Knowledge foundations for teaching reading and spelling

Louisa Moats

Abstract Changes in education policy, the accumulation of research evidence that skilled instruction prevents and ameliorates reading failure, accountability requirements, and a new emphasis on multi-tiered interventions in schools are all causing a growing interest in improving teacher knowledge and skill in reading instruction. Consensus frameworks that explain reading development and individual differences provide an outline for what teachers need to know. The details of that content, however, including the English phonological system, the organization of English orthography, and the language structures that are processed during reading and writing, are challenging for teachers to learn. Recent studies are reviewed that investigate the relationship between teacher knowledge, practice, and student outcomes. The paper argues that teachers must have considerable knowledge of language structure, reading development, and pedagogy to differentiate instruction for diverse learners. Policy mandates for improvement of reading achievement should provide for more effective teacher education, as the knowledge base is not learned casually or easily. Research on how teachers best develop expertise should inform our licensing and professional development programs.

Keywords Teacher education · Teacher preparation · Teacher knowledge · Reading and language

L. Moats (✉)
Sopris West Educational Services, Longmont, CO, USA
e-mail: LouisaM@sopriswest.com

Why teacher preparation for reading instruction is of growing interest to researchers

Recent changes in education policy

Over the past few decades, the efforts of researchers to understand reading development, reading problems, and reading instruction have redirected educational policy in the United States at many levels. The Reading First program of the No Child Left Behind Act of 2001 (PL 107–110, 115 Stat. 1425, 20 U.S.C. § 6301 et seq.) for example, provided funds for the development of quality teachers who can provide direct, explicit, systematic teaching of reading and to primary grade children. The Reading First program extended provisions of the Reading Excellence Act of 1998 (PL 105–277, 112 Stat. 2681–337, 2681–393, 20 U.S.C. § 6661a et seq.). Five essential components of effective reading instruction, explicitly enumerated in the Report of the National Reading Panel (McCardle & Chhabra, 2004; National Institutes of Child Health and Human Development, 2000) have provided the content framework for many advisories, guidelines, and policies adopted by states and are required in programs funded by the federal Reading First legislation. The five essential components of instruction include phoneme awareness; phonics, word study and spelling; reading fluency; vocabulary; and text comprehension (The Partnership for Reading, 2003). While this may be too limited a list for many experts, its inclusion of phoneme awareness and word-level reading skills implies that teachers must know about the structure of language at the sub-lexical level and at the level of semantic organization and discourse structure (Snow, Griffin, & Burns, 2005).

Evidence that instruction matters

Research has also accumulated that documents the obvious: Schooling, in addition to family background and parents' support of education, is a powerful determiner of children's academic growth and life outcomes (Hess, Rotherham, & Walsh, 2004). Policies requiring informed reading instruction are founded on considerable evidence that competent teaching will alleviate or reduce the severity and consequences of reading failure (Blachman et al., 2004; Denton, Foorman, & Mathes, 2003; Foorman et al., 2006; Mathes et al., 2005; Vellutino et al., 1996). This is especially true in high risk populations, including second language learners, children of poverty, and children with dyslexia, who are most dependent on good instruction to overcome their disadvantages. Recent intervention studies that reduce or ameliorate reading failure, however, emphasize the importance of multi-component interventions that require teacher expertise across several content domains, including phonology, phoneme-grapheme correspondence, morphology, semantic organization, syntax, discourse, and pragmatics (Berninger & Richards, 2002; Joshi, 2005; Lovett et al., 2005; Wolf, Miller, & Donnelly, 2002). Furthermore, teachers must be able to organize and implement the instructional activities that lead to improvement in these areas.

   The content knowledge required for effective instruction and intervention (Moats, 2000; Snow et al., 2005) includes knowledge of English orthography and the various ways that it represents spoken language. English is a morphophonemic or "deep"

alphabetic orthography. Its spellings map onto speech sounds quite predictably, although correspondences are complex and variable. For example, "long a" may be spelled with a vowel-consonant-e pattern (raze), an ay at the ends of syllables (ray), an ai in medial position (rain), eig or eigh in a few words of Anglo-Saxon origin (reign), or just plain a in open syllables (rabies). English orthography also represents meaningful parts of words and word origin. The spelling of payment preserves the spelling of the base word, pay, and the noun suffix, ment. Stable, establish, and stability use the same spelling for the Latin root, stab, even though the morpheme is pronounced differently in each word. Explicit and complete explanations of such words require reference to sound, spelling, word origin and meaning. Word-level knowledge such as this, moreover, is only part of what teachers need to know if they are to foster students' insights into words and connected text.

Accountability

Reading First and other federal programs impose financial incentives and punishments for school districts that either meet or fail to meet annual improvement goals. This emphasis on accountability (although unpopular in some quarters) has injected new urgency into discussions of teacher recruitment, preparation, licensing, and professional development. Debates about the conditions necessary for reading improvement, the knowledge and practices associated with the most effective teaching, and the supports necessary for both novice and experienced teachers (Hess et al., 2004; Moats & Foorman, 2003; Snow et al., 2005) are flourishing. Teacher education programs at the University level are under pressure to incorporate more specific and rigorous standards for licensing (Walsh, Glaser, & Dunne-Wilcox, 2006) and to align the content of instruction with scientifically grounded research evidence. Colorado, Maryland, and Massachusetts, among others, have rewritten their guidelines for teacher preparation in reading in the last few years, and California has just rewritten its content standards for its Reading Instruction Competency Assessment (RICA) to keep pace with findings from research on teaching effectiveness. These standards specify that teachers will know the structure of English at many levels necessary for teaching all components of reading effectively.

Emphasis on preventive intervention

Consensus among reading researchers on the effectiveness of prevention and early intervention with reading problems (Fletcher, Lyon, Fuchs & Barnes, 2007; Fuchs, Mock, Morgan, & Young, 2003; Torgesen, 2004) has also affected policy and practice. The reauthorization of federal special education funding rules has allowed states to evaluate at-risk students' *response to intervention* (RtI) as a criterion for classification in the learning disability category of exceptionality (Fuchs & Fuchs, 2006; National Association of State Directors of Special Education (NASDSE), 2006). Districts may direct a portion of their special education funds toward preventive intervention, to reduce dependence on traditional special education solutions. Because prevention begins with and is related to the appropriateness of regular classroom instruction, Reading First and other federal and state initiatives

have promoted a "tiered" approach to the organization of instruction in schools (The University of Texas, 2005).

A three-tiered or multi-tiered approach requires that all teachers, not only reading specialists or special education teachers, understand the best practices of reading instruction and are able to implement programs to best advantage. A tiered approach also requires that: (a) all students are screened periodically, and their screening test results are used for instructional decision-making; (b) a continuum of supplementary interventions will be used, according to student need, before special education services are employed; and (c) the progress of at-risk children will be closely monitored, and changes in approach will be instituted for students according to their response to instruction. Prevention and amelioration of reading problems is viewed as a whole school responsibility, requiring teamwork and consistency of approach. Teamwork and a coordinated approach between classroom teachers and supplementary small group instructors require a knowledge base held in common by all teachers who must collaborate for the benefit of students.

The screening and progress-monitoring measures by which novice readers' response to instruction is evaluated typically measure phoneme awareness, phonic decoding, word recognition and oral reading fluency. Knowledge of the speech sound system and of phoneme-grapheme correspondences, along with the meaning and implications of fluency measures, is essential if teachers are to administer the assessments, interpret student errors, and use assessments for instructional problem-solving (Roehrig, Duggar, Moats, Glover, & Mincey, 2008).

Limitations of published, comprehensive reading instruction programs

One common requirement for state and district funding under Reading First and other grant programs has been the adoption and use of a core, comprehensive reading program that addresses and coordinates all the essential components of instruction. Instructional materials are ample (and expensive) and include scripted teachers' manuals to support the delivery of lessons. California, the largest state with detailed criteria for adopted core, comprehensive reading instruction programs, has driven the major publishers to revise their programs' designs and content to align with the findings of research. Nevertheless, the use of core, comprehensive programs is only one condition that contributes to the success of schools that "beat the odds" (Crawford & Torgesen, 2006; Denton et al., 2003; Edsource, 2003).

The Florida Center for Reading Research (fcrr.org) recently issued a summary of the characteristics of Reading First schools whose results were better than state averages in the 2005–2006 school year (Crawford & Torgesen, 2006). Ten schools whose students' rate of growth exceeded those of schools with similar populations demonstrated these seven common characteristics: strong leadership; positive belief and teacher dedication; data utilization and analysis; effective scheduling; professional development; scientifically based intervention programs; and parent involvement.

The adoption and use of comprehensive teaching programs, then, are not alone sufficient to achieve the goals of Reading First and other reading initiatives. Districts that adopt comprehensive published programs often find that some schools and classrooms do show significant and commendable gains, while others languish at

pre-intervention levels. Large-scale, longitudinal studies of the factors that impact reading achievement in low-performing schools yield significant student, teacher, and school effects, independent of a specific program or approach (Connor, Morrison, & Katch, 2004; Denton et al., 2003; Foorman et al., 2006; Mehta, Foorman, Branum-Martin, & Taylor, 2005; Moats & Foorman, 2008). Furthermore, those effects can be achieved with a variety of instructional programs and materials—some scripted, some less scripted or "responsive" (Mathes et al., 2005)—although effective programs do systematically teach the multiple components described earlier. In Mathes et al. (2005), knowledgeable, well-trained intervention teachers working with a less scripted lesson protocol achieved results that were equivalent to those obtained who worked with a more scripted protocol. In both approaches, teachers addressed all essential skills explicitly, but with varying emphasis and techniques.

Even with well-designed teaching material, more effective teachers adapt to student needs. In an important study by Connor et al. (2004), the matches among content emphasis (e.g., more or less explicit decoding instruction), instructional activities (e.g., more or less student independence), and student characteristics were associated with the pace of student gain in reading. In our large-scale, longitudinal study of low-performing, urban schools (Foorman et al., 2006; Moats & Foorman, 2008), teachers who were more effective than others adapted their instruction, providing more word-level instruction to the poor readers than the better readers even though they were using a core, comprehensive reading program. The implication of these findings is that teachers who can identify student abilities and needs and who then can tailor their instruction to those needs have a better chance of success with a range of student abilities.

Responsive and adaptive teachers decide, often several times per minute, how to correct student errors, how to explain concepts, and what examples to invoke. The structure of a core, comprehensive program may be very helpful for novice teachers and for promotion of cross-classroom consistency, but it cannot replace the analytical thinking of a teacher who understands how and why her students are responding to instruction. An important issue for research, then, is to document what concepts and insights underlie the decision-making capability of an effective teacher of reading.

Consensus findings of research provide frameworks for teacher training

An organizing framework, consistent with current theories of reading psychology, should help in prioritizing the training experiences of preservice and practicing teachers. That framework should respect the findings of consensus documents and research reviews that explicate how children learn to read, why some children fail to become good readers, and what practices are more strongly supported by research than others (e.g., Adams, 1990; McCardle & Chhabra, 2004; National Institutes of Child Health and Human Development, 2000; Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001). The "big ideas" of reading instruction, essential for teacher training, include the importance of efficient letter and word recognition, fast and accurate phoneme-grapheme decoding and encoding, and fluent recognition of syllables and morphemes. In addition, they include the relationships among passage

reading accuracy and fluency, comprehension, and background knowledge (Berninger & Richards, 2002; Cunningham & Stanovich, 1991; Foorman et al., 2006; Mehta et al. 2005; Vellutino, Tunmer, Jaccard, & Chen, 2007). The stages of reading development (Ehri & Snowling, 2004) should be emphasized. Teachers should understand that vocabulary, verbal reasoning ability, and background knowledge will account for an increasing proportion of overall reading achievement as children progress through school (Torgesen, 2005).

Subtypes of reading problems within the population of struggling readers can be conceptualized with reference to extensive validation research (Fletcher et al., 2007). Phonological skills and inaccurate word recognition are often a major roadblock in the development of reading fluency and comprehension (Ehri et al., 2001). These problems, especially when they occur in children with a genetic predisposition toward phonological processing weaknesses (Olson, 2004), are challenging to remediate. Other poor readers have primary difficulty with reading fluency; still others can read words much better than they comprehend (Fletcher et al., 2007). Children with reading difficulties will be found in almost every classroom, but they are not all alike, and again, differentiation of instruction is an effective teacher's constant challenge.

While most poor readers require robust instruction in decoding, teachers must also understand that economically and educationally disadvantaged children may have one-half the oral language vocabulary that is typical of children from middle-class homes with educated parents (Biemiller, 1999; Hart & Risley, 1995) and that vocabulary enrichment is a cornerstone of good teaching. Children with poor vocabularies are also likely to be unfamiliar with the academic or formal English language patterns read in books or required in writing. By the intermediate grades, we found that the majority of the lower SES children in our study sample were poorly prepared for the demands of academic, expository writing (Moats, Foorman, & Taylor, 2006). Sustained and systematic instruction in the word usage, syntax and discourse structure of English is as important for these children as instruction in the expressive aspects of writing.

The multiple components of good instruction, supported by research, imply a rather large menu of concepts, facts, and practices that teachers must know if they are to reach students with diverse needs. The multiple components framework, however, must be substantiated by many details. Those include knowledge of the speech sound system of English; the morphophonemic correspondences in English orthography; and many ways that meanings can be illuminated at the word, sentence, and text levels (Moats, 1999). While the adoption of core, comprehensive instructional programs may be very helpful in structuring teachers' work, the reality of student differences, the variability of student response patterns, and the limitations of the programs themselves require that teachers know as much as possible about the content of instruction and how to get it across.

Beyond the big ideas: details of language and pedagogy

During instruction that addresses all essential components, teachers define, illustrate, and practice many associations and concepts. These include, but are not

limited to, information about phonemes, graphemes, syllables, morphemes, grammar and syntax, and semantic organization at the word, phrase, sentence, and discourse levels. In addition, each concept or association must be practiced—for some children, many times—and applied until it is automatized and useful.

Phonological awareness instruction aims to support children's ability to blend and segment phonemes that are associated with graphemes. Some children must start the process by attending to larger linguistic units and progressing to the smallest, most elusive unit, the individual speech sound. To that end, the teacher must differentiate syllables (e.g., *ac -com- plish*) from onsets and rimes (*pl-ate*) and to count, produce, blend, segment, and manipulate the individual speech sounds in words (*p-l-ā - t*). Phonemes must be distinguished from letter names, so that phoneme-grapheme correspondences can be explicated. For example, *which* and *witch* each have three phonemes and five letters, but the phoneme-grapheme correspondence patterns differ. The graphemes that represent each phoneme in *which* are wh-i-ch, but the graphemes that represent the phonemes in *witch* are w-i-tch. Phoneme-grapheme mapping instruction (e.g., Grace, 2006) requires precise knowledge of both speech sounds and the letters and letter combinations that represent them.

Phonological awareness instruction, moreover, involves more than the manipulation of sub-word units. Accurate identification of and discrimination of confusable phonemes and words (Moats, 2000; Scarborough & Brady, 2002) is important for reading and spelling. If a student confuses *rich* with *ridge*, the teacher can provide explicit feedback regarding the voiceless /ch/ and voiced /j/ -consonants that are otherwise indistinguishable in manner of articulation.

Phonology also plays a role in vocabulary acquisition. Knowing this, a teacher will be sure that students pronounce words accurately, and may break them into syllables or morphemes. If children's attention is directed to subtle differences in word forms such as *consist* and *assist*, *specific* and *Pacific*, and *flight* and *fright* (Stahl & Nagy, 2006), children are less likely to confuse word forms and word meanings. The teacher's articulation and enunciation of phonemes, syllables, and words provides a model for students to internalize.

Phonics and spelling instruction in English requires the teacher to know and explain a multi-layered orthographic system (Moats, 2000; Snow et al., 2005). English orthography represents sounds, syllable patterns, and meaningful word parts (morphemes), as well as the language from which a word originated. Phonic decoding, if properly taught, includes much more than a letter-sound correspondence for each letter of the alphabet. Speech sounds and the alphabet letters do not align perfectly in English. There are more speech sounds than letters (e.g., 15–18 vowel phonemes and six vowel letters) and letters are often used in combination (e.g., ee, ea, e-e, ey, eigh) to spell those sounds. Yet conventions and patterns for using graphemes reflect meaning and word origin as well. The ch combination spells/ch/in words of Anglo-Saxon origin (church), but ch spells/k/ in words of Greek origin (scheme), and spells/sh/in words of French origin (chef). Patterns in English orthography also depend on the position of a sound in a word; final/ ch/right after accented short vowels is spelled -tch. Clear instruction is possible when the teacher can describe why almost any word is spelled the way it is.

Reading and spelling longer words accurately requires the student to parse them by syllable and/or morpheme. Recognition of prefixes, suffixes, roots, and parts of

compounds, and recognition of the morphological structure of words to which inflections have been added, facilitates word recognition, access to word meaning, recall for spelling, and ultimately, comprehension (Perfetti, 2007). Advanced phonics instruction of longer words, to be clear and systematic, includes explicit teaching of these structures.

Vocabulary instruction requires knowledge of more concepts about language and how best to teach them (Graves, 2006; Stahl & Nagy, 2006). The teacher's ability to provide multiple examples of words in context and to elicit verbal production from students is a key to teaching vocabulary, as children's exposure to academic language may occur only in the classroom context. Thorough instruction of word meanings includes explication of a word's structure and pronunciation as well as its grammatical role and relationship with other words in the semantic field. In addition, many aspects of comprehension instruction rest on the teacher's skill in talking about and conveying awareness of word meanings, text organization, genre, inter- and intra-sentence references, figurative and idiomatic language, and the complex sentence structure found in academic discourse. Knowledge of language content, moreover, must be complemented by knowledge of many pedagogical activities and lesson formats appropriate for engaging students in reading and writing.

While delivering instruction in all the necessary instructional components, as well as writing and oral language use, the interdependence of these components should be recognized (Vellutino et al., 2007). For example, students who make gains in phonological skills are more likely to improve in vocabulary (Baddeley, Gathercole, & Papagno, 1998; Hogan, Catts, & Little, 2005), and students who use phonic word attack proficiently are more likely to spell and write well (Berninger & Richards, 2002; Hooper, Swartz, Wakely, deKruif, & Montgomery, 2002). Teachers who realize these interdependencies may be more likely to tie instructional components to one another.

We can expect that teachers of reading, spelling, and writing should be versed in both the big ideas and the content and pedagogical detail outlined above. A series of questions, however, that bear on the priorities, design, and application of teacher education remain: What do teachers typically understand about reading development, language, reading instruction, and individual differences? What level of understanding is required for novice teachers and for experts? What do teachers understand about the reasons behind current program standards, assessment practices, and instruction? What are the relationships between knowledge, practice, and student outcomes? How much and what kind of learning will promote sufficient understanding of essential pedagogical content and practices?

A small but growing body of work is providing valuable insight into novice and experienced teachers' disciplinary knowledge in reading and writing instruction.

Studies of teachers' subject matter and pedagogical knowledge

Almost 15 years ago, as an untenured graduate faculty member, I petitioned my institution to require a "Foundations of Language and Literacy" course for all teachers (a battle that was eventually won). In this course, I examined 52 graduate

students' responses to a survey of knowledge of spoken and written language structures deemed relevant for teaching reading (Moats, 1994). All graduate students were licensed, practicing teachers with between 2 and 20 years of teaching experience, and all had selected this course as an elective. On a pretest, teachers had significant difficulty on items that asked them to identify words with consonant blends, consonant digraphs, inflectional and derivational morphemes, and position-based spelling patterns such as the use of the spelling—ck. Levels of knowledge were not related to whether the teachers were in special or regular education roles, or how many years they had taught. The article that was motivated by this survey argued for better instruction for all teachers in the "missing foundation" for teaching reading. Surprisingly, the argument resonated with a large teacher union, the American Federation of Teachers, who elected to republish the article in *American Educator* (Moats, 1995).

Soon thereafter, additional descriptive studies emerged in the research literature on the declarative knowledge and beliefs held by teachers with varying backgrounds and degrees of experience (Bos, Mather, Narr, & Babur, 1999; Bos, Mather, Dickson, Podhajski, & Chard, 2001; Mather, Bos, & Babur, 2001). Others explored the relationships among teachers' knowledge of language, cultural literacy, beliefs, ability to instruct, and student outcomes (Foorman & Moats, 2004; McCutchen, Abbott, et al., 2002; McCutchen, Harry et al., 2002; O'Connor, 1999). Bos et al. (2001) compared the responses of preservice educators (teachers in training) to those of inservice educators (experienced teachers) on a self-report form and knowledge survey. The experienced teachers were more positive about the need for explicit reading instruction; the inexperienced were more sold on implicit strategies favored by whole language proponents. The experienced teachers knew somewhat more about language structure at the levels of phonology and orthography; the inexperienced knew less even though they were involved in a licensing preparation program. All teachers showed a very weak grasp of phonological concepts and phonics. As in the earlier Moats study, problem areas for teachers included awareness of consonant blends, digraphs, and syllable structures. It is not surprising that in Hill's (2000) interviews with teacher candidates in four major universities, experienced and inexperienced teachers alike felt only somewhat prepared to teach struggling readers.

McCutchen, Abbott, et al. (2002) focused on measurement of kindergarten and 1st grade teachers' knowledge and the relationship of growth in that knowledge base to student outcomes. Teachers' ($n = 44$) initial knowledge of terminology and concepts in early reading instruction was very low in comparison to what the researchers expected. However, researchers also demonstrated that their experimental teachers' ($n = 24$) understanding of phonology and early reading could be significantly improved in a 2-week summer institute. Devoting considerable time to explicating the difference between the English spelling system and the speech sound system, McCutchen and her colleagues emphasized phoneme counting, phoneme-grapheme matching, identification of syllable spelling conventions, awareness of regularities and irregularities in English orthography, differentiation of syllables and morphemes, and the ability to plan beginning reading lessons. A core, organizing principle for teachers' instruction was the continuum of phonological awareness

development: compounds, syllables, onset-rime units, and then phonemes. Teachers studied the relationship between reading and writing as they examined young children's spelling attempts and learned techniques for teaching phoneme awareness, letter formation, handwriting fluency, spelling, vocabulary, and sound blending during decoding. Researchers did not attempt to control or account for teachers' choice of instructional materials; rather, the 24 participating teachers used varying tools in their K-1 classrooms.

After 1 year of monthly follow-up meetings, the experimental teachers' K and 1st grade classes obtained significantly better results than comparison students on almost all outcome measures. The amount of time teachers spent on explicit teaching of phonological skills predicted how much growth students showed in phoneme awareness. With their new knowledge and a perspective on reading development, kindergarten teachers spent more time on explicit teaching of phoneme awareness and letter formation than the control group teachers; 1st grade teachers spent more time on explicit teaching of reading comprehension strategies as children learned to decode. The study concluded that teachers can deepen their knowledge of phonology and orthography in a 2-week institute, with periodic follow-up, and the knowledge that teachers gain affects their behavior in the classroom. Kindergarten and first grade students' achievement on most key variables can improve significantly as a consequence.

Another study by McCutchen's group (McCutchen, Harry et al., 2002) investigated the ways in which 59 kindergarten, first, and second grade teachers' knowledge of children's literature and their knowledge of English phonology corresponded to each other and to philosophical orientation, classroom practice, and student learning. Teachers' philosophical beliefs about reading instruction bore little relation to their practices. Teachers' classroom practices in early reading instruction, however, were influenced by their phonological and phonics knowledge, which in turn predicted student outcomes in end-of-year word recognition abilities at the kindergarten level. The predictive relationship between teacher knowledge and student reading outcomes in 1st and 2nd grade did not hold, however.

Cunningham, Perry, Stanovich, & Stanovich (2004) documented in a large-scale study that teachers' self-evaluations of their own knowledge of language structure are not very reliable. Teachers who knew less about phonics actually knew more than teachers who thought they were strong in the subject matter. The study indicated that teachers often do not know what is missing from their disciplinary knowledge base, especially in the areas of phonology and phonics.

Spear-Swerling and Brucker (2003, 2004) have investigated the relationship between novice teachers' word structure knowledge and the progress of second grade children they were tutoring. Teachers' post-test knowledge of phoneme-grapheme correspondences, following a reading methods class and supervised tutoring experience, and their ability to distinguish regular from irregular spelling patterns in English, were associated with the tutored children's progress in word reading. The authors also reported relatively low levels of knowledge in incoming teacher candidates on pretests of word structure knowledge, and commented that even 6 h of course instruction were not sufficient to bring all teacher candidates up to the ceiling of the test.

Moats and Foorman ([2003](#)), in a large-scale, longitudinal study of reading instruction in high poverty schools serving minority students, investigated the relationship between teachers' knowledge and student achievement in 3rd and 4th grade classrooms. Regression analyses were conducted at the end of year four of the study to illuminate the relationships between teacher knowledge of language and reading, overall instructional competence, site, and reading achievement. Analyses revealed a small but significant relationship between overall teacher competence, as measured by a standardized observation checklist, and 3rd and 4th grade students' end-of-year achievement on the Basic and Broad Reading scales of the WJR-Revised. Teachers rated as more effective in their classroom teaching techniques had students with higher reading outcomes. Scores on the Teacher Knowledge Survey were also related to Broad Reading achievement across both sites. Teacher knowledge scores predicted end-of-year Basic Reading skill in only one site of the two sites involved in the study. The lack of statistical prediction in the second site was attributable to the restricted range of scores, resulting from teachers scoring close to the ceiling of the test. Those teachers had had more direct coursework in language concepts and explicit teaching strategies than teachers at the first site.

Teachers who attended professional development courses regularly scored higher on the knowledge survey than those with low or no attendance. In other words, high attendance at course sessions produced the ceiling effect discussed above. However, participation in professional development courses was not related to overall competence ratings on the teacher observation scale, as some capable teachers did not attend professional development, and some of the less able teachers did. Overall, attendance at professional development courses focused on phonology and reading research, phonics and spelling, vocabulary and comprehension, and teaching writing, produced measurable effects on teachers' content and disciplinary knowledge that in turn were related to students' overall reading achievement. Experienced teachers at all primary grade levels were able to acquire reading content knowledge in summer institute and after-school courses, and those who learned more tended to produce children with higher reading achievement.

Taken together, these studies also converge in documenting the concepts that are particularly difficult for teachers in training to master. Elusive concepts, requiring more practice time and modeling in classroom application, include: (a) the differentiation of speech sounds from letters; (b) the ability to detect the identity of phonemes in words, especially when the spelling of those sounds is not transparent; (c) knowledge of the letter combinations (graphemes) that represent many phonemes; (d) conceptualization of functional spelling units such as digraphs, blends, and silent-letter spellings; (e) the conventions of syllable division and syllable spelling, and how they differ from morphological divisions; (f) the linguistic constituents of a sentence; (g) the recognition of children's difficulties with phonological, orthographic, morphological and syntactic learning in work samples; and (h) understanding of the ways in which the components of reading instruction are related to one another at any point in reading development.

Important implications emerged from the studies conducted prior to 2006. First, teachers' knowledge of phonology, orthography, and other aspects of language is often underdeveloped for the purpose of explicit, clear, systematic teaching of basic

reading and writing skills. These areas of disciplinary knowledge are not acquired just from teaching experience or from being literate. They embody content that is neither easy nor obvious. Many aspiring teachers need more practice than most courses provide in order to master the information. Second, teachers' knowledge of language can be measured directly but is not closely associated with philosophical beliefs, with their own self-evaluations, or with their knowledge of children's literature. Third, what teachers know has (so far at least) been shown to have a somewhat tenuous correspondence to their actual practices and with student outcomes.

Relationships between foundational knowledge and teaching behavior

Critics of these studies might argue that knowledge of the kind described in this paper and in Snow et al. (2005) is not really necessary to teach most students to read. Some students learn with a minimal amount of such instruction or in spite of incomplete instructional programs. That argument loses power, however, in the face of the evidence that explicit teaching improves the outcomes of students who do not catch on easily to the alphabetic code, or who lack the vocabulary and language proficiency to comprehend. More credibly, critics could point to the weak association between teachers' content knowledge, observed pedagogical practices, and student outcomes to argue that depth of knowledge is an academic luxury, not a necessity for professional licensing.

Weak statistical findings connecting teacher knowledge to teaching practices and student reading outcomes may be more symptomatic of inadequate research methodologies than they are indicators of irrelevance. One issue to be addressed in research, for example, is that of knowledge and practice thresholds sufficient for regular classroom teachers and for specialists. How much familiarity with big ideas and content detail is necessary for an effective classroom teacher, and how much more advanced is the reading specialist's skill? These are difficult questions to address because in order to document how content and pedagogical knowledge interact with results, we must be able to identify the teacher's goals, estimate the teacher's level of knowledge and skill, isolate the effect of teaching on student outcomes, and document how the teacher is implementing instruction.

In addition, the impact of a teacher's disciplinary knowledge on student learning may be diffuse, indirect, and cumulative over relatively long periods of time. An oft-stated goal of vocabulary instruction, for example, is to foster students' "word-consciousness" or ability and motivation to explore language independently (Graves 2006; Stahl & Nagy, 2006). Teachers who shed light on the details of language at all levels (sounds, letters, syllables, morphemes, grammar and subtleties of meaning) are fostering word consciousness or linguistic awareness that may generalize into many aspects of literacy learning over time. Appreciation of the structure, meaning, and origin of words, for example, contributes to better spelling, vocabulary, and word choice in verbal expression.

If effective teaching simply demanded the faithful implementation of a core, comprehensive reading program, we could, perhaps, be less concerned about

whether teachers understand why the practices are necessary or how to adapt their instruction. But early identification of reading problems, preventive intervention, and progress monitoring are now commonly expected in schools. At the first "tier" of instruction, the regular classroom teacher should be enabling 75–80% of the children to read at a benchmark level by the end of 1st grade. This is accomplished with a good match between the students' proficiency levels and the kind of instruction that is delivered: code oriented or meaning-focused; teacher-directed or student-directed (Connor et al., 2004). Those students who are not learning well are put into small groups (Tier 2) and their progress in areas of weakness is accelerated. About 5–10% of the population requires intensive, individualized, and (often) special education services at the Tier 3 level. To implement this approach, teachers must know how to interpret data from validated screening and progress-monitoring instruments (Roehrig et al., 2008). But even when teachers are engaged in the practices of screening and progress-monitoring assessment, grouping children for instruction, and implementing core and supplementary programs, their underlying knowledge base may be insufficient to maximize the benefits of these practices.

Our research team recently administered a newly designed Teacher Knowledge Survey (TKS) to 139 primary grade teachers in two districts in Utah and Florida who were participating in a study of professional development (Roehrig et al., 2008). In the participating schools, DIBELS assessment (Good & Kaminski, 2005) had been mandatory for at least 1 year, and teachers were expected to group children and tailor instruction according to the screening test results. On the TKS, teachers demonstrated surprising misconceptions and gaps in understanding foundation concepts that should have enabled their management and delivery of instruction.

Selected items from the Teacher Knowledge Survey (TKS) and average pass rates for each item are included in the Appendix. Of note, beyond some typical inaccuracies in teachers' analysis of spoken and written language, was the misunderstanding of the very principle on which early screening assessment is based. Teachers were asked if this statement were true or false: "Screening at the end of kindergarten can be efficient, reliable, and valid for predicting a child's silent passage reading comprehension at the end of 3rd grade." Only 39 percent of respondents understood that that statement was true. Nevertheless, every participating teacher was expected to use DIBELS results to group children and plan instruction. Clearly, the policy mandate was not sufficient to enable practicing teachers to understand why prediction was possible or the import of the data generated from screening.

Other results from this TKS reinforce and extend findings that have been reported in previous studies. About one-third of the teachers could identify the phoneme-grapheme correspondences in "straight" and about one-half could match phonemes and graphemes in "lodged." The greatest knowledge gaps occurred on all questions having to do with knowledge of morphology. When asked which word has an adjective suffix: *natural*, *apartment*, *city*, *encircle*, or *emptiness*, 7% of respondents correctly identified "natural." One can only assume that, as a group, they had had little to no training in these concepts, which are necessary for advanced word attack, spelling, and vocabulary instruction.

Some reflections on the process of educating teachers

Testimonials and opinions are hardly scientific evidence for the effectiveness of any given approach to instruction, whether we are focused on novice readers or career teachers. But my colleagues and I now have more than 20 years of experience working with teachers in graduate programs and in professional development and continuing education classes. By the teachers' own reports, consistent with Walsh et al. (2006), their licensing programs often bypassed the research literature on the components of effective instruction. Teachers, by self-report, rarely have had sufficient coursework in the structure of English at the phonological, orthographic, morphological, or syntactic levels to inform their instruction. They are also unfamiliar with the procedures of systematic instruction of basic reading skill.

In our program, we have learned to make no assumptions about teachers' prior knowledge even when experienced teachers are in a group. We prefer to teach teachers about language structure prior to emphasizing instructional methodology. To connect content with practice, we engage teachers in multiple practice exercises, team collaborations, video modeling, continual review of content, and application to the classroom. Even so, transfer of knowledge into action is more likely when classroom coaching and follow-up sessions occur at least monthly, and preferably for at least a year McCutchen, Abbott, et al. (2002; Moats, 2007).

To sensitize teachers to the challenge of learning to read, we ask them to learn to read in a novel symbol system. We devote considerable time to exploring the speech sound system of English, with an emphasis on understanding, anticipating, and responding to students' phonological confusions. Mapping phoneme-grapheme correspondences, using letter tiles and "sound boxes," is featured during instruction in orthography. Once teachers are armed with insight about speech and print, they are asked to interpret students' reading, spelling, and writing. For example, if a student leaves the "m" out of "jump", the teacher might ask the student to hold his nose to perceive the nasal segment. If the student spells "progect" for "project," the teacher can infer that instruction in the Latin root, "ject," is necessary. If the student confuses the meanings of similar sounding words, the teacher knows to slow pronunciation, contrast the words, and provide many examples of their use in context.

The error patterns in children's writing provide concrete guidance for instruction. Inflectional morphemes (-ed, -s, -ing), for example, accounted for a large proportion of transcription mistakes in students' writing at the 4th grade level (Moats et al., 2006). To address this common problem, teachers learn how to demystify the relationship between the endings' meanings, sounds, and spellings. If teachers know that the last sound in *dogs* is /z/, not /s/, they will confirm what students may already have discerned: that the plural has several sounds. Likewise, if they know that /t/ ends the spoken word "walked" and /d/ ends the word "hummed" they will be ready to explicate this difficult concept.

More advanced concepts about language that are relevant to both assessment and instruction include etymological features of words; the relationship between a derivational suffix and the part of speech of a word to which it is added; basic grammatical terms and role of a word in a sentence; and the organizing features of expository discourse. For example, to help teachers teach the location of a main idea

or how to write a summary, we first teach them the logical organizations of several kinds of paragraphs. We emphasize that graphic organizers must be selected and matched to the type of text the students are reading. Principles of vocabulary instruction, fluency development, and comprehension strategy instruction supported by research are also taught at some length. Of course, all this takes time and cannot be accomplished in a few hours of cursory overviews.

Teachers in a variety of settings, including high poverty schools (Foorman & Moats, 2004), are almost always enthusiastic about learning this content and applying it. Nevertheless, we cannot yet verify that those who know are those who do. In a current study we are just completing, teachers with high scores on knowledge assessments did not necessarily apply known concepts during reading and language lessons and were sometimes observed using contradictory philosophies and approaches in the same lesson. Knowledge apparently does not have a direct, linear, or predictable relationship with practitioner behavior.

Some concluding comments

What is the disciplinary knowledge base for teaching people to read? What thresholds of knowledge are necessary for a novice, and what levels of knowledge distinguish an expert? What special skills are demanded for those who teach students with reading disabilities? How is this knowledge best taught in preservice and inservice or continuing education? The answers to such questions are important as we seek to capitalize on the valuable findings of reading research. To this date, however, evidence regarding the best ways to teach teachers of reading is much less robust than the evidence base for teaching reading itself. Policy mandates for the improvement of reading instruction should be coupled with greater efforts to improve teachers' knowledge and skill.

Differentiated instruction depends on the teacher's insight into what causes variation in students' reading achievement. Further, it depends on the teacher's ability to explain concepts explicitly, to choose examples wisely, and to give targeted feedback when errors occur—or to be smarter than the core, comprehensive program. Knowledge of language structure, language and reading development, and the practices most supported by research are among the assets of flexible, responsive teachers. The better our field understands and documents what is necessary to promote these insights and understandings in teachers, the better we will be at designing courses, evaluation tools, and training regimens.

Teachers should no longer be taught that students' reading outcomes depend more on gender, IQ, socioeconomic status, handedness, or learning style, than instruction. Teachers should no longer be taught that teaching is an exercise in personal philosophy and that learning to read is a natural, organic process (Walsh et al., 2006). Classroom experience, use of structured reading programs, use of screening tests, and accountability pressures are valuable but not sufficient to build expertise in reading and writing instruction. State and federal policies that support multi-tiered instruction and preventive intervention depend first and foremost on capable, educated teachers. The growing body of evidence on exactly what this

means, including the papers in this journal, is a heartening development that deserves continuing research support.

Appendix

Teacher knowledge survey

Percentage of 139 licensed, practicing primary grade teachers who earned correct scores on the item is in parentheses to the right. Correct responses are italicized.

Items 1–5: How many spoken syllables are in each word?

1.	nationality	1	2	3	4	*5*	(95%)
2.	enabling	1	2	*3*	4	5	(95%)
3.	incredible	1	2	3	*4*	5	(95%)
4.	shirt	*1*	2	3	4	5	(87%)
5.	cleaned	*1*	2	3	4	5	(69%)

6. A syllable is: (50%)

    a.   the same as a rime
    b.   *a unit of speech organized around a vowel sound*
    c.   a sequence of letters that includes one or more vowel letters
    d.   equivalent to a morpheme

Items 7–12: How many phonemes or distinct speech sounds are in each word?

7.	straight	1	2	3	4	*5*	6	7	(33%)
8.	explain	1	2	3	4	5	6	7	(1%)
9.	lodged	1	2	3	*4*	5	6	7	(45%)
10.	know	1	2	3	4	5	6	7	(68%)
11.	racing	1	2	3	4	*5*	6	7	(13%)
12.	eighth	1	*2*	3	4	5	6	7	(75%)

13. Which of the following words has a prefix? Pick one. (9%)

    a.   missile
    b.   distance
    c.   *commit*
    d.   interest
    e.   furnish

14. Which of the following words has an adjective suffix? Pick one. (7%)

    a.   *natural*
    b.   apartment

    c.   city

    d.   encircle

    e.   emptiness

15. Which word has a schwa (/ə/)? (55%)

    a.   eagerly

    b.   prevent

    c.   *definition*

    d.   formulate

    e.   story

16. If a student spells the word "electricity" as "elektrisuty" which of the following is most likely true? (47%)

    a.   The student does not know sound-symbol correspondence.

    b.   The student has a poor ear for the sounds in our language.

    c.   *The student does not know the base word and suffix from which the word "electricity" was constructed.*

    d.   The student has a poor visual memory.

    e.   All of the above.

17. The /k/ sounds in lake and lack are spelled differently. Why is lack spelled with ck? (52%)

    a.   The /k/ sound ends the word.

    b.   The word is a verb.

    c.   *ck is used immediately after a short vowel.*

    d.   <u>c</u> and <u>k</u> produce the same sound.

    e.   There is no principle or rule to explain this.

18. Why is there a double <u>n</u> in *stunning*? (50%)

    a.   *Because the word ends in a single consonant preceded by a single vowel, and the ending begins with a vowel.*

    b.   Because the final consonant is always doubled when adding <u>-ing</u>.

    c.   Because the letter <u>u</u> has many different pronunciations.

    d.   Because the consonant <u>n</u> is not well articulated and needs to be strengthened.

    e.   There is no principle or rule to explain this.

19. A student writes: "I have <u>finely</u> finished my math project." Her misspelling of the word <u>finally</u> most likely indicates that she: (42%)

    a.   is not attentive to the sounds in the word.

    b.   does not know basic letter-sound relations.

    c.   *has not matched spelling to the meaningful parts (morphemes) of the word.*

    d.   has a limited vocabulary.

    e.   has a limited knowledge of sight words.

20. Which of the following is a feature of English spelling? (10%)

    a. A silent <u>e</u> at the end of a word always makes the vowel long.
    b. *Words never end in the letters "j" and "v."*
    c. When two vowels go walking, the first one does the talking.
    d. A closed syllable must begin with a consonant.
    e. All of the above.

Part 2—True or False

21. Students must be able to orally segment and blend the phonemes in complex syllables before they can benefit from instruction in letter-sound correspondence. (F) (72%)
22. If a student is "glued to print", reading slowly word-by-word, the student should be told to read faster and to stop spending so much effort to decode. (F) (80%)
23. Screening at the end of kindergarten can be efficient, reliable, and valid for predicting a child's silent passage reading comprehension at the end of 3rd grade. (T) (39%)
24. The best remedy for a weakness in nonsense word reading is lots of practice reading nonsense words. (F) (65%)
25. Timed letter naming on DIBELS is a good risk-indicator for later reading comprehension. (T) (64%)
26. Phonological awareness exercises should always include letters or print. (F) (57%)
27. A closed syllable always begins with a consonant. (F) (36%)

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