist debates. Such debates often obscure some of the important questions of the ways in

which research traditions may complement each other. Identifying the meanings of teaching, and the underlying epistemologies of research on teaching allows conversations across communities to take place. In the introduction to the *Review of Research on Education*, Secada (2002) argued for a better understanding of the ways in which social phenomena intersect with education interests. He suggests that “the next generation of educational research may need to mount work that crosses disciplinary boundaries and draw on the talents of research scholars representing those disciplines” (p. x). Rather than pitting different ontologies and epistemologies against each other, we need to identify different meanings of teaching, and the different ways in which we come to know teaching. Such an approach allows researchers from different communities to come together, not only to provide for cross-disciplinary conversations, but also to allow multiple methodologies to co-exist alongside each other. In this way, a research team can come together acknowledging the different strengths of each team member and design projects that can look at teaching using “different questions from different angles and visions” (Sleeter, 2001, p. 242).

Ontological and Epistemological Threads in Educational Research

The scene from *The Prime of Jean Brodie* with which we started needs to be complexified if we intend to consider the ontology and epistemology of the visitor: the visitor’s disciplinary discourse community and research tradition; and, whether the visitor is a teacher with insider knowledge or a researcher with more abstract outsider knowledge. Ontology and epistemology are simultaneously *personal* (“I believe that good teaching happens whenever I can measure a change in student knowledge. You believe that good teaching happens whenever you observe students interacting well with one another as they engage in authentic tasks.”) and *social* (“I am a part of the educational psychology community. You belong to the community of

sociologists.”). To be sure, these contrasts are simplistic, and applied to *The Prime of Jean Brodie* scenario, they are sort of silly. The scenario is not real teaching. But we could imagine that you and I might go about discovering that we are watching a rehearsal in different ways. To the extent that we can work together rather than rejecting, or ignoring one another’s work, our endeavor will be enriched, or so we have argued thus far.

In the following sections, we review research published in a recent issue of *The Elementary School Journal* (Ball & Rowan, 2004) that focuses on the effects on student learning in reading and mathematics of three popular educational programs using a variety of types of measures. Three distinct programs, two dissimilar content areas from two discrete disciplinary communities, and assorted measures, or ways of knowing, could point to differences in ontology and epistemology not quite as salient as Secada (2002) and Sleeter (2001) describe, but interesting nonetheless and closely related to work in the HQT project.

Several years ago, scholars at the Consortium for Policy Research in Education created the Study of Instructional Improvement (SII) to examine the effects of Accelerated Schools, America’s Choice, and Success for All on instruction and student achievement (Ball & Rowan, 2004). SII has worked with 120 high poverty schools, focusing on reading/language arts and mathematics. Ninety of the schools have one or more of these programs, and 30 schools without any of the programs are comparison schools. Nine of the schools that are participating in one of the three programs and three that are not serve as case studies. The special issue reports on the development of measures to evaluate the effects of these programs on student achievement.

In the introduction to the issue, Ball and Rowan (2004) noted, “It is increasingly clear that instructional quality affects what students learn in school and how they grow academically over time. However, less is known about *what* makes teaching good or effective. Researchers

also lack adequate knowledge of *how* to measure good teaching, assess its effect on students' achievement, and promote such teaching in schools" (pp. 3-4). This quote can be interpreted to raise questions that are both ontological (*what* makes teaching good or effective, which, admittedly, is not quite the same question as what *is* good teaching) and epistemological (*how* to measure, which, to be sure, is not quite the same question as how do we *know*). Ball and Rowan tend to intermingle ontology and epistemology in their introduction. For our discussion, we attempt to pull them apart. We draw on the separate research reports in the issue to exemplify and amplify the ontological and epistemological issues raised in the introduction.

Ontology

High quality teaching in mathematics or reading can be an elusive concept. Is quality teaching the instruction that promotes standards developed by professional organizations and codified in curriculum frameworks? Is it the instruction promoted in programs, such as Success for All or Accelerated Schools? Is quality teaching the set of practices used by teachers whose students score well on standardized tests? Is it instruction that leads to higher reading performance than other instruction offered to a control group? Answers to the first two approaches for defining teaching seem to us to be purely ontological, independent of the ways of knowing that undergird them. Answers to the third and fourth questions interweave the two. The definition of high quality teaching depends on outcomes; on data collection and analysis; on ways of knowing.

Ball and Rowan (2004) explain that the researchers in the special issue decided to define quality teaching as that which improves student learning. Within this broad definition, they focused on what they describe as two dimensions of quality teaching that can affect student achievement: teachers' content knowledge for teaching and the enacted curriculum. We use these

two dimensions to organize our analysis of the concepts of reading and mathematics instruction in the five studies reported in the special issue. Our analysis focuses more extensively on the three reading studies and draws contrasts with the two mathematics studies.

What is reading instruction? In the titles alone, the special issue refers to “Teaching Reading” (Phelps & Schilling, 2004), “Language Arts Instruction” (Camburn & Barnes, 2004), and “Literacy Teaching” (Rowan, Camburn, & Correnti, 2004). Phelps and Schilling’s goal was to develop measures of content knowledge for teachers of reading; to address the question of what teachers know about reading instruction. Their focus was indeed on reading. Based on a review of research in reading (e.g., Snow, Burns, & Griffin, 1998), their own understanding of the reading curriculum in elementary school, and scenarios gathered from case studies, Phelps and Schilling developed a 2x3 matrix to represent their definition of teacher content knowledge in reading.

Two topics (word analysis and comprehension) were crossed with three types of knowledge (content knowledge, content and teaching knowledge, and content and student knowledge). Comprehension included morphology, vocabulary, comprehension strategies and questions, genre, and fluency. Word analysis included phonemic awareness, letter-sound relationships, and word frequency. *Content knowledge* was knowledge about these topics, *content and teaching knowledge* encompassed teaching strategies for each of the topics, and *content and student knowledge* involved diagnosing and choosing content based on student strengths and needs. Subsequent factor analyses suggested that content and student knowledge was not a separate feature of teacher content knowledge in reading, simplifying the characterization. Teachers demonstrated that their knowledge representation indeed had two

dimensions, word analysis and comprehension, and that they knew instructional strategies to use for each, but that they did not know how to differentiate instruction based on student differences.

Conceiving of reading instruction as language arts instruction resulted in a different characterization of the content. Camburn and Barnes (2004) assessed the validity of a language arts log to be completed by teachers that added writing, concepts of print, research strategies, grammar, and spelling to word analysis and comprehension. Despite specifying these eight strands, the log actually had “focal strand” sections: word analysis, reading comprehension, and writing. Within each of these focal strands, the log specified particular instructional approaches. For example, the choices for writing included generating ideas for writing, organizing ideas for writing, library techniques, and author’s style.

To measure the enacted literacy curriculum in third-grade classrooms in schools with one of the three programs (Success for All, America’s Choice, or Accelerated Schools) or not, Rowan, Camburn, and Correnti (2004) used a version of the log with nine strands. For some unknown reason, they pulled out reading fluency from comprehension (Phelps & Schilling, 2004). The focal strands for this log were reduced to reading comprehension and writing, which the authors explained were the most frequently chosen items. Rowan and colleagues added cognitive demand as an important dimension to literacy instruction, which they defined according to frequency. These researchers ordered the specific skills in reading comprehension and writing in descending order of frequency, based on their belief that the less frequently a skill is taught, the higher the cognitive demand.

Rowan and colleagues also referred to the characterization of the literacy instruction in the three programs under study. They described Success for All as built around a 90-minute reading block composed of three timed segments—listening comprehension (20 minutes),

reading instruction (55 minutes), and skills instruction (15 minutes), whereas America's Choice focused on the use of writer's workshops to improve writing instruction. According to the authors, the Accelerated Schools Program worked to help teachers internalize the imprecisely defined ideal of "powerful learning" (Rowan et al., p. 86). It is unclear the extent to which the conceptions in these programs influenced the characterizations of literacy in the log measure.

How does the ontology of mathematics instruction compare and contrast with reading instruction? First, titles in the special issue—"Mathematics Knowledge for Teaching" (Hill, Schilling, & Ball, 2004) and "Mathematics Curriculum" (Rowan, Harrison, & Hayes, 2004)—are signaled as ontologically identical. Similar to the characterization for reading, Hill and colleagues developed a 3x2 matrix to represent their definition of teacher content knowledge in mathematics. Three topics (Number concepts, operations, and patterns, functions, algebra) were crossed with two types of knowledge (Content knowledge, and content and student knowledge). Number concepts and operations are important concepts in the K-6 curriculum, and research exists on the teaching and learning of them. Patterns, functions, and algebra are a good contrast because they have been newly added to the elementary school curriculum and have been researched far less. Content and student knowledge was defined in this work as knowledge that teachers have about the types of misunderstandings that students may hold. Subsequent factor analyses suggested that teachers' knowledge representation of mathematics instruction had two dimensions rather than three, Number concepts/operations and patterns/functions/algebra, and that they knew the sorts of understandings about the content that students would hold.

Comparable to his work on the enacted literacy curriculum in third-grade classrooms, Rowan and colleagues (2004) analyzed the mathematics curriculum and instruction in early grades by using a teacher log with nine topics to characterize mathematics instruction: Number

concepts, operations, patterns/functions/algebra, learning about money/telling time/reading a calculator, representing/interpreting data, geometry, measurement, probability, percent./ratio/proportion, and negative numbers. Similarly to the reading log, these topics were reduced to three focal topics either expected to be the most frequently taught or a focus of mathematics reform: Number concepts, operations, and patterns/functions/algebra. Within each of these focal topics, the log specified subtopics and types of instruction. For example, the choices for number concepts were: whole numbers, fractions, decimals, or some combination.

The log defined types of instruction according to three dimensions: direct teaching, the pacing of instruction, and the nature of student work (routine practice, involving applications, or involving analytical reasoning, which appear to us to increase in cognitive demand). Finally, Rowan, Harrison, and Hayes (2004) noted that the mathematics content in Success for All, America's Choice, and Accelerated Schools Program was underspecified, with both Success for All and America's Choice focusing far more on literacy and Accelerated Schools emphasizing a commitment to "powerful learning" in both mathematics and reading/language arts. These programs appear to have little effect on the conceptualization of mathematics instruction.

At first glance, the ontology of mathematics instruction and reading instruction would appear to differ in important ways. Mathematics instruction has a disciplinary base that reading instruction lacks. The variety in titles on the one hand and the sameness on the other reflect these differences between the two subject areas. The content, of course, is very different, as are the skills. But comparing the conceptualization of reading/language arts/literacy instruction in three articles with the conceptualization of mathematics instruction in two articles reveals an interesting comparability. Two to three content dimensions capture most of the teacher knowledge and most of the topics covered. Skills can be ordered according to cognitive demand.

We do not intend to minimize the differences. But the commonalities suggest the possibility that identifying the meanings of teaching, and the underlying epistemologies of research on teaching could indeed allow conversations across the literacy community and the mathematics community to take place.

Epistemology

As we described earlier, much of the discussion within the philosophical literature deals with the nature, source, and limits of knowledge. How does one establish that the information or evidence gathered is true or accurate? Is justified information knowledge rather than belief? Much of the rigor in the articles reviewed herein comes from a focus on answers to these questions. Ball and Rowan (2004) catalogued the problems with previous approaches to learning about quality teaching, concluding, “[M]any studies use inexact measures of doubtful reliability and validity....(p. 4).” Teachers have completed annual surveys on their daily practices, which probably often misrepresented their actual practice. Interviews can lack objectivity. Observations can be too infrequent to represent instruction accurately. Further, broad-scale studies can lack detail while smaller-scale, in-depth studies can be too dependent on the observer to be valid and reliable and are not generalizable to a larger population. The Study of Instructional Improvement developed an array of types of measures to collect data on teaching. As we subsequently describe, these measures were analyzed meticulously according to established quantitative and qualitative analytical tools.

As we explained above, the articles in the special issue focused on measuring teachers’ content knowledge for teaching and the enacted curriculum. The measurement instruments were intended to measure instruction on a broad scale in reading or mathematics. Earlier we referred to different epistemological frames: two types of internalists who believe that the source of

justification lies within and two types of externalists who look to external sources for justification of claims (Murphy et al., in press). The five articles in the special issue hold an externalist frame in which beliefs must be bolstered by evidence that resides outside of the researchers own minds and that is submitted to logical or empirical test. For reliabilists, one of the two sub-frames, the basis for justifying reasoned beliefs is whether they predict actual events or data in the world. Accordingly, the researchers in these studies formulated specific hypotheses or asked research questions and gathered data that either supported or disconfirmed the hypotheses or answered the questions.

Perhaps the work that was the most epistemologically interesting was the use of triangulation to assess the validity of the first version of the Language Arts Instruction Log (Camburn & Barnes, 2004). Thirty-one teachers pilot tested the log for three months. Eight researchers conducted observations. Two researchers observed each of the teachers for one school day, described all of the instruction in language arts, and completed logs themselves. Both teachers and researchers prepared. Teachers learned to use the log through training sessions and self-study. They also received copies of a glossary that defined and exemplified items on the log. Researchers trained for one week by watching videotaped segments of instruction. Four kinds of data were collected for each observation: logs completed by the teacher and both observers, narrative descriptions from both observers, notes from both observers reflecting on why their responses differed from one another, and a post observation interview with the teacher on why his or her responses differed from the two observers.

Log data from teachers and researchers were analyzed quantitatively to address two research questions. To what extent do researchers and teachers agree when they use the log to describe the same segments of instruction? How do levels of agreement vary with respect to the

kind of instruction being observed and reported? Camburn and Barnes (2004) addressed the questions by fitting a series of hierarchical generalized linear models (HGLMs), which nested raters' matches on log items within the items themselves, assessing whether interrater agreement varied by item. The authors noted that most validity studies of instructional measures stop after gauging the degree of disagreement among raters. They sought, instead, to ask why raters agreed or disagreed.

The observation narratives, observers' reflections about their disagreements, and follow-up teacher interviews were analyzed qualitatively to answer the following questions. In what ways does rater perspective influence responses on the log? In what ways does the nature of instruction being reported affect responses? How do insights about raters' responses on the log inform our understanding of its validity? The quantitative analysis suggested answers to the first two questions and formed a priori categories for the analysis. Nonetheless, Camburn and Barnes (2004) reported that additional themes emerged after repeated readings of the data. Trained field researchers coded the three types of data according to specific language arts log items. They entered the text and codes into a software program for analyzing qualitative data. Subsequently, they were able to generate reports that included the match results of the three raters, coded text units describing the instructional segment, and raters' comments about why they coded the text as they did.

Triangulation in this analysis did not mean convergence on one point. Instead, Camburn and Barnes (2004) saw the researcher's role in triangulation as making sense of data that at times converge and at times diverge. They explained: "In using this triangulation strategy, we felt that investigating why data diverge could shed as much light on the validity of the log as simply documenting whether or not they converge" (p. 51).

Across the remaining studies (Hill, Schilling, & Ball, 2004; Phelps & Schilling, 2004; Rowan, Camburn, & Correnti, 2004; Rowan, Harrison, & Hayes, 2004), researchers used experts to design items according to conceptual understanding of reading or mathematics instruction, collected data from teachers attending professional development or in schools that either did or did not have Success for All, America's Choice, or Accelerated School Program, and analyzed the outcomes using factor analysis, item response theory analyses, and hierarchical linear modeling.

The epistemological frame was consistently reliabilist. It is interesting that this frame did not vary for the two subject matters. The approaches used to analyze the data and justify the outcomes were nearly identical. It is also the case that authorship overlapped across reading and mathematics. Rowan was first author on both studies that used teacher logs to measure curriculum and instruction in reading and mathematics. Often, it has been assumed that reading and mathematics teaching have different epistemologies; that knowledge about the former is justified by scholarship in psychology, sociology, linguistics, and literature, whereas knowledge about the latter is justified by the discipline of mathematics. Typically, researchers who study the two are different and rarely cite one another. Indeed, these two groups of researchers could be described as belonging to different disciplinary communities. However, the corpus of studies in the special issue suggests that by focusing on the measurement of teaching, it is possible to employ virtually identical analytical tools to discover and justify knowledge about teaching in reading and mathematics. In the next section, we turn to our own efforts to characterize high quality teaching in these two subject areas and justify our characterization.

The High Quality Teaching Project

HQT is a four-year study of teaching quality that focuses on what teachers do to help struggling 4th and 5th grade students succeed in reading and mathematics. The project also considers how educational policies and organizational factors influence the ability of teachers to sustain effective pedagogy over time. HQT has now collected four academic years of data from multiple instruments over some 65-75 teachers in 11-18 schools in a single district. Students in these schools tend to score higher on standardized tests in mathematics and reading than would be predicted by their SES level.

Our research team comes from at least five disciplinary communities: Educational psychology, educational sociology, reading education, and mathematics education. Whereas we certainly never referred to “ontology” and “epistemology” as we worked together to design and conduct our study or analyze our data, we realized retrospectively that we were addressing ontological and epistemological issues throughout. Our goal was to be sensitive to and measure the features of high quality teaching that reading and mathematics instruction have in common, as well as what distinguishes these two.

Ontology

Our characterization of high quality teaching in reading and mathematics is hierarchical. At the top-most level is a conceptualization of high quality teaching based on the Learner-Centered Psychological Principles forwarded by the American Psychological Association (Learner-Centered Principles Work Group, 1997). Instruction that is learner-centered builds and draws on students’ knowledge, enhances strategic processing or executive control, fosters motivation and positive affect, is responsive to developmental and individual differences, and creates situations and contexts that are conducive to learning. These principles define quality

teaching for subject areas at a general, abstract level. More specific characterizations are needed to capture teacher/student behavior and curriculum coverage during instruction. At the next level of specificity in our conceptualization of quality teaching are seven major categories: Teacher activity, student activity, classroom organization, content, context, classroom behavior, and technology/materials. At a lower level are specific details. For example, under teacher activity are requests, poses, elaborates and eight other categories including models, lectures, and reads aloud. Several of these categories are further specified. Teachers can request students to reflect on their learning, provide an alternative answer, conduct self-assessment, elaborate on another student's response, and pay attention to another student's response or idea. The specifics for math and reading for five of these categories are nearly identical.

Content and Technology/Materials differ for the two subject areas. Content for reading instruction is hierarchical, divided initially into reading, writing, vocabulary, and eight other categories including decoding, performance, and illustrating. Several of these categories are further specified. Reading is divided into comprehension, strategy, fluency, and processing text, and comprehension is specified according to genre, theme/main idea, story elements/poem elements/text design, personal response, and literal response. Content for mathematics is characterized at a higher level of abstraction as procedural, conceptual, or linking procedural and conceptual. Mathematical topics are at a more specific level (e.g., algebra/patterns/functions, geometry, measurement, and so on), but these topics are orthogonal to the other three characteristics. For example, geometry content could be procedural, conceptual, or linking procedural and conceptual.

Technology/materials also differ. Our conceptualization of mathematics instruction does not include materials. However, this category is an important feature of our characterization of

reading instruction. Materials are initially specified as narrative, exposition, or poetry, and each of these text types is characterized according to specific genre (e.g., realistic fiction or historical fiction; essay or procedural text; limerick or haiku).

In the following section on epistemology, we describe the basis for these conceptualizations and the instruments that we developed to measure them. But, before turning from ontology, we characterize some of the challenges that our diverse group faced as we worked to clarify what we meant by teaching in reading and mathematics. Throughout many of our discussions, our understanding of teaching in general and in reading and mathematics in particular often appeared to differ substantially. As Graeber, Jones, and Chambliss (2006) explain in a companion paper, not only did we use different terminology, but at times, our conceptual understanding of the same terms differed. For example, *procedural* for an educational psychologist means something quite different from *procedural* for a mathematics educator.

In some ways, characterizing reading instruction was more problematic than characterizing mathematics instruction, not unlike our analysis of reading in the special issue. Does reading instruction include writing, speaking, performing, and illustrating as well? We could justify including writing in response to reading, but what about writing that is unconnected to anything read? We decided on a compromise, including all of this content in our measures, but leaving it up to the teacher to determine exactly when reading instruction was occurring.

Epistemology

What was the basis for our conceptualization of quality teaching in general and of reading and mathematics instruction in particular? What did we do to ensure that the data we collected were trustworthy? To address the first question, we primarily took on the frame of social epistemologist. You will recall that for social epistemologists, “truth” is what the community of

practice upholds as justified. To answer the second question, we took on the frame of reliabilists using established procedures and standards to develop measures that were valid and reliable. In this section, we begin with the basis for our conceptions of teaching, followed by a description of how we developed our instruments, focusing on our observation protocol in particular.

First, research syntheses influenced our conceptualizations of teaching in general and reading and mathematics teaching in particular. The five principles that guided our understanding of instruction in general were originally proposed by Alexander and Murphy (1998) in their review of the research support for the Learner-Centered Psychological Principles forwarded by the American Psychological Association (Learner-Centered Principles Work Group, 1997). Research syntheses in reading (e.g., National Reading Panel, 2000) and mathematics (e.g., Hiebert, 2003) further added to our understanding.

Second, our conceptualization of teaching in reading and mathematics was heavily influenced by the understandings of the reading and mathematics educators on the research team. And their understandings were in accord with characterizations in reading/language arts and mathematics curriculum frameworks, more particularly, *Standards for the English Language Arts*, published by the International Reading Association (IRA) and the National Council of Teachers of English (NCTE), and *Principles and Standards for School Mathematics*, published by the National Council of Teachers of Mathematics (NCTM). For example, *Standards* states that all learners learn language by using it purposively to communicate with others. Therefore, students need frequent opportunities to read, write, talk, and listen, actively engaged in using language to communicate (IRA and NCTE, 1996). Accordingly, we broadened our definition of reading instruction to include writing, speaking, and listening. Our characterization also reflected the curriculum of the district within which the targeted schools reside. For example, our

taxonomies of genre types and mathematics topics were based at least in part on the district curricular frameworks. Finally, we fine-tuned our conceptualization according to actual classroom practice by interviewing the district curriculum coordinators and classroom teachers and observed in the teachers' classes.

Our measures grew directly out of our ontology: our understanding of quality teaching in reading and mathematics. We designed observation protocols in reading and mathematics that were organized according to the seven major categories in our hierarchy, teacher logs according to three of those categories, and an attribution scale according to the five learner-centered principles. We videotaped and took field notes to prepare illustrative lesson cases, analyzing the data according to the features of instruction in our conceptualizations. We interviewed principals, reading specialists, and mathematics coaches for their understandings of quality reading and mathematics teaching. Our measures were closely linked to our conceptualizations.

To ensure that our measures were trustworthy, we followed a rigorous approach for developing our protocols, provided training for observers and data analysts, checked regularly for interrater reliability of observers, provided regular retraining for observers, and worked in groups on all qualitative data analyses. To develop our protocols, we studied measurements used in other research, developed items and approaches in accord with our understandings, conducted recursive rounds of classroom pilot testing for our observation protocols, programmed our observation protocols onto laptop computers and the logs onto PDA's to minimize data entry error, and used a computer program to analyze our qualitative data.

HQT had two epistemological frames: social epistemologist and reliabilist, and these frames did not vary for the two subject matters. The approaches used to characterize teaching in reading and mathematics, develop measures, analyze the data, and justify the outcomes were

virtually identical. As noted, it has been assumed that reading and mathematics teaching have varied epistemologies. Typically, researchers who study the two rarely cite one another, and rarely are on the same research team. However, HQT goes beyond even the corpus of studies in the special issue. By working together and focusing on the measurement of teaching, researchers from several disciplinary communities developed a variety of analytical tools to discover and justify knowledge about teaching in reading and mathematics.

Implications

Making Ontological and Epistemological Decisions Transparent

Earlier we admitted that we did not expressly consider our decisions with the HQT project in light of ontology or epistemology concerns, although those threads were in fact woven throughout that decision-making process. We consider that oversight to be unfortunate, albeit unintended. We do not believe we are alone in such ontological and epistemological neglect. We were lucky that our diverse perspectives and research histories nearly forced us to put our ontological and epistemological views on the table in the HQT study. How much better would the process have been if we had participated in that philosophical examination with awareness?

It would seem that efforts to engage in meaningful and informative research on teachers and teaching would be enhanced if the ontological and epistemology threads of such research were not treated as after-thoughts but were rather made explicit and valued components of the conceptualization, design, implementation, and interpretation of teacher education studies.

Achieving Philosophical Compromise while Maintaining Pedagogical Integrity

One of the benefits of engaging in interdisciplinary research on teachers and teaching is that diverse discourse communities may well spark reflection on critical ontological and epistemological concerns that might otherwise go unconsidered. Yet, this theoretical asset can

have practical side-effects. The design, conduct, and interpretation of data ultimately require researchers to reach decisions about what will be studied, how it will be studied, and what the emerging data suggest about pedagogy. In other words, engaging in pedagogical research around complex issues like quality instruction will likely necessitate ontological and epistemological compromise for researchers. Even if certain ontological and epistemological views should not be privileged theoretically, someone's position or some compromise position must emerge as the framework for the questions asked, the methods employed, the analyses undertaken, and the interpretations made.

As this philosophical compromise unfolds, researchers must work to ensure that pedagogical integrity is safeguarded. For example, while diverse perspectives on what constitutes teaching have enriched the HQT project, we were careful that the emerging conceptualization of teaching that framed the study did not violate anyone's ontological principles. We were not willing to consider all actions occurring during the observation period to be called "teaching," for instance and held to our fundamental beliefs that there was in fact time devoted to non-teaching acts such as passing out papers or physically transitioning from one location to another.

Crossing Boundaries

Lampert (1999) reminded us that communication about teachers and teaching often occurs within the boundaries of discourse communities. Yet, what we are advocating herein is a level of reflection and dialogue that crosses those existing community boundaries. Consequently, what must be considered as those boundaries are traversed are the fundamental effects on ontological and epistemological beliefs about teachers and teaching. For instance, one might question whether the essence of quality teaching should remain consistent regardless of the

educational context (e.g., high-poverty versus low-poverty schools), the academic domain (e.g., reading or mathematics), or the student population (e.g., African American or Western European students). Certainly this would be the position of coherentists who would seek internal consistency in the characterization of quality teaching, even as one crosses the boundaries of discourse communities or moves from one educational setting or student population to another.

On the other hand, social epistemologists, with their reliance on external authority, may perceive the construct of quality teaching as more fluid and malleable. Thus, for these individuals it would be questionable to attempt a characterization of quality teaching that was not sensitive to time, place, or population. We see this tense between internal and external epistemological frames at work in our own research efforts (e.g., Graeber et al., 2006), as well as that of others (Rowan, Camburn, & Correnti, 2004).

Juxtaposing Ontological and Epistemological Reflections with Post-Hoc Determinism

Throughout this discussion, we have been advocating for thoughtful reflection on fundamental ontological and epistemological issues regarding teaching and learning. What do we believe teaching or quality teaching is? What sources of evidence should be sought to substantiate or justify claims regarding quality teaching? Yet, what has become evident to us through our own research and that of others is that quality teaching in an age of accountability has taken on an air of post-hoc determinism. That is to say, within the current sociopolitical climate, quality teaching is best described as the actions that result in the raising of high-stakes test scores and it is the test scores that are the privileged and often sole source of evidence that merits consideration. Thus, as researchers we may struggle with critical philosophical issues that become de-valued within the everyday life of teachers and school administrators who must take on the ontological and epistemological beliefs of those in positions of power.

Acting the Role or Writing the Play

This latter issue of accountability and pedagogy brings us to a concluding realization that cannot be ignored. In the opening of this discussion we presented the scenario of the visitor to a school who peeks into a classroom door, sees a woman standing before a group of young people seated at desks, as she gestures toward a formula on the blackboard. The visitor mistakenly assumes that s/he is witnessing teaching. In reality, what s/he was witnessing was a scene from a play. The point of this scenario was to warn against ontological and epistemological missteps in the study of pedagogy.

Yet, let us consider this scenario from an alternative perspective. Specifically, we might wish to ponder the degree to which practicing teachers in today's educational world of high-stakes testing and accountability write their own pedagogical role within the classroom or, conversely work off a script they have been handed by others. When we, as researchers, observe within classrooms are we watching some orchestrated production in which the significant players are not free to improvise or ad lib? If we were to ask teachers what they would *want* to do in their classrooms or what they believed *high quality* education means would those descriptions bear much resemblance to what we saw or documented in the course of teachers' and students' lives in the classroom? If teachers, students, or administrators are indeed acting out prescribed roles, what is the reality of teaching or what evidence would truly justify claims of quality? The ontological and epistemological conundrum for us must remain unresolved.

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