

Challenges of Improving Instruction: A View from the Classroom

by Deborah Loewenberg Ball and David K. Cohen
University of Michigan

Reformers hold high hopes for improving students' opportunities to learn. Exhortations abound for goals that do not sacrifice concern for fundamental skills but that also emphasize capacities for reasoning, original creation, complex application, and problem solving. Although the details and the rhetoric vary, the frameworks, materials, and assessments with which teachers must contend encompass an ambitious set of aims. Teachers are to work toward these complex aims with all their students, across a range of subject matters: Elementary teachers, for instance, may work with students whose achievement spans several grade levels, whose experience differs widely, and in subjects as different as mathematics, reading, and social studies. Teachers must develop practices more varied and more complex than those of their own school experience, and also likely different from their current professional practice. They must do so with materials that often under-support the goals toward which they are to work, in the face of assessments that are weakly aligned with materials and goals, and without adequate opportunities to learn – either on their own, with colleagues, or in sustained and focused forms of professional development.

We have been investigating challenges of teaching toward more ambitious goals along two main avenues. One is through our investigation of others' efforts to change and improve teaching and to observe challenges endemic to those efforts. A second is through Ball's continuing to teach children herself and to use that teaching as a site for uncovering and articulating recurrent problems of practice that teachers encounter and which they must address.

Instruction and the Environments of Instruction

We use the term **instruction** to refer to the *interactions among teachers and students around educational material*.¹ Rather than seeing instruction as something the teacher does, or curriculum as resident in books and standards, or students as recipients of teachers' and books' opportunities and inputs, we see what happens in classrooms as a function of the interaction among these elements in instructional environments.

¹ Cohen, D.K. and D.L. Ball (1999). *Instruction, Capacity and Improvement* (CPRE Research Report No. RR-043) Philadelphia, PA: University of Pennsylvania, Consortium for Policy Research in Education.

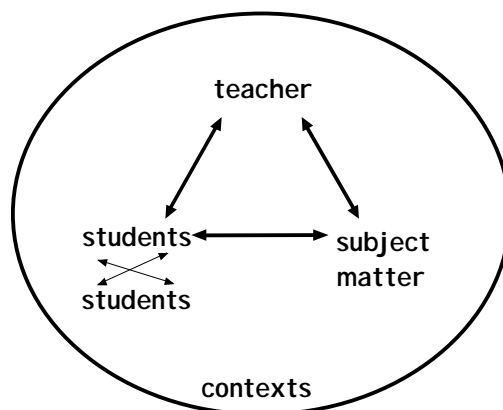


Figure 1. The Dynamics of Instruction²

Teachers' intellectual and personal resources influence instructional interactions by shaping how teachers apprehend, interpret, and respond to materials and students. There is considerable evidence that teachers vary in their ability to notice, interpret, and adapt to differences among students. Important teacher resources in this connection include their conceptions of knowledge, understanding of content and flexibility of understanding, awareness of and familiarity with students' knowledge, ability to relate to, interact with, and learn about students, repertoire of means to represent and extend knowledge and to establish classroom environments. All these resources mediate how teachers shape instruction. Consequently, teachers' opportunities to develop and extend their knowledge and capabilities can considerably affect instruction by affecting how well teachers can make use of students and materials.

Most discussion of instruction and its improvement focuses on teachers, but much research shows that **students'** experiences, understandings, interests, commitments, and engagement are also crucial to instructional capacity. One way to consider the matter is that the resources that students bring influence what teachers can accomplish. Students bring experience, prior knowledge, and habits of mind, and these influence how they apprehend, interpret, and respond to materials and teachers. The same assignment used by the same teacher can produce different instruction with one group of students than with another. Students – and interactions among students – shape the resources for their own learning. At the same time, what students “bring” is also interactive with what they are asked to do, what the teacher pays attention to, and how she or he interprets the student.

By **materials** we mean what students are engaged in, as presented in texts and other media, as well as in problems, tasks, and questions posed to students by teachers or assessments. Instructional materials can mediate students' engagement with the content to be learned, though sometimes the

²Many people have used this triangle to represent relations in and around teaching and learning, including David Hawkins and Magdalene Lampert. See, for example, Hawkins, D. (1974). Nature, man, and mathematics. In *The informed vision: Essays on learning and human nature* (pp. 109-131). New York: Agathon. (Original work published in 1972.)

materials themselves are what is to be learned. They can be thought of as the material (as opposed to social) technologies of instruction, including print, video, and computer-based multi-media.

Students' and teachers' interactions with curriculum material comprise the enacted curriculum – as opposed to the intended curriculum as envisioned by curriculum designers.³ Materials influence instructional capacity by constraining or enabling students' and teachers' opportunities to learn and teach. Teachers' interpretations and use of materials affect what students have to work with and, similarly, students' understanding and use of what teachers offer shapes the tasks which teachers then seek to steer. These interactions are iterative; close tracking reveals how the curriculum evolves interactively and across time.

It follows from this analysis that any given element of instruction shapes instruction by the way it interacts with and influences the other elements. Although reformers often seem to behave as though introducing new materials or training teachers would change instruction, our argument would suggest that changing any single element of instruction would affect instruction only as a function of how it affected interactions among the elements. For example, curriculum materials might be designed with complex tasks of a kind that teachers rarely assign their students. Following the new book, a teacher might assign such tasks, and her students might produce work unlike any she had seen them produce before. If this happened over a period of time, and if she noticed this and considered the implications of what she was seeing, she might begin to revise her ideas about the capabilities of her students. As she did, she might be more inclined to press them to do more difficult work. As she did this, students' opportunities to learn would be enhanced. On this example, the interaction of curriculum, students, and the teacher might lead to changes in instruction. This is perhaps implicit in the hopes of reformers, although some curriculum reformers may assume that if the work that students encounter in their books changes, their learning will necessarily change as well. However, another scenario is at least equally likely. Using a new textbook that offers open-ended and complex problems as the core of the mathematics curriculum, a teacher who knew little mathematics might assign the work without fully appreciating where it would or could lead. When her students got stuck or became confused, she might reduce the complexity and ambiguity of the work by explaining, bounding, making decisions for and with students. When her students came up with significant mathematical insights, she might not notice or know how to use their ideas. Through these sorts of interactions, as the teacher works with the new text, intellectually challenging material might be reconstituted in quite conventional form.⁴

Instruction is situated in the broader contexts that we call the **instructional environment**. Teachers and students work together in schools, which are located in often diverse communities, local and state policy contexts, and subject to a flurry of guidance and aspirations for student performance. Four points are important here.

³Doyle (1984) highlights the importance of distinguishing the “enacted curriculum” as it is constructed by teachers and students.

⁴Stein, M. K. Grover, B., and Henningsen, M. (1996). Building student capacity for mathematical thinking and reasoning: An analysis of mathematical tasks used in reform classrooms. *American Educational Research Journal*, 33, 455-488.

First, rather than seeing each of these as separately influential on instruction, the range of “external” (to classrooms) signals, values, ideas, and guidance interact with one another as they are perceived and interpreted by teachers and students. When the principal announces that the district’s reading program needs to be updated to meet the new state framework for language arts, a teacher may elect to attend a workshop on getting parents to read with their children. Whatever she hears there will be mixed with her principal’s interpretation of the district’s agenda and with various interpretations of the language arts framework. Echoes of these, in unpredictable combination, may enter her thinking as she teaches reading or plans her next unit.

Second, we do not draw a line at the classroom door between what are often seen as “external” and “internal” to instruction, for the environments of instruction permeate interactions among teachers, students, and materials. Instructional policies, parental attitudes, community values, administrators’ and districts’ priorities influence instruction as teachers perceive, interpret, and respond to them. For example, if parents criticize the new math homework that their children bring home, saying it is not math, too easy (or too hard, incomprehensible, or beside the point), this can affect students’ attitudes toward the work as well as their ability to do it. Students, worried about impending placement exams, may press their teachers to move faster, make work more algorithmic, or reduce complexity. Influences often thought to come from “outside” (parents, high-stakes tests) can be seen as inside interactions among teachers, students, and materials; they shape instruction as they suffuse the interactions.

Third, which external influences do suffuse the interactions has, in part, to do with how individual teachers and students perceive, interpret, and respond to them. Two teachers teaching in adjacent classrooms may differ dramatically in their perception of the school’s principal, parents, or the district’s instructional policies.

Finally, schools differ in how much they regulate these influences. A good deal depends on how they buffer teachers from outside signals. Some schools are very porous, allowing influences to permeate classroom interactions subject to teachers’ individual perceptions. In others, strong leadership or a common strong program may filter the flow of messages and guidance.

Four Challenges of Practice and Improving Practice

Given these ways of thinking about instruction and the environment, we turn now to consider four challenges of practice that bear both on practice and on improving practice. These challenges are not intended to be exhaustive, but are arguably crucial for efforts to develop instruction in ways that would improve students’ opportunities to learn and their learning.

1. Knowing and using knowledge in instruction⁵

That teachers' own knowledge of the subject affects what they teach and how they teach it seems so obvious as to be trivial. However, the empirical support for this "obvious" fact has been surprisingly elusive. For example, teachers' mathematical knowledge has shown weak and, more often, no effects on student performance. In a well-known meta-analysis of studies of teacher effects, for example, the number of credits in mathematics beginning at calculus was shown to have positive main effects in only 10 percent of the cases, and, perhaps more jolting, had negative main effects in 8 percent.⁶ Perhaps higher level mathematics makes little difference in practice, but more likely this is a problem of measurement: Course-taking is not a good proxy for knowledge. Still, there remain unexamined questions regarding how content knowledge matters to good teaching, and the field's lack of understanding plagues policy about professional preparation and certification, teacher education, and weakens research on teaching and teacher learning.

We have turned the question of what content teachers need to know on its head: instead of asking what do teachers need to know, we ask, "What is teaching, and what does it take to teach?" We examine mathematics teaching and consider the mathematics entailed in its specific activities. What mathematics do teachers use – or might they use – to prepare for class, to follow or depart from their textbooks, to set tasks for students, to conduct class, to evaluate students' work, to figure out next steps? What is the mathematical knowledge, what are the mathematical skills or sensibilities that do – or could – play a role in helping students learn mathematics? We seek to analyze mathematics as used in teaching mathematics, as one might analyze mathematics as used by engineers, biologists, nurses, or tailors.

Even if we can offer more grounded ideas about the specific content that teachers need to know, the important question is not just what teachers need to know about the subjects they teach, but how they use content knowledge in teaching. Take, for example, figuring out what students understand and what they are learning, sizing up an activity in the textbook and revising it to make it work more effectively, or managing a classroom discussion toward a set of goals. Each of these depends on the ways in which the teacher can flexibly bring to bear her own understanding of the content.

Consider the following vignette from Ball's third grade classroom, in which she was trying to use mathematical knowledge to figure out what students were thinking and trying to decide whether or not to pursue either of their ideas. In our view, her work in this fragment of instruction depended not just on what Ball knew, but on her ability to make use of what she knows in these typical and yet challenging pedagogical contexts.

⁵ We draw here from Ball's work with Hyman Bass. See, for example, Ball, D. L. (1999). Crossing boundaries to examine the mathematics entailed in elementary teaching. In T. Lam, (Ed.), *Contemporary Mathematics*. Providence: American Mathematical Society; Ball, D. L. and Bass, H. (in press). Making believe: The collective construction of common knowledge in the elementary classroom. In D. Phillips (Ed.), *Yearbook of the National Society for the Study of Education, Constructivism in education*. Chicago: University of Chicago Press.

⁶ Begle, E. (1979). *Critical variables in mathematics education: Findings from a survey of the empirical literature*. Washington, D.C.: Mathematical Association of America and the National Council of Teachers of Mathematics.

The example arises from a day in Ball's third grade class. She had planned to have the students work further on a set of ideas which they had generated about even and odd numbers. After working on several problems that involved patterns of sums, they had noticed that even numbers added to other evens seemed to always equal even numbers, and that evens added to odds equaled odds, and so on. Not only were these important ideas, but the fact that they had come up with these conjectures was exciting, and their enthusiasm for figuring out whether these were always true made Ball realize that they were learning some things about mathematical work. She thought that they might be able to figure out how one might actually prove that these conjectures were true, going beyond simply giving examples of them.

Near the beginning of the lesson the class was revisiting some discussion they had had the day before about the number zero. A boy named Nathan said⁷:

Um, first I said that um, zero was even but then I guess I revised so that zero, I think, is special because um, I – um, even numbers, like they, they *make* even numbers; like two, um, two makes four, and four is an even number; and four makes eight; eight is an even number; and um, like that. And, and go on like that and like one plus one and go on adding the same numbers with the same numbers. And so I, I think zero's special.

Ball did not quite understand. What was he saying? Was he saying that two even numbers when added together yield even sums? Was he talking about powers of two? What did he mean that zero was "special?"

Knowing some possible interpretations of Nathan's comment is helpful. But even if one can figure out on the fly what he might be saying, knowing what to ask next or whether it is important to ask something next is far from obvious.

Seeking insight, she asked Nathan:

Can I ask you a question about what you just said? Were you saying that when you put even numbers together, you get another even number – or were you saying that all even numbers are made up of even numbers?

He assented: "Yeah, they are." What did he mean? Was that what he is saying, that all even numbers are "made up of even numbers?" Ball still was not sure what he was thinking.

A moment later, Betsy disagreed with what she thought Nathan was saying, pointing out the number 6. And then Sean joined in, saying that, "Six is two odd numbers to make an even, to make an even number." Betsy agreed. Nathan, pondering this, continued to try to express his idea:

⁷ Data from transcript of Deborah Ball's third grade class on January 19, 1990.

I know that, but um, um I'm talking about like two plus two is four, and four plus four is eight and I just skipped the six so I just added the ones that, that add. Like the two plus two is four, and four is an even number and I'm just talking about the things that um, like what I just said – the, um, two plus two is four and four plus four is eight . . . "

Betsy interrupted asking:

So what you're doing is you're going by twos and then what two equals from then you go from – all the way up?

Nathan: Yeah, I'm not going by every single number like two, four, six, eight.

At this point, Ball still wasn't sure what he was saying, and with a roomful of students, she decided to continue on with the lesson and not pursue his idea further just then. Ball thought it likely that he was noticing something interesting. But she did not think she could take up more class time right then, when it was not clear what he was actually saying and she was unsure how to probe it further in productive ways at that moment. Her simultaneous commitments to the integrity of mathematics as a discipline, to taking students' ideas seriously, and to working effectively as a collective interacted and jostled her thinking as she deliberated about what to do. On one hand, the mathematical ideas that Nathan was contemplating were potentially significant. On the other hand, one individual student was still struggling to bring his ideas to the surface, and the ideas were not in a form that would make them accessible even to the teacher, much less to his classmates, without considerable work. Each of these commitments – to subject matter, to students, and to intellectually collective work – is worthy, and yet what it means to work in ways that are shaped by these commitments is often quite abstract. This example helps to illuminate their interaction in the small yet significant moments out of which teachers construct practice.

Listening to students or interpreting their papers requires more than willingness. Was this moment with Nathan and his classmates worth pursuing? Why or why not? Was Nathan perhaps confused about something important? Was he on the brink of an important mathematical insight? Was this worth pursuing right now, given that none of this was on the explicit agenda of her lesson? These and other questions flew through Ball's mind even as she decided to move on, with some regrets. Moments later, Sean, still pondering what he had heard, said that he had been "thinking about the number six" and that it could be an odd and an even number:

'Cause there could be two, four, six, and two, three twos, that'd make six. And two *threes*, that it could be an odd *and* an *even* number. Both. *Three* things to make it and there could be *two* things to make it.

When Ball heard him, she thought at first that he was building on what Nathan had been saying. She thought that he might have been thinking that Nathan had been thinking that all even numbers were made up of two even numbers, and Sean wanted to point out that some even numbers – six, for instance

– were made up of two odd numbers. She tried to explain that Nathan had not been claiming that, and Nathan agreed. However, Sean’s claim that “six could be even or it could be odd” roused the other students. Cassandra said she disagreed with Sean. She went to the board and, using a pointer on the number line, showed that if he called six an even number, then, by extension, zero would have to be odd, which they all knew not to be the case: “Zero’s not an odd number,” she asserted firmly.

Sean persisted:

Because six, because there can be three of something to make six, and three of something is like *odd*, like see, um, you can make two, four, six. Three twos to make that and two threes make six.

“That doesn’t necessarily mean that six is *odd*,” Keith pointed out. Other students nodded. “Just because two odd numbers add up to an even number doesn’t mean it has to be odd.”

The students were growing increasingly invested in this discussion, and this still was not what she had planned to do in class that day.⁸ Deciding what to do is complex. Ball had goals and a lesson plan, but seizing “teachable moments” is also important. But was this one of those moments? How does one know? And if it were, what was it that a teacher might do to take advantage of it? If it were not such a moment, why not, and what might a teacher do to put it aside? What were Nathan, Sean, Betsy, Keith, and Cassandra doing? What was going on with the children who were not contributing to this discussion?

In this vignette, the teacher’s sense of what was at play depended both on her own understanding of mathematics and her ability to use that knowledge to hear and interpret her students. Was what Sean was saying a sign of flawed understanding of even and odd numbers? Or was his idea an interesting mathematical insight? What should she ask or do next? These and the myriad other pedagogical decisions that teachers face depend on what they know about the content, as well as how they are able to use that understanding in the context of their work to understand their students, steer the course of students’ engagement, determine next steps, and figure out where to stop and where to head.

On this account, the challenges of using content knowledge interact with and extend beyond knowledge of content. One teacher’s interactions with a class of fifth graders, for example, may produce different work than those of a colleague who works with the same class, if the first teacher is more adept at evoking and making use of students’ ideas. This means that speaking in terms of what teachers or students “bring” to interactions may be misleading, since what students and teachers bring may be used to better or worse advantage by others. In discussing what students bring to a task it is important to recognize that it depends in part on what teachers can see and use in students. One reason that different teachers elicit different responses and work from the same students is that what teachers know, believe, and can do shape

⁸ This episode is analyzed in detail in Ball, D. L. (1993). With an eye on the mathematical horizon: Dilemmas of teaching elementary school mathematics. *Elementary School Journal*, 93(4), 373-397.

their perceptions of what students bring, the opportunities they subsequently extend to students, and their interpretations of students' ensuing work.

Similarly, materials both depend on their use by students and teachers and affect such use. From one perspective, the use of reading materials would be shaped by the nature of the text they offer students and the approaches used to develop students' reading, comprehension, and interpretation. From another perspective, materials are shaped by students' ideas and experiences and how they approach and interpret them.

But here we can see teachers' unique position in shaping what goes on in instruction. Teachers' knowledge, experience, and skills affect the interactions of students and materials in ways that neither students nor materials can. That is, because teachers mediate instruction their interpretation of educational materials affects curriculum potential and use, and their understanding of students affects students' opportunities to learn.

As teachers learn new things about content and students, they notice different things about both and are able to use them differently. Change in students, teachers, or materials has the potential to change the relations of teachers, students, and materials, and hence affect instructional capacity. But change in teachers has unique potential, because teachers mediate all relationships within instruction.

As teachers mediate those relationships, they must manage three central problems: coordinating instruction, creating incentives for performance, and learning in practice.

2. Managing coordination of instruction

Effective instruction requires complex coordination: Teachers, students, and material interact in context and over time. Many threats to coordination of these elements exist. Teachers may misinterpret or mispredict their students; the test may align poorly with the textbook. Different teachers working with the same student may provide different guidance, confusing the student. Students move, teachers change assignments, new frameworks emerge, and district leadership is fickle. The potential for fragmentation, disconnection, and discontinuity is high.

Some threats to coordination derive from the fundamental nature of instruction, requiring interactions among teachers, students, and materials, each developed with perspectives and purposes, and not at all necessarily in tune. For instance, a teacher comes to class with an agenda about what she wants students to do and learn – as Ball did in the vignette earlier in this paper. She gets her students to work on a task, but as she discusses it with individual students, she sees that they are thinking about it differently. They raise questions, which bear on their learning the topic she had in mind. What does a teacher do to coordinate between her students' ideas and her agenda? If she stops to take full account of their thinking, she risks losing her agenda and getting off track. If she listens to them, and then proceeds on with her own plans, she may leave them confused. Coordinating between a teacher's goals and students' actual understanding is never easy. Lectures may appear to be a way of managing the problem of coordinating between the agenda for the class and students' unanticipated ideas or questions, for in this mode, teachers can maintain their agenda more reliably. However, maintaining the

agenda may not produce better learning. Later, when students do the homework or take a quiz, the disconnection between what they understood and what the teacher intended can reemerge and become significant.

Some examples are internal to the development of a topic. Take, for example, a teacher teaching second graders to subtract with regrouping (“borrowing”). She uses bundled popsicle sticks, base ten blocks, pictures in the children’s books, the metaphors of “trading,” “bundling,” and “unbundling,” and she helps them record problems in standard written symbolic form. Often teachers use these sequentially, such that one succeeds the other, as students “graduate” to the “real” (symbolic) form. Without substantial effort and attention to connections, however, these different representations may each exist discretely in students’ understanding. The mapping of one on each of the others is critical if students are to develop integrated understanding and skill in mathematics.

Other examples derive from the structures of schooling. One is coordinating learning over time, given the extreme fragmentation of American schooling. Classes are interrupted constantly, special events disrupt the regular academic schedule a remarkable amount of the time, and schooling halts for two days every week and for over three months each summer. Subjects are taught either in 50-minute periods or in fragments across an “integrated” unit; coordinating the development of ideas across time blocks is no small challenge. Still another – perhaps more commonplace in the contemporary policy discourse – is the challenge of “alignment” among the many sources of guidance for instruction: frameworks, district goals and objectives, textbooks, standardized tests, state assessments.

The problem of coordination often is exacerbated when reformers seek to make instruction more intellectually challenging. The variance in curricular guidance increases if extant guidance is not dropped, alignment becomes still fuzzier, and complex ideas may require longer, less interrupted time to develop. Moreover, as students are asked to work with more open-ended problems and tasks, write and talk more, their ideas will be more diverse and less predictable to their teachers. Mediating among students’ different ways of thinking and between theirs and the teacher’s own assumptions and knowledge is still more complex.

Environments can reduce or increase the threats to coordination by the ways in which they buffer or amplify multiple messages about instruction, by the ways in which schooling and school schedules are structured, by the numbers of people who work with students and how much they communicate with one another. The kinds and availability of information about students and the uses to which such information is put can make a difference in the coordination of instruction. For example, when teachers work together to examine student performance data to consider individual and group patterns or anomalies, when they work to calibrate instruction with such information about students, or when teachers’ opportunities to learn are aligned with areas of special focus, their decisions can be more closely coordinated with information about students.

3. Creating incentives for high quality instruction

Incentives for performance are mixed. Since teachers’ success depends on that of their students, there are significant disincentives to make students’ academic work difficult, to push students, and to

probe deeply to see if they have learned. But there are also incentives for students to press teachers to reduce the challenge of the work. If the work is clear and students do not become stuck, and if there is sufficient constraint such that they are shaped to get the work “right,” then both teachers and students will look successful.

Consider that the principal way for teachers to succeed is for their students to succeed.⁹ A major complication, however, is that there are different ways to define success in classrooms, some of which are more complex, difficult and risky to attain, and others of which are easier. Teachers face competing incentives to reduce the complexity of students’ work, on one hand, and to hold a high bar for challenging engagement, on the other. Helping students to get “right answers” and do neat, clear work is a reasonable wish. When such work is valued, it makes students and parents pleased and proud, and creates a sense of accomplishment and confidence. Pressing students to engage in complex, more ambiguous work is often less appealing. There is a greater chance that their work will fall short or be quite varied. Students may fail, feel frustrated, never finish, and not learn. Parents may complain.

The irony is this: Teachers who structure students’ work so that the space for working is constrained can increase the chances that they will get “right answers,” but what they have accomplished is perhaps less major in terms of learning. Teachers who make more complex work for students do aim at more ambitious outcomes, but may be increasing their risks of attaining those with their students.

The problem of incentives is exacerbated by reforms that aim at intellectually complex instruction. As standards for performance are raised, teachers must work to reach these standards with their students in order to be successful, or have a way of explaining why their students were not capable of attaining the goals. The risks are great, and some teachers manage this problem by blaming students for their lack of attainment or pointing the finger at parents, community, and environmental factors.

4. Learning in and from practice

Improvement of instruction depends not only on using knowledge well, managing coordination, and creating incentives for high quality instruction. It depends also on learning, and, in particular, on teachers’ ability to learn in and from practice. Instruction occurs in particulars – particular students interacting with particular teachers over particular ideas in particular circumstances. Despite the significance of the knowledge that we discuss above, no amount of such knowledge can fully prescribe appropriate or wise practice. No matter how well-coordinated are the signals, elements, and environments of instruction, nor how smartly conceived and supported the incentives, high quality instruction depends on teachers who are skillful at learning in and from practice. Teaching requires improvisation, conjecturing, experimenting, and assessing. Teachers must be able to adapt to contexts and develop practice in response to specific events.

⁹ Dan Lortie wrote two decades ago about the “psychic rewards of teaching,” pointing to the dependence that teachers have on their students for their sense of professional achievement. See Lortie, D. (1975). *Schoolteacher: A sociological study*. Chicago: University of Chicago Press.

Learning and teaching about practice in practice does not imply either that teachers must become researchers or that the only way to improve one's teaching is in the context of one's own classroom. Instead, a range of contexts of practice can serve as sites for learning.¹⁰ How, for example, might teachers be helped to develop usable knowledge of content by studying videotapes of classroom lessons, or examining children's ideas or written work? How might working closely with new curriculum materials and experimenting with their use across several classrooms, in collaboration with other teachers, help to develop knowledge of content and of typical ways in which students respond to that content? How might records of practice be studied by teachers, alone or with others, and what sorts of learning are possible through different sorts of study? These and other examples illustrate what might be meant by learning in and from practice and reveal the importance of developing ways to use practice as a medium for more grounded opportunities to learn that facilitate both the development of usable knowledge as well as knowledge about knowledge use itself, in context.

Take, for example, the brief vignette in this paper. Closer study of what Nathan is saying, viewing the tape, and considering what other students had been saying would offer rich opportunities to learn to hear children mathematically. What guesses might we make about what is shaping Nathan's thinking? What evidence is there that he might be thinking intuitively about powers of two? What is there to understand about powers of two and what might one ask Nathan, or his classmates, if one wanted to open this up, beginning with his observation? How might one sensitively table his idea in ways that respect his initiative and yet permit it to be tabled for now? Such professional analysis and inquiry, focused closely on one small episode from one classroom, could be effectively used as a site for teachers to work on a set of important mathematical ideas, to develop skills at hearing and interpreting students, expanding a repertoire of how to respond to students' ideas, and designing strategies for contending with recurrent problems of practice.

Another promising avenue is the deliberate use of textbooks and other curriculum materials as sources for teachers' – not just students' – learning.¹¹ Teachers' guides might be written, read, and used to provide a kind of guidance for instruction that is uniquely possible because of the daily use of curriculum materials. Teachers who study lessons and experiment with the use of new curricula in their classrooms may hear and see their students doing things that they had not realized they could. Curricular materials could function to offer support and guidance as teachers venture into new curricular and pedagogical territory, in ways that prior efforts at "teacher-proof" materials ironically missed.

¹⁰ Our ideas here grow from Ball's collaborations each with Magdalene Lampert and Hyman Bass. In addition to other references cited here, see Lampert, M. & Ball, D. L. (1998). *Mathematics, teaching, and multimedia: Investigations of real practice*. New York: Teachers College Press. Many others are also working on related approaches, including, in mathematics, Deborah Schifter, Nanette Seago and Judy Mumme, Carne Barnett, Margaret Smith, Mary Kay Stein, and Ed Silver.

¹¹ Ball, D. L. & Cohen, D. K. (1996). Reform by the book: what is -- or might be -- the role of curriculum materials in teacher learning and instructional reform? *Educational Researcher*, 25, 6 - 8, 14.

We have much to consider if we were to take seriously the need to develop ways to learn in and from practice. Opportunities for learning that disconnect content from students, knowledge from practice, curriculum from teaching, leave worrisomely to chance the possibility of developing the sort of resources crucial for instruction and its improvement.

Challenges for Improving Instruction

Three conclusions are worth highlighting from this discussion of instruction and central challenges of practice. First, problems inherent in instruction are also problems for its improvement. Using knowledge, having opportunities to learn in and from practice, coordinating among a host of fragmented and disconnected parts, and responding to incentives are all central problems of instruction; they are also challenges with which those who seek to improve instruction must contend. Efforts to improve instruction that do not take these problems into account are likely to misfire, for they leave teachers and others on their own to contend with these central challenges of practice. For example, providing teachers with new knowledge of content or students with new materials, but failing to consider the challenges of using knowledge in practice is less likely to impact what teachers can do. Exciting teachers with new images of instruction but neglecting to consider all the disincentives for such work are similarly likely to fall short.

Second, improvement and support efforts that do not design to work directly on instruction are much more chancy than those that do. It is astonishing to see how often initiatives aimed supposedly at the improvement of instruction focus on everything other than instruction: on recruitment, incentives, restructuring, time. Instruction is a complex set of relations and entails complicated practices. Given its complexity, creating structures for teachers to talk with one another may help them develop crucial resources for the improvement of instruction, but it may not. Whether or not time or structures or resources make a difference for instruction depends on how these are perceived and used. Raising teachers' salaries or recruiting different people into teaching may affect instruction, but there is no special reason why these strategies would, for no automatic link exists between these avenues and the quality of instruction. Without a focus on the very elements and their interactions that constitute instruction it should not be surprising if efforts at improvement fall short. Such strategies create possibilities, but it is in how these are used that makes the difference. No guarantees follow from creating such possibilities, and in fact, evidence suggests that they disappoint more often than succeed.

Third, improving instruction depends on understanding the connections between classrooms and their environments. Designing approaches to improvement that take seriously the ways in which the external environment permeates the minute-to-minute interactions of instruction are more likely to impact instruction than those that ignore the role of environments. This implies that opportunities to learn that leave to chance how teachers can make use of such learning in the contexts of their work are less likely to be helpful than those that situate opportunities for learning in practice and take account of the environments in which practice is itself situated.