JUST THE FACTS... Information provided by The International DYSLEXIA Association®

Effective Reading Instruction for Students with Dyslexia

The most difficult problem for students with dyslexia is learning to read. Unfortunately, popularly employed reading approaches, such as Guided Reading or Balanced Literacy, are not effective for struggling readers. These approaches are especially ineffective for students with dyslexia because they do not focus on the decoding skills these students need to succeed in reading.

What does work is *Structured Literacy*, which prepares students to decode words in an explicit and systematic manner. This approach not only helps students with dyslexia, but there is substantial evidence that it is more effective for *all* readers.

Structured literacy instruction is marked by several elements.

Phonology. Phonology is the study of sound structure of spoken words and is a critical element of *Structured Language* instruction. Phonological awareness includes rhyming, counting words in spoken sentence, and clapping syllables in spoken words. An important aspect of phonological awareness is phonemic awareness or the ability to segment words into their component sounds, which are called phonemes. A phoneme is the smallest unit of sound in a given language that can be recognized as being distinct from other sounds in the language. For example, the word *cap* has three phonemes (/k/, /ă/, /p/), and the word *clasp* has five phonemes (/k/, /l/, /ă/, /s/, /p/).

Sound-Symbol Association. Once students have developed the awareness of phonemes of spoken language, they must learn how to map the phonemes to symbols or printed letters. Sound-symbol association must be taught and mastered in two directions: visual to auditory (reading) and auditory to visual (spelling). Additionally, students must master the blending of sounds and letters into words as well as the segmenting of whole words into the individual sounds. The instruction of sound-symbol associations is often referred to as phonics. Although phonics is a component of *Structured Literacy*, it is embedded within a rich and deep language context.

Syllable Instruction. A syllable is a unit of oral or written language with one vowel sound. Instruction includes teaching of the six basic syllable types in the English language: closed, vowel-consonant-*e*, open, consonant-*le*, *r*-controlled, and vowel pair. Knowledge of syllable types is an important organizing idea. By knowing the syllable type, the reader can better determine the sound of the vowel in the syllable. Syllable division rules heighten the reader's awareness of where a long, unfamiliar word may be divided for great accuracy in reading the word.

Morphology. A morpheme is the smallest unit of meaning in the language. The Structured Literacy curriculum includes the study of base words, roots, prefixes, and suffixes. The word instructor, for example, is contains the root *struct*, which means *to build*, the prefix *in*, which means *in* or *into*, and the suffix *or*, which means *one who*. An instructor is one who builds knowledge in his or her students.

Syntax. Syntax is the set of principles that dictate the sequence and function of words in a sentence in order to convey meaning. This includes grammar, sentence variation, and the mechanics of language.

Semantics. Semantics is that aspect of language concerned with meaning. The curriculum (from the beginning) must include instruction in the comprehension of written language.

Structured Literacy is distinctive in the principles that guide how critical elements are taught.

Systematic and Cumulative. *Structured Literacy* instruction is systematic and cumulative. Systematic means that the organization of material follows the logical order of the language. The sequence must begin with the easiest and most basic concepts and elements and progress methodically to more difficult concepts and elements. Cumulative means each step must be based on concepts previously learned.

Explicit Instruction. *Structured Literacy* instruction requires the deliberate teaching of all concepts with continuous student-teacher interaction. It is not assumed that students will naturally deduce these concepts on their own.

Diagnostic Teaching. The teacher must be adept at individualized instruction. That is instruction that meets a student's needs. The instruction is based on careful and continuous assessment, both informally (for example, observation) and formally (for example, with standardized measures. The content presented must be mastered to the degree of automaticity. Automaticity is critical to freeing all the student's attention and cognitive resources for comprehension and expression.

The International Dyslexia Association · 40 York Road · Fourth Floor · Baltimore · MD · 21204
Tel: 410-296-0232 · Fax: 410-321-5069 · E-mail: info@interdys.org · Website: http://www.eida.org

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Opinion

iMedPub Journals
http://www.imedpub.com

Journal of Childhood & Developmental Disorders
ISSN 2472-1786

2016
Vol. 2 No. 3: 26

DOI: 10.4172/2472-1786.100034

The Dyslexia Dilemma: A History of Ignorance, Complacency and Resistance in Colleges of Education

David P Hurford[1], Jeremy D Hurford[2], Kimberly L Head[3], Michelle M Keiper[4], Samantha P Nitcher[1] and Lauren P Renner[1]

1 Pittsburg State University, Pittsburg, Kansas, USA
2 Northeastern State University, Oklahoma, USA
3 The Dyslexia Project, Oklahoma, USA
4 Decoding Dyslexia, Oklahoma, USA

Corresponding author:
David P Hurford

dphurford@pittstate.edu

Pittsburg State University, Center for Reading, 1701 S. Broadway, Pittsburg, Kansas 66762, USA.

Tel: 620-235-4534
Fax: 620-235-6102

Citation: Hurford DP, Hurford JD, Head KL, et al. The Dyslexia Dilemma: A History of Ignorance, Complacency and Resistance in Colleges of Education. J Child Dev Disord. 2016, 2:3.

Abstract

Dyslexia is the most common and widely studied learning disability affecting nearly 20% of the children in the United States. Although the Science of Reading provides considerable information with regard to the nature of dyslexia, its evaluation and remediation, there is a history of ignorance, complacency and resistance in colleges of education with regard to disseminating this critical information to pre-service teachers. Information concerning weaknesses in the training of doctoral-level faculty which trickles down to graduate students in education and pre-services teachers is discussed along with potential solutions. Children with dyslexia and reading difficulties are waiting to be taught to read and the knowledge and skills necessary to do so exist. It is essential that the Science of Reading become part of the vocabulary, knowledge base and training within colleges of education.

Keywords: Dyslexia; Education; Teacher Training; Reading Difficulties

Received: May 17, 2016; **Accepted:** August 10, 2016; **Published:** August 16, 2016

Introduction

Reading acquisition is one of the most complicated and important skills in which humans engage. In our culture, the social and economic success that a person enjoys is very much related to his or her reading skills. There is hardly a career or job that does not depend on some level of reading proficiency. This was not always the case. An examination of the past 150 years indicates that the number of skilled labor jobs [1-3] and the number of family-owned farms has declined [4], and the need for a high school diploma has increased [5,6]. In the past, individuals who had difficulties learning to read could find gainful employment that did not require a high school education or the ability to read. This is simply not the case in contemporary society. As a result, all children need to learn how to read and they need to have adequate reading skills as adults, beyond simply reading for pleasure. Poor reading skills can act as a barrier for social engagement and influence [7]. As a result, the development and maintaining of adequate reading skills are of paramount importance.

Unfortunately, for the nearly 20% of individuals in the United States who have dyslexia, reading acquisition is painfully difficult [8,9]. Dyslexia is the most widely studied and common learning difference. In addition to the various academic problems associated with dyslexia and poor reading skills, individuals with dyslexia also suffer poor self-esteem [10], can become depressed, suicidal, and experience post-traumatic stress [11,12] are more likely to abuse substances, be victims of parental physical abuse [13], drop out of school [14], be adjudicated as juveniles [15] and later as adults [14] and are more likely to live in poverty [14]. Dyslexia and reading difficulties are not only a very serious academic issue, but are also very serious social issues. Fortunately, reading scientists have discovered the nature of the fundamental systems involved in reading failure. The term the Science of Reading refers to the corpus of knowledge that includes what science has determined to be relevant to reading, reading acquisition, assessment of poor reading and the interventions available for poor readers. The Science of Reading involves precisely what science has discovered to be relevant not only to reading, its subskills and reading acquisition, but how to

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modify experiences such that struggling readers and individuals with dyslexia can become competent readers. This knowledge includes phonology, phonics, orthography, fluency, vocabulary, comprehension, neuro-processing as it relates to reading and its genetic basis, visual, perceptual and memorial processing, the various writing systems, the alphabetic principle, letter-sound correspondences, among other areas.

Insuring that pre-service teachers are competent in applying their knowledge of the Science of Reading is critical in reducing reading failure and poor performance in reading [16]. The scientific evidence contained within the Science of Reading has guided the creation of interventions that are successful in assisting individuals with dyslexia and reading difficulties to become competent readers. Given the potentially disastrous negative effects of dyslexia and the likely loss of contribution that an individual with dyslexia can make toward society due to the barriers inherent in the current educational system; utilizing strategies to assist individuals with dyslexia to become competent readers, and thus, able to make a contribution to themselves, their families, communities and society is critically important.

Dyslexia is characterized by difficulties with accurate and/or fluent words recognition. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge" (International Dyslexia Association). Specifically, although the exact mechanisms are not completely elucidated, dyslexia involves a great difficulty in manipulating the sounds of language, difficulties in assigning the sounds associated with their representative letters and decoding letters into the sounds that they represent. These difficulties pose barriers to fluent reading which then causes comprehension to be lacking or absent, spelling and writing difficulties, and a host of other related problems.

Speech Acquisition and Learning to Read

The ability to learn to speak is natural and relatively effortless for nearly all infants and toddlers. For most infants, simply exposing them to a language guarantees that they will learn the language. Regardless of nationality, infants are natural language learners and are generally born with the ability to utter all of the sounds that humans are capable of producing [17-21]. After some time in a particular language environment, the infant will stop producing some sounds in favor of those that he or she is consistently hearing. The infants and young toddler's vocabulary also increases in leaps and bounds. For the most part, this process is seemingly so automatic and effortless that Noam Chomsky theorized that infants are born with a Language Acquisition Device [22,23]. The LAD is a theoretic neurological device whose primary purpose is to help the individual to acquire language with relative ease. The only requirement is that children must be exposed to language on a frequent and consistent basis. Their neurological systems recognize the patterns and conventions of the language and the child appears to "learn" the language rather effortlessly. Although individuals may be born with LADs that help them to acquire spoken language skills, it seems to have a limited life. The LAD seems to be present at birth and remains intact until the individual acquires his or her spoken language. After early childhood, the ability to easily and effortlessly acquire languages is diminished. This reality is experienced by anyone who attempts to learn a second language after middle childhood. At this point, learning an additional language becomes quite effortful.

Learning to read, on the other hand, is not a natural process and is a task in which children must exert tremendous cognitive effort [24,25]. Providing young children exposure to text does not result in spontaneous reading. Children must map the sounds for which they are already familiar to the letters used to represent them. They must learn how to use the knowledge of these relationships to decode words, synthesize individual sounds into words, and then recognize the word as a word that they have in their vocabulary. Lastly, and most importantly, the child must be able to comprehend the written material. Comprehension is the goal of the reading process, but is typically dependent on all of the preceding skills any of which could cause difficulties for comprehending text. As already noted above, many of our nation's children have grave difficulty learning to read. Learning to read is certainly an effortful act that can be delayed if children do not have the prerequisite skills to become adequate readers [26,27].

Speech evolved as a mechanism for humans to communicate and is a neurologically expected event [28]. An examination of an infant's development includes the progress made in relation to learning to speak. Reading, on the other hand, is an invention of humans that took advantage of neurological systems that evolved for purposes other than reading [29]. The spoken word is transcribed into symbols that represent the various aspects of the language. An individual must learn the association between those symbols and their sounds and how to apply that knowledge to the process of reading. The reading process is not "pre-wired" into the brain as has been argued for speech development. As an example, at the time of birth, infants process speech sounds in a categorical manner without prior experience. Acoustically, speech is a continuous phenomenon. However, we hear each sound or phoneme in words categorically. That is, we can distinctly hear the specific sounds in a word. However, when viewing speech signals acoustically, it is difficult to determine where the beginning and end of a sound or word is. In **Figure 1** the sentence "I like to read." is presented. One of the reasons that it is difficult to determine the demarcation point for sounds and words is that the sounds overlap each other even though we hear the sounds categorically.

Human brains are able to make sense of acoustic information without actually learning to do so. They are uniquely prepared for their language environments and are ready to begin the process of speech acquisition. This is simply not the case for reading. To learn to read effectively, one has to exert considerable effort and energy and to come to understand that the written language is a code that represents the spoken language.

Writing Systems

There are many different ways to communicate meaning through

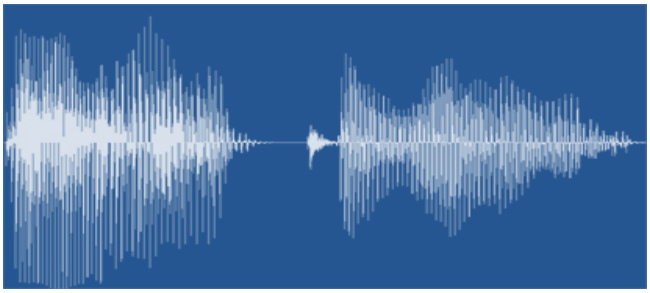

Figure 1 Illustration of the acoustic view of the sentence "I like to read."

symbols. Logographic systems do so by representing words, phrases or concepts to symbols. The Chinese logographic system represents syllables. As an example, two Chinese logographs are used to represent the word "reading;" Read. To be fully literate in Jiantizi, an individual would need to know approximately 3,000-4,000 logographs. To learn this large number of logographs is extremely time-consuming and challenging. There have been unsuccessful attempts to replace the logographic system with an alphabetic system as the alphabetic system is much more economical when examining the mnemonic effort required to learn logographs compared to alphabets [30].

The English Writing System uses symbols as well, but rather than representing morphemes or meaning, letters are used to represent the sounds or phonemes of the English language. The great advantage of doing so concerns the enormous number of words that a reader of the English Writing System can read and, as a result, has access to from a very early time in the individual's reading development. Additionally, when new words are encountered, the proficient reader generally has the skills to read the word successfully. Essentially, once the individual comprehends that sounds are represented by letters, the most probable combinations of particular letters, and the many variations in which specific sounds can be represented, the number of words that this individual could read is practically limitless. However, the writing system should represent the spoken language in terms of fit as well. Some languages are more easily represented by logographs, syllables or alphabets.

A transparent writing system is a writing system in which each sound of the language is represented by one and only one symbol. In addition, each symbol represents one and only one sound. There is a direct relationship between the sounds and their symbols. Examples of transparent writing systems include Greek, German, Finnish, Serbian, and Turkish.

Practice translating or decoding the symbols into their sounds helps the individual become more efficient. Once an individual has repeatedly practiced a skill it becomes increasingly more proficient and can become nearly automatic. Cognitive scientists define an automatic process as a process that requires little or no cognitive energy to perform [31,32]. Each individual has cognitive skills and abilities and a finite amount of cognitive energy. When a task is very difficult or effortful most or all of that cognitive energy is required to perform that task. Practice begets efficiency and efficiency requires less cognitive energy.

When individuals have been reading for many years, it is likely that the initial reading processes will become automatic. That is, the reader may require little cognitive energy to perform decoding and synthesizing skills. For the skilled reader, what is being read seemingly and instantaneously transfers from text to meaning. The beginning reader very carefully decodes each letter into its respective sound and then synthesizes those sounds into words until he or she has read every word in the sentence. This process is deliberate and time consuming and requires an enormous amount of cognitive energy. However, as individuals practice these skills, they become more efficient, and as a result, require less cognitive energy. As the analysis (decoding) and synthesis (blending) skills become more automatic, the savings in the use of cognitive energy can be applied to other cognitive tasks such as comprehension [33].

Neurologically, individuals with dyslexia learning to read a transparent writing system are just like children who experience reading failure with the opaque English writing system, but since the transparent writing system is less burdensome to decode, their experience with reading failure results in very slow reading rather than being bogged down in the quagmire as is the case for children learning to read an opaque writing system. Additionally, students who are learning to read in languages that have transparent writing systems begin formal reading acquisition training later and end it sooner than those children who are learning to read in writing systems that are not transparent.

An opaque writing system does not have a one-to-one system for representing sounds like the transparent writing system. English employs one of the most opaque writing systems, has been influenced by many languages and continues to evolve each day. It is a dynamic and fluid language that embraces change. The English writing system has allowed each of the languages that have influenced English, such as Anglo-Saxon, French, Latin, Greek, and Danish, to retain their writing systems. Some of those languages are also opaque. As a result, learning to read English is an extraordinarily difficult enterprise. J. R. Firth, in 1937, stated, "English spelling is so preposterously unsystematic that some sort of reform is undoubtedly necessary in the interest of the whole world." Mastering the English writing system involves great time and effort on the part of the learner because of the borrowing and using of other writing systems with their unique spelling protocols. As an example, there are several alternative spellings for the "ē" sound (e.g., "e," "ee," "ea," "y," "e-consonant-e," "ie," "ei," "ey," "i," etc.) just as there are alternative spellings for several sounds. Some sounds are represented by digraphs (e.g., "ow," "ou," "sh," "th-voiced," "th-unvoiced," etc.) and vowels are modified if they are followed by the letter "r" (r-controlled vowels, e.g., "ar," "ir," "er," "ur," etc.). To complicate the system further, there are different spellings of words based on context (e.g., "to," "too," and "two;" "threw" and "through;" "tow" and "toe," etc.). Children begin the process of learning to read an opaque writing system earlier than their transparent-writing-system peers and take much longer to learn it.

It is necessary for beginning readers to acquire the alphabet principle [34-36]. That is, to understand that sounds are represented by letters. Reading an alphabetic writing system involves translating the written code into its phonemes and synthesizing those phonemes into words. Unfortunately, individuals with dyslexia have grave difficulty decoding the written

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text into sounds and then synthesize them into words and the basis for this difficulty appears to be related to poor phonological processing skills [37,38]. Improvement in phonological processing requires explicit instruction and intervention in children with dyslexia [39,40]. Waiting to determine if the child will spontaneously acquire these skills is problematic [41]. A child with dyslexia must have explicit training to develop the skills necessary to learn to read. It has been known for some time that children who are not given explicit training to resolve their phonological processing deficiencies become adults who experience illiteracy [42].

The History of Ignorance, Complacency and Resistance

The science is relatively clear on issues related to reading acquisition, how to teach reading, the causes of dyslexia and reading failure and how to identify and provide remediation strategies for children with dyslexia and reading difficulties [43-45]. The history within colleges of education has been a resistance to the Science of Reading, widespread ignorance and complacency. In each case, colleges of education faculty have ignored the scientific knowledge that informs reading acquisition and the identification and intervention strategies for struggling readers. As a result, the pre-service teachers who are being educated at these institutions fail to receive the necessary training that would allow them to be effective in providing remediation to students with dyslexia [46]. "For the greatest enemy of truth is very often not the lie—deliberate, contrived and dishonest—but the myth—persistent, persuasive, and unrealistic. Too often we hold fast to the clichés of our forebears. We subject all facts to a prefabricated set of interpretations. We enjoy the comfort of opinion without the discomfort of thought" [47].

The results of this ignorance, resistance and complacency can be seen at many levels. The Nation's Report Card indicated that 33% of fourth graders were reading at a level below Basic and 58% are reading at a level below Proficient. Reading at the Basic level indicates partial mastery of the skills necessary for proficient work at a particular grade level. Reading at the Proficient level denotes appropriate academic performance in which students have demonstrated their competency to read challenging material [48]. These percentages have not changed appreciably since 1992 when the percentage of students reading below Basic and Proficient were 38% and 55%, respectively [48]. Although considerable concern and effort have been placed on issues related to students who are performing poorly in reading, the data suggest that not much progress has been made in student performance even though the Science of Reading has established how reading acquisition occurs and how to remediate the deficient skills and subskills related to reading.

The concerns regarding reading are certainly not new. Three decades ago, the National Commission on Excellence in Education provided ample evidence that many of our nation's children experienced academic difficulties that resulted in poor reading and mathematics proficiency. These difficulties were also found to persist into adulthood [49]. Since that time several key pieces of legislation were enacted that attempted to rectify these issues (Improving America's Schools Act, 1994; Goals 2000: Educate America Act, 1994; No Child Left Behind Act, 2002). Although these efforts provided illumination of the difficulty, and in the case of the No Child Left Behind Act enormous accountability requirements for school systems, academic performance has not changed and a nearly equal percentage of students are continuing to experience reading failure. Educational critics have argued that poor classroom instruction, particularly for very low-performing students, is responsible [50]. One could argue that accountability aspects of these pieces of legislation, particularly No Child Left Behind, resulted in poor performance on reading tests. The requirement that testing be used to determine the academic progress of students necessarily reduced the time that teachers could spend teaching basic skills in the classroom due to increased need to teach students how to pass high-stakes testing. This argument seems unlikely for several reasons, most notably that poor reading performance existed prior to the enactment of legislation and that the raison d'etre for the legislation was specifically to increase reading skills. As discussed above, a very large percentage of teachers lack the basic knowledge that is required to teach reading acquisition [51,52]. This unhappy fact would seem to play a very large role in the reason that students are performing so poorly on high-stakes reading tests. In fact, if teachers were successful at "teaching to the test," performance would have increased on reading tests. The fact of the matter is that teachers do not receive training in the Science of Reading which leads to an inability to provide appropriate instruction in the classroom.

There is considerable scientific knowledge concerning reading acquisition and the strategies that are the most effective in teaching children to read [53-56]. Classroom instruction that teaches these skills related to the Science of Reading is more effective than those that do not. Unfortunately, it appears that these skills and the components of the Science of Reading are often not directly taught to many pre-service teachers [57-59].

Approximately 53% of pre-service and 60% of in-service elementary teachers who will be most responsible for assisting students with reading acquisition, were unable to correctly answer half of the questions regarding knowledge of language structure [60]. Only 20% of 722 teachers could segment words into speech sounds; only 30% correctly identified the number of phonemes in half the items; and only 60% positively identified the irregular words in a list of 26 words. During debriefing, teachers reported that they had not received formal instruction regarding the complex structure of phonological processing during their academic training [52].

Despite being experienced and well-educated, teacher participants generally demonstrated low levels of the explicit, specialized knowledge necessary to effectively provide reading instruction to students [61]. Pre-service teachers were also found to overestimate their knowledge [52].

Teacher training programs generally fail to provide adequate instruction and acceptable resources regarding how to teach students to read. Instead, teachers must rely on their own skills and on other resources to learn how to teach reading. Most colleges of education encourage pre-service teachers to

"develop their own personal philosophy of reading" [58] rather than teach pre-service teachers the mechanics of the Science of Reading. Such misguided encouragement results in a considerable variety of positions regarding teaching reading, most of which are inconsistent with the Science of Reading, and thus with reality.

Not only are teachers not receiving adequate preparation, they also are not provided with appropriate resources during their training. In a 2006 examination by the National Council on Teacher Quality (NCTQ) of college-level reading courses, the authors considered a textbook to be an acceptable example of a core resource for the course if it thoroughly presented the five components of reading instruction which were identified by the National Reading Panel as phonemic awareness, phonics, fluency, vocabulary and comprehension [59]. The four textbooks found to be acceptable in a survey of 227 were used in less than five percent of the courses examined. Often, inaccurate information was presented in widely used textbooks [62].

It has been documented that teachers are not providing beginning readers with consistent and adequate reading instruction. Reading failure rates have not changed appreciably in several decades even though the scientific literature regarding reading, its subskills and proper teaching techniques have been repeatedly substantiated. It is clear that pre-service teachers are not receiving proper instruction regarding the Science of Reading. Pre-service teachers, experienced teachers, and university instructors all perform poorly on measures of constructs relating to reading acquisition and literacy. Thus, the lack of the knowledge related to the Science of Reading could be the reason for the resistance in teaching these concepts to future generations of teachers. An alarmingly small number of teacher education programs provide coursework that presents the appropriate knowledge base of the Science of Reading to its students, hence the impetus of Greenberg, McKee and Walsh's [58] work to link evaluative scores to colleges of education so that individuals who have a desire to become teachers can make informed decisions regarding matriculation.

In their eight-year study to develop and implement a method to examine teacher education programs, only 22% of the 594 teacher certification programs involved in the study received scores of three or higher on a four-point rating scale [58]. Additionally, 78% of the elementary education programs received scores of 0 ("program coursework does not adequately address strategies for struggling readers," p: 41) for Standard 4 (Struggling Readers) which is the standard most germane to this discussion.

The lack of knowledge regarding the Science of Reading witnessed in pre-service teachers, in-service teachers and their professors is paramount to complacency, ignorance and resistance and falls fully on colleges of education who willfully and knowingly resist disseminating the Science of Reading to their students. Faculty in colleges of education often have insufficient training in science and research methods such that they are not able to read the research available that would inform them of the content of the Science of Reading. As an example, the weaker the training in research the more likely that an institution offers an Ed.D. rather than a Ph.D. in education [63]. Further, Townsend [64] expressed that many Ed.D. programs lack value and are "seen as a watered down version of the Ph.D. in Education and seemingly fail to provide practitioners with the knowledge, skills, and behaviors for effective leadership in educational settings" [64]. Faculty in colleges of education often do not possess the skills necessary to read, understand and critically evaluate the scientific literature concerning the cognitive, linguistic, neurological, etc. components of reading. Boote and Beile [65] discovered that literature reviews for dissertations en route to the Ed.D. were generally weak, lacked substance and failed to demonstrate that the candidate had a firm grasp of his or her field. Without training in research which includes first and foremost an understanding of the literature in one's field, individuals cannot be consumers or contributors to this literature. When faculty lack training in research and science, they are susceptible to strategies that are not aligned with science and therefore not appropriate. As a result, parent-led-grass-roots organizations are leading the charge to transform colleges of education and to require that they teach the Science of Reading so that identification and intervention techniques can be used to teach children with dyslexia.

An approach that has permeated the education of pre-service teachers and is antithetical to the Science of Reading refers to an approach referred to as whole language (WL). Goodman [66,67], who developed the WL approach, conceptualized learning to read in a similar fashion as language acquisition described by Chomsky. Goodman argued that learning to read is natural and should mirror the development of language acquisition [68]. It was argued that exposure to print should result in literacy in the same way that exposure to a language results in language acquisition. Unfortunately, reading development does not occur as a function of mere exposure to print as language does; nor is reading acquisition a function of a "psycholinguistic guessing game." Smith [69,70] suggested that focusing on phonemes deterred children from learning to read and that "children learn to read only by reading" [70]. Learning to read requires explicit and systematic instruction, language acquisition does not. An alphabetically-based writing system, such as that which is used in English, represents the sounds of the language with letters. The English Writing System, like all alphabetic writing systems, is a code. Access to phonology occurs as a function of deciphering the symbols into their respective phonemes. Once an initial understanding of the relationship between sounds and their symbols has been developed, decoding and reading acquisition training commences. Its reciprocal process, encoding, is used to represent the spoken language with words conveyed through letters so that thoughts can be made permanent. Complete comprehension of the code requires both decoding (reading) and encoding (writing). With intense and sustained practice, individuals who do not have dyslexia become able to develop a high level of skill such that these processes become nearly automatic. Individuals with dyslexia who are learning to read the English Writing System struggle tremendously. Learning to read an alphabetically-based writing system specifically and emphatically requires attending to and learning about the smallest units of language.

Sophisticated eye movement technologies examining skilled adult readers have indicated as many as 15 - 25% of words are

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not initially fixated during reading [71]; thus words that are short, high-frequency, predictable and are acquired early in reading development are likely to be skipped and, therefore, not fixated. In addition, compared to adults, children are more likely to have more fixations (fixating on more words than adults), have fixations of longer duration, have shorter saccades, have more refixations (fixating on a word that was previously fixated), and make more regressions [72]. Eye movement studies only included children who were capable of reading simple sentences without the need for decoding [73]. For children beginning reading acquisition, attention to each letter in a word is necessary. The unit of analysis in terms of reading is the letter. It is the letter that holds the key to deciphering words into their sounds such that reading can take place.

As an example of the difficulties associated with utilizing a system that does not employ the Science of Reading, California in 1987 embraced the conceptual framework of WL. The school systems used WL textbooks and the phonics approach was largely deemphasized if not eliminated. By 1994, the fourth-grade reading scores from California were tied with Louisiana's and Guam's as the worst of the 39 states and territories that participated in the national standardized reading test (National Assessment of Educational Progress). As a result, legislative hearings occurred and a task force was commissioned. Granted, there were likely other ancillary reasons for the poor reading skills observed in 1994, but their combined reports determined that the WL approach was an inappropriate reading acquisition strategy.

Soon thereafter, the Australian Government in 2005 recommended systematic instruction of synthetic phonics and argued that WL, "on its own, is not in the best interest of children, particularly those experiencing reading difficulties." [74] and also reported that "direct systematic instruction in phonics during the early years of schooling is an essential foundation for teaching children to read" (p: 11).

The WL framework has been the persistent persuasive myth of our time. It sounds so organic and liberating. Simply expose children to good literature and to common words consistently and allow them to grow naturally into strong readers at their own pace and they will become competent readers. No need to first instruct children how the writing system actually works, that words need to be decoded before they can be read. Simply guess at the pronunciation of the word. Obviously, even to the individual who has no background in reading acquisition, this sounds ludicrous and it is. It is crucial that children engaged in reading acquisition have access to the meaning and purpose of the English writing system and that it represents a code. Reading acquisition is first and foremost a process of learning how to decipher printed words into their respective sounds and synthesizing those sounds once decoded to read words. The English Writing System was based on an alphabet, which acts as a Rosetta Stone so that individuals can transcribe sounds into symbols and directing the symbol representation of the sounds. It is crucial that children learning to read are taught the relationship between sounds and symbols, decoding and synthesizing.

Many children are able to comprehend the nature of the code and are able to appreciate that the English writing system is indeed a code to be used to decipher text. Once this notion has been comprehended, more advanced strategies can be deployed. Unfortunately, the child with dyslexia and many children who do not naturally divine the relationship between sounds and letters have grave difficulties learning to read. Most children require the code to be explicitly taught. Instructional strategies that initially assist beginning readers to understand the nature of the code and then build upon that foundational knowledge emphasizing comprehension and other strategies, become competent readers [75]. Failure to present this vital information results in a large number of children who experience reading failure. Colleges of education are complicit in this conspiracy and are negligent when they forsake to educate pre-service teachers in the Science of Reading. Failure to do so results in teachers who know very little about the specific nature of reading acquisition and who are unable to assist struggling readers. It is imperative that students who desire to be teachers have a strong knowledge base in the Science of Reading. The continued failure to adequately prepare future teachers with regard to the Science of Reading, reading acquisition, the nature of dyslexia, assessment and interventions will result in a continuation of reading acquisition failure. This is extremely unfortunate in that the knowledge, skills and technology exist so that reading failure can be prevented or attenuated.

It is clear that pre-service and seasoned teachers along with professors of education who teach these individuals have insufficient knowledge with regard to the Science of Reading; the underlying principles related to reading and it subcomponents that guide reading instruction, evaluation and intervention strategies. This is just not true with regard to reading acquisition in general, but training individuals with dyslexia to read. The root cause of this deficiency of knowledge rests squarely on colleges of education in two very important ways. The first involves the lack of appropriate training of individuals pursuing the educational doctorate and the second involves the lack of dissemination of the scientific literature to pre-service teachers by colleges of education faculty who lack exposure to science, research methods, design and analysis.

Higher Education's Contribution to Reading Failure

Doctoral training

Shulman et al., [76] wrote that "the problems of the education doctorates [Ed.D. and Ph.D.] are chronic and crippling. The purposes of preparing scholars and practitioners are confused; as a result neither is done well.". Purinton [77] argued that "Ed.D. programs—even highly ranked ones—have a long way to go in establishing their indispensable value; by far, such degrees have still not lived up to the standards set by other professional doctoral programs" (p: 25). The major deficiency with education doctorates is that they appear to lack the necessary training in research methods, design and analysis. Although these degrees often include coursework that include research methods, design and analysis, the incorporation of these courses into other content areas is lacking. "In education, the judgments of 'experts'

frequently appear to be unconstrained and sometimes altogether unaffected by objective research. Many of these experts are so captivated by romantic ideas about learning or so blinded by ideology that they have closed their minds to the results of rigorous experiments. Until education becomes the kind of profession that reveres evidence, we should not be surprised to finds its experts dispensing unproven methods, endlessly flitting from one fad to another. The greatest victims of these fads are the very students who are most at risk." [78]. As a result, it is critical that those pursuing education doctoral degrees have a very good working ability to engage in consuming research. There appears to be a serious lack of quality in educational research which [65] argued is directly related to weaknesses in doctoral preparation. In fact, the Carnegie Project on the Education Doctorate (CPED) was created to redesign the doctoral preparation to address the growing criticism regarding this lack of preparation. The CPED presently consists of 83 colleges and schools of education whose goal is to critically examine the doctorate in education. In particular, one of the initial goals was to differentiate the Ed.D., which was considered a practitioner doctorate preparing candidates to solve educational issues, from the Ph.D., which was considered a research-based doctorate that prepares candidates to be university faculty and educational scholars. Unfortunately, these two degrees fail to be differentiated in this manner. Frequently, neither degree provides the appropriate training in science for either of them to generate scientific knowledge that can be used to solve educational issues [79]. This is most certainly the case when reading acquisition failure is considered. Lastly, the curriculum often lacks practical relevance in relation to the educational issues that exist [80].

The second dimension of suggested pedagogy from the CPED is that "teaching and learning are grounded in theory, research, and in problems of practice." [81]. There is no doubt that this should be the case, teaching and learning should unequivocally be grounded in research and theory; however, the status quo in far too many doctorate programs in education is that research is not seriously emphasized, taught or integrated into doctoral program course content. The redesign of doctoral training in education must be framed around a scientist-practitioner or scholarly-practitioner model in which the process and content of science are firmly established. Otherwise, the discipline is doomed to continue following unsubstantiated notions that do not allow practitioners to firmly understand educational realities. In fact, the CPED suggests that the "scholarly practitioner" model be used by colleges of education use to build or redesign Ed.D. degree programs. The scholarly practitioner should have a very firm grasp of the process and content of science including the scientific method, understand the importance of science in solving educational issues and should consult the scientific literature when addressing educational problems.

Doctoral programs in education, whether the program provides training for the Ed.D. or the Ph.D. degree, should provide candidates considerable background in science which would include research methods, design and analysis with emphasis placed on incorporating these concepts within each content area and course. Doctoral students should engage the primary source literature in each class and become very proficient in its content. Students in Ph.D. programs should also be required to develop a research proposal in each content area and course that is strongly based on the scientific literature relevant to the course. This not only helps the student understand the importance and necessity of becoming proficient in a literature, but also helps them to learn the craft of the literature review and the research enterprise. Students pursuing the Ed.D. should be provided coursework that strongly emphasizes the importance of science in solving educational issues. Students should always search for solutions to educational issues from the scientific literature. To be able to do so requires that the student have a firm grasp of how to read scientific material and its importance. After students have a basic understanding of science, research methods, design and analysis, all students must also be proficient in the Science of Reading. This cognate should be part of each doctorate in education program. Before reading failure can be adequately addressed, a common thread of knowledge must be present in all of the following personnel; superintendents, principals, reading specialists, teachers, school support personnel, and paraprofessionals. This knowledge is necessary so that all have a common language in which to converse and have a reasonable expectation of providing appropriate interventions. This conversation must be led by those engaged in doctoral training so that the doctoral candidate will graduate with the appropriate knowledge. Other cognate areas should be determined by the specialization that the program wishes to offer, but it should be nonnegotiable that all doctorate in education programs include a substantial core of knowledge that emphasizes the importance of science in the pursuit of educational knowledge, presents research methods, design and analysis as stand-alone courses in addition to infusing this content into each course. These science-based courses should be presented at the very beginning of the student's course content and performance in these courses could act as a litmus test for continuing the degree. Additionally, the Science of Reading cognate must be part of each doctoral program. This is the only way that reading failure can be adequately addressed. Failure to provide essential knowledge in science and exposure to its literature continues to promulgate ignorance with regard to educational knowledge, which is particularly the case with regard to reading, reading acquisition and reading failure. Binks-Cantrell et al., [82] refer to this lack of knowledge as the Peter Effect [83] in which individuals cannot teach what they do not know themselves. There is no specialization area that would lead to a doctorate in education that could forgo the Science of Reading content. One might argue that this information is not pertinent to the doctor of education degree (e.g., curriculum and design, administration or leadership), but this is simply not accurate. Understanding the nature of reading acquisition and how to rectify acquisition failure is vitally important. This content must be firmly addressed in the curricula of both the Ed.D. or Ph.D. Failure to do otherwise continues the trend of failing to meet the needs of children with dyslexia, their families and society in general that requires that it citizens read and read well.

It is critically important that individuals who will become faculty members in colleges of education have the knowledge contained within the Science of Reading. The great failure has been the lack of training in the Science of Reading in colleges of education

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faculty members. The current state of affairs of the Science of Reading has provided considerable information regarding the acquisition of reading skills, particularly in children who have dyslexia and reading difficulties, the nature of evaluation and assessment, and science-based interventions and curricula. The abysmal performance of pre-service and in-service teachers and college of education faculty on the content of the Science of Reading trickles down to the students who are suffering due to the lack of training of all of these individuals. The Science of Reading needs to be requisite for both doctor of education degrees.

Given the vital importance of correcting the dilemma facing our nation's colleges of education, public and private elementary and secondary schools with regard to reading failure, it is recommended that colleges of education only hire faculty who have been trained in the Science of Reading during their doctoral training. For those who have not, it is also recommended that colleges of education provide post-doctoral training in the Science of Reading. There will be those who argue that this is not necessary, but the fact that nearly 20% of our nation's children have dyslexia and that 32% of fourth graders were reading at a level below Basic and 65% were reading at a level below proficient [84] are very strong counter arguments for this position. It is essential that colleges of education faculty have the requisite knowledge to dispense the science-based and appropriate knowledge to teach reading to pre-service teachers. Failure to do so will only prolong the inability of students to acquire proficient reading skills. As articulated by Louisa Moats, "Everyday I'm in a school and working with teachers I continue to be astounded by the gulf of knowledge, the gulf between our knowledge base in the scientific community and the practices that go on in teacher training" [85].

Graduate training

The same arguments as articulated above should also apply to any graduate training in education, be it the master's in education degree or the educational specialist degree (Ed.S.). It is critically important that these degrees have content with regard to science, research methods, design, statistics, and the nature of dyslexia and reading failure which should include coverage of etiology (genetic and neurological), characteristics related to children who experience dyslexia and reading failure, characteristics of dyslexia, evaluation tools, and science-based interventions and curricula with practicum experience based on the content concerning the Science of Reading. A graduate degree in reading absolutely must comprehensively and specifically cover these content areas.

Undergraduate training

At the undergraduate level, many teacher education programs do not provide adequate training for pre-service teachers [59,86,87]. As mentioned above, pre-service teachers perform poorly on their knowledge of the Science of Reading. Reorganizing and restructuring colleges of education courses to include the Science of Reading is necessary. A core curriculum for pre-service teachers should include coursework covering reading psychology and development, the structure of language, applying best practices in reading instruction and using validated, reliable and efficient assessments to inform classroom instruction [44]. Unfortunately, only a very small number of colleges of education include such coursework. This led [58] to develop a strategy where colleges of education could be rated on their ability to provide instruction. An alarmingly great many of the colleges of education provided minimal to no training in the Science of Reading. This is certainly disappointing as research has determined interventions that are successful in improving reading skills of students experiencing reading failure [88]. The vast majority (78%) of elementary education programs were found to have curricula that did not "adequately address strategies for struggling readers" [58] for Standard 4: Struggling Readers. The authors indicated that the criterion used to determine if a program met this standard was quite low. Even so, nearly 80% of the programs failed to meet this standard.

What specifically should be taught?

Pre-service teachers must be provided with a curriculum that includes the Science or Reading. The Science of Reading corpus includes the nature of reading, how reading should be taught, evaluation tools for determining appropriate progress in reading and interventions that are useful to assist struggling readers to become competent readers. However, prior to students' exposure to the Science of Reading, they must also have exposure to prerequisite courses that would allow them to understand the mechanics of the Science of Reading.

A very useful guide in developing the curriculum for pre-service teachers can be found in the Knowledge and Practice Standards for Teachers of Reading that was developed by the International Dyslexia Association **(Tables 1 and 2)**. The Knowledge and Practice Standards for Teachers of Reading includes essential knowledge (Section I) in addition to standards concerning demonstrating the knowledge and skills that teachers should have to provide services to students with dyslexia or reading difficulties (Section II). The standards in Section I comprise oral and written learning, knowledge of the structure of language, phonology, phonics and word recognition, fluency, vocabulary, comprehension, handwriting, spelling, written expression, assessment for planning instruction, and knowledge of dyslexia and other learning disorders. The standards in Section II concern the demonstration that the teacher is competent to teach reading (Level I) and for specialists who intend to provide services to individuals with dyslexia and other learning disorders.

It is recommended that pre-service teachers fulfill prerequisite courses before exposure to the content of the Knowledge and Practice Standards. These prerequisites would be comprised of research methods, linguistics, cognition and a course outlining the Science of Reading. Section II of the Knowledge and Practice Standards lists practicum experiences that are recommended. If the Knowledge and Practice Standards are not used as a guide for developing the sequence of courses, then two different practicum experiences should be included **(Table 3)**. The rationale for the prerequisite courses concerns providing the appropriate background knowledge so that pre-service teachers could benefit from the courses designed from the Knowledge and Practice Standards. The course would be an overview of the

Table 1 Section 1 of the knowledge and practice standards for teachers of reading.

Section 1 Knowledge and Practice Standards	
Areas	**Examples**
Foundation Concepts about Oral and Written Learning	This section outlines the standards regarding the knowledge and application related to the influence that oral and written language contributes to reading and writing, cognition and behavior that affect reading and writing, environmental, cultural and social factors, typical development, causal relationships of the above, and reasonable goals and expectations for learning. Phonological, orthographic, semantic syntactic and discourse processing; attention, executive function, memory, processing speed, graphomotor control; development of oral language, phonological skill, printed word recognition, spelling, reading fluency, reading comprehension, written expression.
Knowledge of the Structure of Language	This section outlines the standards that refer to the individuals teaching reading should have regarding the structure of language with regard to phonetically regular and irregular words, common morphemes and sentence structure. Phonology (concepts regarding vowels and consonants), orthography (graphemes, high frequency and irregular words, orthographic rules, syllable types), morphology (common morphemes in the English Writing System), semantics (semantic organization), syntax (distinguish phrases, dependent and independent clauses in sentences, parts of speech) and discourse organization (narrative and expository discourse, construct expository paragraphs, identify cohesive devices in text).
Structured Language Teaching: Phonology	This section outlines the standards that refer to teaching phonology. Underdeveloped phonological processing has been identified as a core weakness in individuals who have dyslexia. Teaching phonological processing skills is a very important component in remediating poor reading skills. Identify goals of phonological skill instruction, know the progression of phonological skill development (rhymes, syllables, onset-rimes, phonemes), principles of phonological skill instruction (brief, multisensory, conceptual and auditory-verbal), understand the reciprocal nature of phonological processing, reading, spelling and vocabulary, and understand how the phonological features of a second language might interfere with English pronunciation and phonics.
Structured Language Teaching: Phonics and Word Recognition	This section outlines the standards that refer to teaching systematic phonics and accurate word decoding skills. Recognize how to order phonics concepts, understand explicit and direct teaching, understand multisensory and multimodal techniques, understand lesson format from word recognition to fluent application in meaningful reading and writing, understand research-based adaptations of instruction for students who have weaknesses in working memory, attention, executive functioning or processing speed and the application of the above concepts.
Structured Language Teaching: Fluent, Automatic Reading of Text	This section outline the standards that refer to teaching fluency. Underdeveloped or poor fluency is a characteristic of dyslexia and inhibits other reading processing including comprehension. Understand the role of fluency in reading, that fluency is a stage of normal reading development occurs with practice and may be a symptom of some reading disorders, understand the concepts of frustration, instructional and independent reading levels, what instructional activities are likely to improve fluency, techniques that will assist in reading motivation, and understand the appropriate use of assistive technology and the application of these concepts.
Structured Language Teaching: Vocabulary	This section outlines the standards that refer to vocabulary and its importance with regard to reading comprehension in addition to providing teachers information with regard to the importance of vocabulary in reading and listening and how to provide a classroom environment that is rich in access to vocabulary. Understand the role of vocabulary development and knowledge in comprehension, understand the role of direct and indirect methods of vocabulary instruction, know the techniques used to teach vocabulary before, during and after reading, understand the reasons for the considerable variability in students' vocabularies, and teaching word meaning.
Structured Language Teaching: Text Comprehension	This section outlines the standards that refer to reading comprehension, particularly teaching comprehension and identifying weaknesses that require intervention. Be familiar with teaching strategies that are appropriate before, during and after reading, contrast the characteristics of major text genres including narration, exposition and argumentation, understand the relationship between text comprehension and written composition, identify potential miscomprehension in text, understand the levels of comprehension including surface code, text base and mental model/situation model, understand factors that contribute to deep comprehension.
Structured Language Teaching: Handwriting, Spelling and Written Expression	This section outlines the standards that refer to handwriting, keyboarding, spelling and written expression including capitalization and spelling. Know research-based principles for teaching letter naming and letter formation, techniques for teaching handwriting fluency, recognize and explain the relationship between transcription skills and written expression, identify students' levels of spelling development and orthographic knowledge, be able to explain the influences of phonological, orthographic and morphemic knowledge on spelling, understand the major components and processes of written expression and their interactions, know grade and developmental expectations for students' writing and understand appropriate uses of assistive technology in written expression.

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Interpretation and Administration of Assessments for Planning Instruction	This section outlines the standards that refer to interpreting and administering assessments for planning instruction. This section includes standards that must be demonstrated for not only the content knowledge and its application, but also competencies for teaching students with dyslexia and related difficulties. Understand the differences between screening, diagnostic, outcome and progress-monitoring assessments, the basic principles of test construction, including reliability, validity and norm-referencing and know the most well-validated screening tests, understand the principles of progress-monitoring and the use of graphs to demonstrate progress, know the range of skills typically assessed by diagnostic surveys of phonological, decoding, oral reading, spelling and writing skills, recognize the content and purposes of the most common diagnostic tests used by psychologists and educational evaluators, interpret measures of reading comprehension and written expression.
Knowledge of Dyslexia and Other Learning Disorders	This section outlines the standards that refer to understanding the nature of dyslexia and other learning disorders. Understand the most common intrinsic differences between good and poor readers, the tents of the NICHD/IDA definition of dyslexia, that dyslexia and other reading difficulties exist on a continuum of severity, be able to identify the distinguishing characteristics of dyslexia and related reading and learning disabilities, identify how symptoms of reading difficulty may change over time in response to development and instruction, and understand federal and state laws that pertain to learning disabilities, especially reading disabilities and dyslexia.

Table 2 Section 2 of the knowledge and practice standards for teachers of reading.

Section 2: Guidelines pertaining to Supervised Practice of Teachers Who Work in School Settings	
Level	**Description and Requirements**
I	Description: This level is intended for novice teachers in training who implement an appropriate program with fidelity, formulate and implement an appropriate differentiated lesson plan, and demonstrate proficiency to instruct individuals with reading disability or dyslexia. Requirements: 1. Pass an approved basic knowledge proficiency exam. 2. Demonstrate, over time, instructional proficiency in all Level 1 areas outlined in table above. 3. Document significant student progress with formal and informal assessments as a result of the instruction.
II	Description: This level is intended for specialists who must demonstrate additional expertise and abilities to provide services to individuals with dyslexia and other learning disorders. Requirements: 1. Pass an approved basic knowledge proficiency exam. 2. Complete a one-to-one practicum with a student or small group of one to three well-matched students who have a documented reading disability. A recognized, certified instructor* provides consistent oversight and observations of instruction delivered to the same student(s) over time, and the practicum continues until expected proficiency is reached.** 3. Demonstrate (over time) instructional proficiency in all Level 1 and 2 areas outlined above. 4. Provide successful instruction to several individuals with dyslexia who demonstrate varying needs and document significant student progress with formal and informal assessment as a result of the instruction. 5. Complete an approved educational assessment of a student with dyslexia and/or language-based reading disability, including student history and comprehensive recommendations.

Note. *A recognized or certified instructor is an individual who has met all of the requirements of the level they supervise, but who has additional content knowledge and experience in implementing and observing instruction for students with dyslexia and other reading difficulties in varied settings. A recognized instructor has been recommended by or certified by an approved trainer mentorship program that meets these standards. The trainer mentorship program has been reviewed by and approved by the IDA Standards and Practices Committee.

**Documentation of proficiency must be: 1) Completed by a recognized/certified instructor providing oversight in the specified program; 2) Completed during full (not partial) lesson observations; and 3) Must occur at various interval throughout the instructional period with student.

technical aspects of the scientific method, design, analysis and how scientific results are communicated. It is important that pre-service teachers are provided with a framework to comprehend not only the knowledge contained within the Science of Reading, but to appreciate the procedures in which data are collected and analyzed. The suitability of pre-service teachers to engage in teaching reading will be determined by their understanding of the methods by which data are generated to answer specific questions that lead to practical applications. The course in linguistics will include phonology, phonetics, morphology, syntax, semantics and grammar so that the pre-service teacher will have specific knowledge regarding language. Having a working knowledge of language and its subparts is critical to understanding reading acquisition. The last prerequisite course should include content in cognition as much of the Science of Reading content was developed from cognitive science. As a result, a familiarity with the concepts, strategies and theories in this domain will prove to be essential. The content of this course

Table 3 Potential required courses to be included in an elementary education program to promote the science of reading.

Course Title	Course Content
Research Methods	Basics of scientific principles
Linguistics/Psycholinguistics	Introduction to linguistics
Cognition	Introduction to cognitive sciences which would include empirical methods, models, and data
Science of Reading	See Table 4
Science-based Reading Evaluation and Interventions	Theoretical basis of assessment instruments and their results in addition to developing individualized interventions based on assessment protocols
Practicum in Reading I	Evaluation of reading and comprehension utilizing phonological processing, phonics, fluency and vocabulary. Develop strategies to assist in the development of reading acquisition
Practicum in Reading II	Evaluation of reading and comprehension in struggling readers utilizing phonological processing, phonics, fluency and vocabulary. Develop strategies to assist in the development of reading acquisition

should include attention, memory, perception, language and metacognition. These three prerequisite courses should provide a working knowledge of the content that will prepare them for understanding the content within the Science of Reading courses. Other potential prerequisite courses could also include an introduction to human neuropsychology, memory, sensation and perception, and additional coursework in research methods.

The Science of Reading material could be offered as a single course or a series of courses; the material is voluminous **(Table 4)**. There is enough content that several courses could be offered to outline the specific details. Other topics could be included as well. It is essential those pre-service teachers are not only familiar with the content, but can apply it. The two practicum courses would be designed to address the application of the material learned in the Science of Reading course or courses, the first of which would involve assessment and evidence-based strategies to assist with reading acquisition while the second practicum course would involve assessment and intervention strategies specifically for struggling readers. The instructor would observe and evaluate each student's technique providing feedback during and after the process. The series of courses outlined above would provide pre-service teachers the knowledge and skills necessary for them to appropriately teach reading to their students, it would also provide them with the ability to identify children at risk for reading failure and to provide the necessary intervention. Pre-service teachers desperately want this information as they want to be the best-possible educators possible. Those who believed that their pre-service preparation was less than satisfactory were more likely to leave teaching [89]. There is also evidence that teacher turnover harms student achievement [90]. Teacher preparation programs

Table 4 Potential content for a science of reading course designed for undergraduate pre-service teachers.

Course Content
Writing Systems Alphabetically-Based Writing Systems History of English Writing System Orthography Languages that contributed to the English Writing System
History of Teaching Reading 1880 to present
Mechanics of English Writing System Letter-Sound Correspondence Phonics
Visual Processing and Reading
Phonology and Phonological Processing
Lexical Access
Fluency
Morphemes and Syllable Structure
Interdependence of Phonological Processing, Fluency, and Vocabulary
Comprehension
Literacy
Assessment of Dyslexia and Reading Difficulties
Interventions for Dyslexia and Reading Difficulties
The Role of Attention in Reading Attention Deficit Hyperactivity Disorder Appropriate assessment
Potential interventions The Effect of ADHD on Reading

must provide pre-service teachers with all of the knowledge and skills that will be needed to provide quality education to their students. Those who are ill-prepared to begin their teaching careers are likely to harm their students' academic achievement by first not knowing the appropriate reading acquisition and remediation strategies to provide to their students and then by leaving their profession. Students who struggle to learn to read are more likely to drop out of school. An enormous amount of human potential is not being realized due to the weaknesses throughout the educational process beginning with lack of rigor with regard to the Science of Reading during doctoral training which trickles down to pre-service teachers, reading specialists and masters-level educators. Colleges of education are behooved to develop the recommendations listed above.

Continuing education strategies

It is recommended that colleges of education develop continuing education strategies for in-service teachers to be exposed to the Science of Reading. This can be in the form of a potential master's degree in which the major focus is on the Science of Reading, or courses and activities to mirror what was recommended above with the training sequence of pre-service teachers. Success has occurred in professional development strategies to assist in-service teachers understand various aspects of the Science of Reading [91]. If in-service teachers are provided with the appropriate content in professional development opportunities, they can become proficient in their knowledge of the Science of Reading [92] outlines the issues with regard to professional development and the variables that must be addressed for positive change to occur. It was also found that when university

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instructors were provided with professional development, their knowledge of the Science of Reading significantly improved as well as their pre-service teachers who they were teaching [93].

An example

The 79th Texas Legislature enacted House Bill 1, the "Advancement of College Readiness in Curriculum." The goal of Section 28.008 of the Texas Education Code was to increase the number of high school graduates who were ready to begin college or careers. In the bill, the Texas legislature required the Texas Higher Education Coordinating Board (THECB), which oversees post-secondary education in Texas, and the Texas Education Agency (TEA), which oversees public education, to determine how they could act together to prepare students for post-secondary education. The act also required the THECB and the TEA to create Vertical Teams, which were comprised of faculty from secondary and post-secondary institutions and was the organization that developed the College and Career Readiness Standards (CCRS). The THECB established the Texas Faculty Collaboratives Initiative so that faculty who were preparing pre-service teachers would have access to current information regarding the CCRS so that they could train pre-service teachers which, in turn, would allow pre-service teachers to more effectively prepare their students to become college and career ready.

The Texas Higher Education Collaborative (HEC) was created in 2000 to ensure that scientifically based reading research (SBRR) and scientifically based reading instruction (SBRI) were contained within pre-service teacher education programs, alternative certification programs, and community teacher preparation classes. The objectives of the HEC are to support the Reading First Initiative by insuring that college of education faculty present SBRI to pre-service teachers, assist college of education faculty to incorporate SBRR materials into their courses, establish a collaborative so that college of education faculty who prepare pre-service teachers could support each other, to address Reading First Initiatives and to provide professional development for elementary and special education teachers to insure appropriate reading achievement of students. The HEC provides opportunities for teacher preparation faculty from colleges, universities, community colleges and alternative certification programs to communicate and discuss issues related to reading in addition to providing informational materials. HEC also provides an online collaborative; HEC Online. Interestingly, the HEC encourages educational administrators to act as literacy leaders. HEC also supports and encourages Educational Leadership and Educational Administrator faculty to embed SBRR into their courses as well. The major focus is not only to ensure that SBRR is integrated in courses so that pre-service teachers learn about the Science of Reading, but also ensuring that all higher education faculty are proficient in the Science of Reading and that they are disseminating that information to all of their students regardless of degree or program.

HEC provides seminars, assists in revising syllabi and course requirements to reflect SBRR, participates in site visits to ensure implementation of SBRR, provides online discussion groups, examines implementation of HEC initiatives with faculty and pre-service teacher surveys and examines pre-service teachers' knowledge through surveys. Results of the HEC initiatives have indicated that higher-education faculty found participating in HEC activities to be highly beneficial. Not surprisingly, pre-service teachers were more knowledgeable with regard to the Science or Reading [94]. The success of the HEC initiatives are due to legislative action that compelled change to occur, strong and collaborative leadership in developing programs, secondary and post-secondary faculty collaborating to develop appropriate standards, providing the support for higher-education faculty, many of whom had little to no knowledge with regard to the Science of Reading, the opportunity to learn, to change their thinking and to change course content. The satisfaction of higher-education faculty in the support and materials that were gained from HEC led to changes in course content which then led to increased knowledge of the Science of Reading in pre-service teachers.

The Texas experience is a model for other states and indicates that it is possible to provide the types of change outlined above. An enormously important component that contributed to the success of Texas' initiative was that the knowledge and skills of research scientists were utilized in presenting at conferences and seminars hosted by HEC, many of whom are cited above. The content was driven by the Science of Reading (SBRR and SBRI), which is essential. Other states that attempt to create such an initiat, should model their programs very carefully to Texas' HEC. Imperative in this approach is to have a legislature that is appropriately informed regarding the necessity of the inclusion of the Science of Reading including SBRR and SBRI. There will be resistance as has been documented thoroughly above, and the typical legislator will need to be educated on the importance of the Science of Reading rather than be persuaded by those who fear and resist change. Developing a goal with regard to reading success and then assisting faculty in and outside of colleges of education to participate in the creation of programs to address embedding the Science of Reading into courses for pre-service teachers is also important. The main focus should be on the students, particularly struggling readers, all of whom are dependent on colleges of education to create appropriate coursework so that pre-service teacher can become in-service teachers competent in their ability to teach all students to read.

Conclusions

Approximately 20% of our nation's students are experiencing reading difficulties and the percentage of fourth-grade students who are reading below Basic and Proficient (33% and 58%, respectively) has not appreciably changed since 1992. Fortunately, there is a solution. First and foremost the history of ignorance, resistance and complacency needs to be exposed. Secondly, there is a scientific literature that prescribes how to improve reading abilities in young students. The solution involves providing pre-service teachers with the knowledge that will assist them to provide their students, particularly struggling readers, the types of assessment and interventions that will lead to improved reading skills. Reading courses must be developed or revamped to include the Science of Reading. In addition, pre-service teachers must be provided with the appropriate coursework such that they will be able to understand the mechanics of the Science

of Reading prior to their exposure to that information. There really is no reason that individuals with dyslexia cannot become competent readers.

For there to ever be gained and sustained any social progress regardless of the ultimate ideal; for as Chomsky observes, social revolutionary change is gradual and incremental, building upon previous gains; the population must be better educated. At minimal, people must be able to read both in print and online.

One of the primary goals of social progress has always been mass education. Education begins with reading, and learning to read begins with a proper understanding and application of the Science of Reading. Children not only need not resign themselves to perpetual literacy difficulty and only partaking in a limited envisioned future. There exists in the immediate present a corpus of knowledge represented in the Science of Reading that is being stifled and opposed by the uninformed, educational social structures and educational power elite. It is necessary that a revolution begin such that the Science of Reading is presented in colleges of education so that pre-service teachers can become competent to teach reading to all of their students. This is, in fact, what pre-service teachers actually desire and should demand; to become the most competent teachers possible. The most promising way to ensure that students with dyslexia and those who are experiencing reading failure can become competent readers is to expose the current tragedy of ignorance, complacency and resistance on the part of faculty within many colleges of education. It will be necessary to build stronger doctoral degrees in education with an emphasis on science, research methods, design and analysis along with substantial content within the Science of Reading. These faculty will then be competent to teach pre-service teachers reading acquisition strategies so that children will learn to read, even those with dyslexia and potential reading difficulties. “A society cannot afford to continue funding teacher training institutions whose educational philosophy promotes a bankrupt theory and its associated pedagogy in the name of social justice (or ‘inquiry’) in order to disguise their own intellectual bankruptcy. Alternatives to dysfunctional institutions must be created. A civically healthy society needs a system for teacher preparation that respects and honors rational approaches to issues in curriculum and instruction” [95]. The ability to create strong colleges of education whose mission involves utilizing science to solve educational issues and to disseminate the continued and growing knowledge contained within the Science of Reading is essential. Children with dyslexia and reading difficulties will continue to suffer until this is accomplished.

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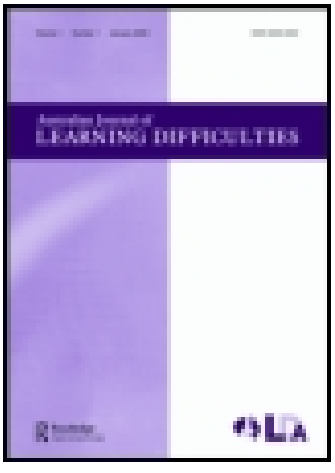

Australian Journal of Learning Difficulties

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/rald20

What teachers don't know and why they aren't learning it: addressing the need for content and pedagogy in teacher education

Louisa Moats[a]

[a] Moats Associates Consulting, Inc., Sun Valley, Idaho, USA

Published online: 04 Aug 2014.

To cite this article: Louisa Moats (2014): What teachers don't know and why they aren't learning it: addressing the need for content and pedagogy in teacher education, Australian Journal of Learning Difficulties, DOI: 10.1080/19404158.2014.941093

To link to this article: http://dx.doi.org/10.1080/19404158.2014.941093

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Australian Journal of Learning Difficulties, 2014
http://dx.doi.org/10.1080/19404158.2014.941093

Routledge
Taylor & Francis Group

EMINENT RESEARCHER AWARD OF LEARNING DIFFICULTIES AUSTRALIA, 2014

What teachers don't know and why they aren't learning it: addressing the need for content and pedagogy in teacher education

Louisa Moats*

Moats Associates Consulting, Inc., Sun Valley, Idaho, USA

This article discusses the lingering problem of poor and inappropriate preparation of professional teachers of reading and learning disabilities – why it exists and what we can do about it. Because most students classified as having learning disabilities experience primary difficulties with language-based learning, teachers must know how to teach the forms and processes of language on which literacy depends, but most teacher preparation programs fail to teach this content at a level that supports teachers' implementation of effective instruction. The evidence suggests that teachers may cling to unproductive philosophies of teaching not only because science-based instruction is neglected in many teacher training programs, but also because the requisite insights are elusive and the content is difficult for many to grasp, even with some exposure. While ideologies can be blamed for much resistance to explicit, systematic methodologies, we must ask why they develop in the first place. Although there is a substantial body of research on the relationship between teacher knowledge, practice, and student outcomes in reading on which to build reform in teacher training and mentoring, more thought should be given to how prospective teachers are taught. First, the disciplinary knowledge base required to teach students with reading and related difficulties must be unambiguously explained in the standards by which teachers are educated and evaluated, and then programs must be set up to build teachers' insight as well as their knowledge of basic reading psychology, language structure, and pedagogy. Those who teach teachers in university settings or who provide professional development must be included in a supportive educational process, as wars of ideology are having only limited positive effects.

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As the grateful and humble recipient of this year's Eminent Researcher Award from Learning Difficulties Australia, I must first confess that I am more teacher than researcher. My life's work, although it at times involved roles as Principal Investigator (PI) or Co-PI on research studies funded by the US National Institutes of Health, has included many years as a teacher, teacher trainer, and developer of materials for teacher education. I taught and worked as a "learning specialist" in clinical settings for about 10 years before enrolling in a doctoral program and taking my first course in the psychology of reading from Professor Jeanne Chall (Chall, 1989) at Harvard and before studying *Introduction to Language* from Professor Carol Chomsky.

None of my courses in learning disabilities at the master's level, and none of my elementary education courses, had addressed either the structure of language or the psychology of learning to read. None had provided me with theoretically sound perspectives that made sense in explaining good and poor reading, and I was unable to see

*Email: louisa.moats@gmail.com

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what was confusing to my students or how to respond to them. I for years was unconsciously unskilled, although licensed with a master's degree and "specialist" title.

What I finally learned in my doctoral program permitted me to understand the necessity for explicit, systematic, structured language teaching, how it differed from language experience, whole language, and literature-based instruction, and why such instruction was necessary for students who were not wired to read. Determined that other teachers should be better prepared, I began to teach in schools of education, and found, of course, that my student–teachers were, as predicted, uneducated about language, reading acquisition, or reading disabilities. I devised courses in language and literacy to teach graduate students, but then found that the special education department at my university would not require the courses because the state's teacher licensing regulations did not evaluate candidates on their knowledge of this content. Eventually, priorities shifted, but only after many years of petitioning by students who had taken the courses.

Meanwhile, I devised a survey of teachers' knowledge of English language structure at the word level – imperative for informed teaching of word recognition and spelling – and reported the results in *Annals of Dyslexia* (Moats, 1994). The paper argued that although teachers should be able to teach explicitly many aspects of language that were integral to reading and writing (phoneme awareness, phonics, morphology, syntax, etymology, etc.), they themselves had a poor grasp of the concepts; indeed, most admitted readily that they were ill-prepared to explicate concepts of language structure to students who did not learn them easily, naturally, or through exposure alone (Moats & Lyon, 1996). I argued for a fundamental change in the teacher preparation curriculum, with more emphasis on language, psychology, and explicit teaching and less emphasis on education history, philosophy, self-reflection and agnostic surveys of existing methods. Much to my great surprise, the American Federation of Teachers (AFT) picked up the article for reprinting in its influential journal, *American Educator* (Moats, 1995). A few years later, the AFT sponsored publication of the paper, *Teaching Reading is Rocket Science* (Moats, 1999).

Many colleagues joined the effort to document teachers' inadequate content knowledge, producing a series of studies illuminating the knowledge gaps of general and special education teachers whose primary job is teaching reading and writing (e.g., Bos, Mather, Dickson, Podhajski, & Chard, 2001; Carlisle, Correnti, Phelps, & Zeng, 2009; Cunningham, Perry, Stanovich, & Stanovich, 2004; Mather, Bos, & Babur, 2001; Spear-Swerling & Brucker, 2003), exploring why those gaps exist, and examining the relationships among teacher knowledge, practice, and student learning. Out of this literature have emerged some complex themes that merit close examination if we are to gain more influence on educational policies and practices affecting students who struggle to read and write. The remainder of this paper has three objectives: (1) to illustrate in greater detail why, and at what level, knowledge of language and cognition is a professional necessity; (2) to draw inferences from my own and my colleagues' work regarding the barriers to change; and (3) to inform the Australian professional community about several initiatives in the USA that might inspire similar initiatives in Australia.

Why knowledge of language and cognition is necessary for teachers

Children's incoming levels of specific reading-related skills are the best predictors of future reading ability (Olson, Keenan, Byrne, & Samuelsson, 2014), but effective instruction that builds foundational insights about print and its meanings enables individual teachers and schools to "beat the odds" (Denton, Foorman, & Mathes, 2003; Foorman et al., 2006; Torgesen, 2004). Especially when the instruction explicitly teaches

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students how the alphabetic system works, builds skill incrementally and synthetically (linguistic elements to whole words), and provides sufficient practice for students to gain automaticity, poor readers can improve significantly (Blachman et al., 2004; Brady, 2011).

Although reading disability may be caused by a complex mix of genetic and environmental factors (Elliott & Grigorenko, 2014; Hulme & Snowling, 2009), intervention studies are consistent in supporting the efficacy of explicit, systematic, language-focused instruction, regardless of the presumed origin of the disability. Current research emphasizes the mixed nature of most language-based reading disabilities, the changing nature of reading disability over time, and the fallacy of single-solution approaches such as isolated training in phoneme awareness, singular focus on phonics, or fluency practice that excludes other essential components of instruction (e.g., Adlof & Perfetti, 2014; Elliott & Grigorenko, 2014; Perfetti, 2011; Vellutino, Tunmer, Jaccard, & Chen, 2007). What should vary in informed teaching is the instructional time, depth, and sequencing of activities aimed at building skill in phonology, phoneme-grapheme correspondences, spelling, morphology, word meaning and use, syntax, and/or discourse comprehension (Calhoon & Petscher, 2013; Calhoon, Sandow, & Hunter, 2010). Instructional priorities, in turn, should depend on the nature of the student's difficulties and his/her point of progress on the continuum of reading development.

A well-prepared teacher, then, must have a solid grasp of both the complexities of English orthography and the language systems that print represents in order to teach students recognition of written words. Without such knowledge, the teacher is likely to promote guessing strategies ("What might make sense here?"), bypass strategies ("Skip that and go on."), the belief that accuracy does not matter ("Nice try."), or rote memorization of higher frequency words. To teach text comprehension, the teacher needs substantial preparation in how to teach word meanings, sentence structures, referential and cohesive aspects of text, and overall text organization. Without that background, teachers are much more likely to rely on formulaic comprehension strategy approaches, reading aloud or passage rereading as a substitute for teaching students how to interpret the text, or discussion of the content of the passage without attention to the manner in which meaning is conveyed. Even if they use one of the many well-designed and scripted intervention programs, teachers must rely on background knowledge of their own to tailor lessons for individual students. The following three aspects of individualization, and the insight they require, can serve to illustrate how knowledge of language can inform teaching.

Interpreting errors and designing corrective feedback

Suppose an 8-year-old student, while writing to dictation, writes WOCD for walked, TRANDED for trained, and WONTER for wanted. The consistency of confusion about the past tense inflection should signal to the teacher that careful, incremental teaching will be necessary before the student will consistently spell this apparently "simple" grammatical element. But teaching this concept is more complex than it might appear on the surface. Learning to use the past tense in spelling requires attention to meaning, morpho-syntax, orthography, and phonology. First, the student must learn that the English regular past tense has three pronunciations (/t/, /d/, /əd/) that are governed by the properties of the final phoneme in the base word. A base word ending in a voiceless consonant such as /s/ (kiss) adds the voiceless /t/ as the spoken form of the past tense (kissed). A base word ending in a voiced consonant or vowel such as /m/ or /ou/ (hum; vow) adds the voiced /d/ for the past tense (hummed, vowed). And base words ending in /d/ or /t/ add the syllable /əd/ (wanted, ended). The spelling "ed" looks like a syllable but in most instances is not pronounced as a

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syllable; it is a stable morpheme preserved in orthography to convey meaning. To explain this ubiquitous inflection so that it makes sense to the learner requires reference to consonant/vowel distinctions, voicing and devoicing of consonant phonemes and vowels, reduction of the vowel in /əd/ to schwa, syllabification, and morphemic analysis. The past tense is linguistically complex, and for those who have limitations in linguistic awareness, must be learned gradually along with the prerequisite underlying concepts of language structure. Even then, persistent errors on inflections are very common in the writings of students with underdeveloped language skills (Moats, Foorman, & Taylor, 2006).

Ordering of concepts and choosing an approach

An 8th grade student, with IQ in the mid-average range (96), has a severe reading disability (1st %ile). He reads *bick* for brick; *fish* for flesh, *pern* for prop, *flake* for fake, and *bove* for brave. The student is unable to read the words *drove, flake, globe*, and *crime* in a list. When asked to segment spoken words into phonemes, the student is unable to orally segment words such as "blot", "trip", or "treg" and treats each as if it has three phonemes, unitizing the consonant blends. Given the student's underlying phonological disability and the revelation that no phonological skills were ever addressed in prior instruction (the school had been pursuing a "whole language" approach, to bypass the student's weaknesses), a remedial specialist would have to choose: What first? What next? With what method? Do I even try to address this problem? Can this student learn to read? These decisions are difficult, but must at least be informed by awareness that reading and spelling words with blends is more challenging than reading words with single consonants; that the phonemes /l/ and /r/ are particularly problematic for students with phonological disabilities; that accurate reading and spelling requires the ability to identify all phonemes in a syllable; that phonological awareness can be improved by multisensory techniques wherein the articulatory feel, mouth shape, and sound of a phoneme is emphasized (Ehri, 2014; Liberman, 1999); and that inclusion of encoding activities in the lesson is more likely to result in progress than phoneme awareness or decoding only (Weiser & Mathes, 2011).

Seeing opportunities for language instruction presented by text

Referents and cohesive devices can be missed by students who are laboring to decode words or who are not attending closely to meaning. If the text says, "Firefighters who fight wildfires often set backfires to clear the terrain. They can create a dangerous inferno," an alert teacher might pause and ask, "What does the word 'they' refer to?" The question would be motivated by knowledge that poor comprehenders fail to process cohesive and referential aspects of text, including pronoun references (Cain & Oakhill, 2012; Oakhill & Cain, 2012). If the text uses figurative language ("button your lips") or idioms ("she froze in her tracks") to express ideas, the teacher might pause to ensure that students can paraphrase the non-literal meanings. If the text says, "Barry, who had refused to play after he had been offended by David, failed to take his position," the teacher might pause to ask who had offended whom. Passive voice, long sentences that split the head noun from the main verb, and many other syntactic landmines interfere with text comprehension, so the informed teacher must be vigilant in helping students monitor whether they are understanding or not. Rarely does any teacher's manual anticipate the enumerable ways that students misinterpret what is intended; there is no substitute for a teacher who recognizes what is challenging about the words and what might be done to explicate the meanings.

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What, then, would an informed teacher of students with reading difficulties know and be able to do? In teaching word-level reading, the professional should be prepared to explain a word from any of several angles: the history of the language; morphology (inflections, prefixes, roots, derivational suffixes, compounds); phoneme-grapheme correspondences; position-based constraints on those correspondences; orthographic rules peculiar to English, such as the syllable spelling conventions; and occasionally, syntax and word use (Moats, 2010; Snow, Griffin, & Burns, 2005). Further, the teacher should be able to select and use – if not design – a logical pathway through this maze of information. The system of symbolic representation in English – or any alphabetic orthography – consists of categories of elements with properties and features; any single element can be understood in relation to others. An element can be talked about and understood in relation to the whole, and as Willingham (2006) has pointed out, students are much more likely to remember something they have thought about and that makes sense. Many popular methods and programs claim to have a phonics component but lack a scope and sequence that covers the full range of patterns in English orthography. Further, they often fail to make sense of the linguistic concept being taught, instead treating the whole subject of the written code as a hodge-podge of unrelated bits of information. In some, phonics is presented as bitter medicine, to be taken in small doses and appealed to as a last resort. Incremental teaching is impossible, however, without a defined, logical, and comprehensive roadmap of the content, and it is this coherence of subject matter that is so often missing in programs, textbooks, and teacher education courses.

For the subject of language to be taught coherently, all layers must be considered in sufficient depth for the teacher to manage word recognition, text comprehension, and written expression problems. While teaching comprehension, the teacher should, for example, be able to examine the text at hand for aspects of form and structure that poor comprehenders might not understand, and design the lesson in response to the challenges presented by the text. Not only would direct teaching of key vocabulary be necessary, but also direct teaching of cohesive devices, transition words, academic syntax, and text organization.

To integrate all of the essential instructional components named in the National Reading Panel report (National Institute of Child Health and Human Development, 2000), as well as writing and oral language use, a teacher should appreciate the interdependencies of these components. For example, vocabulary learning is facilitated by phonological awareness (Ehri, 2014; Perfetti, 2011), and students' ability to write is related to proficiency in using phonic word attack strategies and to manipulate a writing implement (Berninger & Wolf, 2009). Language processing is the "unitary construct" underlying the acquisition of reading skill (Mehta, Foorman, Branum-Martin, & Taylor, 2005; Perfetti, 2011); therefore, the effective teacher will be able to address all dimensions of language learning – or at least recognize that cross-referencing word form, meaning, and use is a purposeful enterprise.

If this characterization of the professional knowledge required to teach literacy makes sense so far, then the next most obvious question to ask is why so few teachers have this level of expertise.

Barriers to progress

Institutional shortcomings

The first answer, in the USA at least, is that scientifically grounded concepts of reading acquisition and information about language structure are not taught in the majority of

teacher preparation institutions. The National Council on Teacher Quality (NCTQ; www.nctq.org) in its recent review of over 1000 teacher training institutions (Greenberg, McKee, & Walsh, 2013) found that only 29% of the institutions required coursework pertaining to four or five of the five essential components of instruction identified by the National Reading Panel (phoneme awareness, phonics, fluency, vocabulary, comprehension). The majority of schools – 59% – addressed two or fewer of those components – taking into consideration all relevant courses offered by the institution. Even more disappointing, 78% of the schools were deemed inadequate in preparation for teaching "struggling readers" – a non-specific term that includes students with learning disabilities.

There are many reasons why coursework for teachers has remained impervious to scientific evidence regarding the nature and treatment of reading disabilities. The gulf between science and the educational philosophies held by many faculty members in schools of education is discussed in detail by Seidenberg (2013). Beginning with a review of historical influences on education in the USA, Seidenberg accurately portrays deep differences between the cultures of reading science and reading education, the anti-intellectual and anti-science bias in our schools of education, and the destructive, enduring influence of mis-placed constructivist ideas that continue to have a firm grip in reading and literacy education. He is correct that teachers learn mainly about values or ideas such as multi-culturalism, text characteristics (Level A, M, or Z?), and vaguely defined "literacy practices," and are taught to rely on intuition, self-reflection, personal experience, and anecdotal evidence as they develop their teaching habits. Many are actively taught to be suspicious of scientific research.

Another reality, moreover, must be brought to light to understand why teachers are not equipped to teach reading. In a brave study published in a leading scientific journal, Binks-Cantrell, Washburn, Joshi, and Hougan (2012) compared university faculty members' responses to those of their students on a survey of language and reading knowledge. Overall rates of correct responses were startlingly low among the university faculty who were responsible for teaching teachers how to teach reading. For example, only 15% were familiar with the five essential components of reading named in the National Reading Panel report. Only 29% knew that "frogs" has two morphemes, and only 26% knew that "observer" has three morphemes. Only 58% recognized the correct definition of phoneme awareness from multiple choice items, most often confusing it with phonics. Only 65% recognized a word (napkin) with two closed syllables. On every item of the survey, student teachers scored less well than their professors, as might be expected. The authors named this the "Peter principle" – which states that one cannot give to others what one does not have oneself.

Absence of incentives for practicing teachers to change

In a recent study of the impact of professional development on working first grade teachers, Brady et al. (2009) found that experienced teachers came into their study knowing no more about reading and language than novice teachers, as measured on objective assessments. This finding suggests that teachers do not learn how reading works just from being exposed to reading programs or from spending years in the classroom. The underlying psychological mechanisms of reading acquisition are not self-evident, and the fact that some students learned to read easily lead teachers to attribute other students' reading failure to anything other than the instruction they were providing. Further, some of the most experienced teachers tended to be the most skeptical of Brady's professional development project and the most inclined to reject information about explicit teaching of

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language structure if it challenged their prior beliefs. In the experimental schools, there was no established process for evaluating teachers on their ability to implement the evidence-based practices they were being taught. Similarly, the more eager participants who obtained better results, did not receive either monetary rewards or professional recognition for the quality of their work. The teachers who chose to adapt did so entirely for the intrinsic reward of getting better results with students and for believing that the researchers had something important to teach them.

Ubiquitous misinformation

A clear obstacle to improvement of the disciplinary knowledge base for reading instruction is the dearth of good textbooks and teaching materials for teacher preparation and professional development. Walsh, Glaser, and Dunne-Wilcox (2006), in the first NCTQ survey of reading courses, found that the most popular texts used in reading courses failed to address the five essential components of instruction identified by the National Reading Panel. Any information provided about language and reading research was skimpy or inaccurate most of the time. Joshi, Binks, Graham, et al.'s (2009) study of textbooks echoes and elaborates those findings. Not only do the most often-used textbooks in reading fail to explain the essential components of research-based instruction, but also outright misinformation about the findings of research on reading acquisition, the nature of English orthography, and the difference between phonology and phonics are found in the majority of texts.

Spencer, Schuele, Guillot, and Lee (2008), for example, reported that the instructional materials used by the teachers in their study contained many errors of linguistic analysis. The word *ox* was identified as having two phonemes (it has three, /ŏ/ /k/ /s/) and *off*, *on, olive*, and *one* were identified as beginning with "the sound for the letter o," although these words begin with the phonemes /au/, /ŏ/, and /w/. Details matter; with such inaccuracies, both teachers and their students may conclude that the orthographic code is nonsensical.

More specialized concepts about language that are seldom taught but that are also relevant to both assessment and instruction include etymological features of words; the identification of schwa (the unaccented, indistinct vowel so common in Latin-derived 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.

Surprisingly elusive concepts

Research accumulated to date shows unequivocally that teachers, even those who are experienced or those who specialize in learning disabilities, often are unaware of or misinformed about the elements of language that they are expected to teach explicitly. Concepts such as phonemes, graphemes, syllables, morphemes, basic parts of speech, sentence structures, and narrative or expository discourse organization are the meat and potatoes of explicit, systematic instruction, yet teacher education programs do not routinely own responsibility for ensuring that practitioners know what's what, or why any of this is important. That reasonably bright, literate professionals as a group seem either indifferent or outright hostile to the importance of this content continues to be puzzling.

On one hand, terms such as phoneme awareness and morphology appear in widely disseminated documents such as the Common Core State Standards (CCSS) adopted by the majority of the USA. On the other hand, few people understand what those terms

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mean. Spencer et al. (2008), reported that "the phonemic skill level of the reading and special education teachers was not sufficient to provide accurate phonemic awareness intervention . . . " and "many teachers had specific misconceptions about speech and print (p. 517)." For example, only 55% of teachers accurately indicated that the word *stop* has four phonemes, even though this item was one of the easiest on the survey of teachers' ability to segment words into their phonemic constituents. Spencer concluded that "effective training must help educators to thoroughly understand that speech maps to print (and not the reverse), to analyze speech without reference to print, and ultimately, to think clearly about how speech maps to print (p. 518)", because gaps in understanding were so pervasive. What does seem obvious after studies like Spencer's and others' (Fielding-Barnsley, 2010; Washburn, Joshi, & Binks-Cantrell, 2011) is that literate adults have forgotten what was involved in learning to read. The skills they employ as fluent readers are unconscious and beyond introspection; they have lost the ability to reflect on speech independently from print, and reconstruct what was involved in learning the alphabetic code.

In addition, educators may assume that anything taught in kindergarten or first grade, or at a foundational level for poor readers, should already be known to them because it is part of the early elementary curriculum. Therefore, they do not believe that study of orthography, for example, could be a richly rewarding experience that would enable them to explain any printed word to their students. In our new national Common Core standards, the foundational skills of reading literally are given a back seat to comprehension, placed toward in the rear of the document. The topic of foundational writing skills is not treated at all, and the topic of "language" is divorced from both reading and writing. No wonder educators come to believe that they already know what is necessary to teach students how to read, and that good teaching is focused almost exclusively on "close reading" of complex text, regardless of the student's level of readiness.

Ironically, research indicates that educators who understand the least about the details of the alphabetic system may be the most hostile to learning more about it – possibly because the need to know, again, is not self-evident to a fluent reader. Cunningham, Zibulsky, and Callahan (2009) documented that preschool teachers tend to overestimate their knowledge of phonological skills, the alphabetic principle, phonics, and early reading acquisition in relation to objective assessment. Cunningham's group (Cunningham et al., 2004) had previously shown that elementary school teachers did not accurately calibrate their knowledge in relation to the results of objective assessments. Teachers with higher levels of awareness of language structure tended to underestimate what they knew, whereas teachers with lower levels on objective measures tended to overestimate what they knew.

The inaccurate self-assessments may also diminish teachers' receptivity to learning more about the "technical" aspects of their discipline. Cunningham et al. (2004) reported that first grade teachers' priorities and preferences in beginning reading instruction typically did not conform to models substantiated by current research. Even special education teachers did not favor intensive code-based instruction for students at risk. Teachers with more knowledge of the orthographic code were somewhat more inclined to spend time teaching phonics, but overall, the content knowledge of first grade teachers was relatively low and the teachers preferred to spend their time on literature-based activities and independent reading and writing.

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Insufficient time allotted to foundational content in teacher training courses

Courses provided in teacher training programs are often insufficient in content and design to enable students to learn the subject matter and apply it to the teaching of reading (Walsh et al., 2006). Even when courses are well designed and focused on teaching substantive understandings of reading psychology and individual differences, the few hours allotted to the study of language, language-based learning, and instruction may not be enough to enable prospective teachers to achieve high levels of mastery (Spear-Swerling, 2009; Spear-Swerling & Brucker, 2003, 2004). As Cunningham et al. (2009) reported, teachers learn at different rates and often begin their coursework or professional development with inaccurate ideas about how much, and what, they should learn to be effective in the classroom. Many need direct feedback about the differences between their actual knowledge and what they believe they know. Some will need much more time to learn concepts that are abstract and inaccessible than survey courses allow. Many, like their students, have poorly developed phonological skills that must be bolstered through considerable practice. Very few come into teaching with appreciation for scientific inquiry and how research can inform their practice. A response-to-intervention model makes sense for teachers, too, wherein formative assessments and progress-monitoring tools are used to inform teachers about their attainment of content mastery, and extended learning opportunities are available for those who need them.

McCutchen et al. (2002) and McCutchen, Green, Abbott, and Sanders (2009) have been among those researchers able to demonstrate how much time it takes to impart the necessary understandings to teachers of beginning reading. McCutchen's group, in the first study, measured kindergarten and first grade teachers' knowledge and the relationship of growth in that knowledge to student outcomes. Teachers' (n=44) initial grasp of terminology and concepts in early reading instruction was very low in comparison to what the researchers expected. However, researchers also demonstrated that their 24 teachers in the experimental group could significantly improve if sufficient time was devoted to filling in the gaps in their professional knowledge base. In this case, an intensive 2-week summer institute followed by monthly seminars through the year produced gains in teachers and corresponding gains in their students, across a range of outcome measures.

During the 2-week summer institute, the instructors dwelt on the difference between the English spelling system and the speech sound system, 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. Teachers 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 control or account for teachers' choice of instructional materials once they went back to the classroom; rather, the 24 participating teachers used varying tools in their K-1 classrooms.

One year of monthly follow-up meetings and school visits from mentors was necessary for teachers to translate the information into practice. Ultimately, students in the experimental teachers' K and first grade classes obtained significantly better results than comparison students on measures of phonological awareness, oral reading fluency, reading comprehension, spelling, and compositional fluency. 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; first 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 enhances the effectiveness of their teaching. This approach, focused on the underlying knowledge for successful implementation, worked as well for the teachers of struggling students in grades three through five (McCutchen et al., 2009).

Spear-Swerling and Brucker (2003, 2004) investigated the relationship between novice teachers' word structure knowledge and the progress of second grade children tutored in a clinical setting. 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 hours of instruction during the course was not sufficient to bring all teacher candidates up to the ceiling of the test. In a 5-year study conducted in high poverty, urban schools (Moats & Foorman, 2008), we spent at least 30 hours of workshop time on *each topic* – phonology, phonics, vocabulary, comprehension, and writing – ultimately to the significant benefit of participating teachers and their students.

As we continue working with practicing teachers across the country, we consistently find that the most elusive concepts about reading and language that take the most time to teach are: (1) the distinction between speech sounds (phonemes) and the letters or graphemes that represent them; (2) the ability to detect the identity of phonemes in words, especially if the spelling of a word does not bear a transparent relationship between phonemes and graphemes; (3) knowledge of orthographic patterns in English, such as the rule that no word ends in plain "v"; (4) conceptualization of functional spelling units such as digraphs, blends, vowel teams, and silent-letter spellings; (5) the conventions of syllable division and syllable spelling; (6) the identity of phrases and clauses in sentences; and (7) the organization of narrative and expository texts. Of course all of this information can be taught to teacher candidates and to practicing teachers, but once-over-lightly treatment is not sufficient to prepare anyone for the challenges of teaching literacy to students who lack aptitude for easy processing of written language.

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Is positive change possible?

It has been 20 years since I first wrote about the obvious: that intervention specialists, along with our general education colleagues, are often poorly prepared to understand the scientific foundations for good and poor reading and writing. In many teacher preparation programs, at least in the USA, there are no courses on the psychology of reading and cognitive development, on language acquisition, or the structure of language, spoken or written. The language differences that characterize students of more and less educated families, or of English learners, are seldom studied at a level that allows teachers to compare and address differences between indigenous language and academic English.

Adoption of the CCSS in the USA has not been helpful in this regard. Presently the target of much discussion and political manipulation from both the political left and right, the Common Core was intended to provide all 50 states in the USA a common set of academic goals at each grade level that would promote richer curricula and rigorous teaching comparable with other advanced societies. The intention was commendable, but

the document itself obscures the important relationships between language, reading, and writing, and between lower level (foundational) and advanced reading and writing skills. In addition, implementation so far has marginalized students in the lower end of the academic spectrum, including the less privileged and students with learning disabilities, and directed teachers away from explicit, systematic skill-building. As a consequence of our national anxiety about unflattering international comparisons, teachers are being asked to give their students harder texts to read and more challenging writing assignments, regardless of whether those students have the prerequisite skills to be successful. This turn of events is another sign that the education community, let alone the general public, has not grasped what is involved in learning to read and why so many students struggle to become literate. We have a long way to go before reading science goes mainstream.

Not all is lost, though, as there are a few very positive initiatives to promote and improve teacher preparation in the area of reading difficulties.

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Higher education consortia

Texas led the way in establishing a higher education consortium to improve and update university course content in reading (Higher Education Collaborative, 2006). Supported with a combination of state and university funds, faculty who teach reading courses were invited to participate in a cooperative effort to improve their courses' alignment with research. Several 100 course instructors voluntarily joined in the effort to share syllabi, textbooks, and ideas for assignments. The consortium has produced tangible improvements in the content and requirements of general and special education coursework related to reading instruction (Joshi, Binks, Hougen et al., 2009). Student teachers prepared by faculty members who have participated in the Collaborative have been shown to obtain better student outcomes than instructors from non-participating programs (Binks, 2008; Binks-Cantrell et al., 2012; Joshi, Binks, Hougen, Dean, et al., 2009). Other states (and international communities) might consider replicating this model, which includes several face-to-face meetings yearly, consultation from researchers, and an active series of web-based exchanges among participants.

One dilemma in formulating an approach to teacher training is how to challenge the established schemas of educators who believe that learning to read should be easy or natural, and who are ready to blame parents, cultures, poverty, or laziness for students' failure to read. In our ongoing work with teachers, we take time initially to build insight and empathy with a "learning to read" exercise that requires participants to learn a novel symbol system. In the process of learning to read the unfamiliar code, participants regress to slow, dysfluent, early-stage reading behavior as they learn the new alphabet. This "experiential learning" episode is then followed by explicit teaching of basic theoretical frameworks that explain word recognition and its relationship to language comprehension, such as Perfetti's (2011). We build empathy by drawing analogies between learning to read and learning to play music, produce graphic art, or excel at athletics, endeavors in which individual aptitudes and motivation, genetic predispositions, and learning opportunities are readily understood by most.

We also find that it is important to validate teachers' prior beliefs about literature-based instruction as appropriate for students who learn to read easily and naturally (often students who are just like them). Teachers will be less defensive and more open if we emphasize the range of individual aptitudes for reading and ask them to gather data on children's basic skill levels very early in their training. Some need to see many examples of students who cannot spell or read short vowels, consonant blends, vowel teams, or

multi-syllable words before they are convinced that reading must begin with the basics. Finally, we use quizzes liberally throughout our workshops and courses, but always with the promise that we will teach teachers anything they do not fully understand. In consortium settings, we often share responsibility for generating test items – itself an activity that promotes more attention to detail and wider discussion of the knowledge base for teaching.

Ranking of institutions by the NCTQ

The independent NCTQ has for the first time conducted and published rankings of teacher preparation programs across the USA. Although these rankings are based on a very broad set of criteria that extend to practicum requirements, admission standards, and overall expectations, instruction in reading (for both general education and special education programs) is evaluated on the basis of its alignment with scientific research. Programs that are built around promotion of Reading Recovery and related materials, for example, are given low scores. Of course the ranking of programs is controversial (especially among the university faculty!), but has produced a lively national discussion and greater awareness among funding sources, policy makers, and the general public of just how much – and in what way – the teacher preparation programs must improve.

Adoption of knowledge and practice standards for teachers of reading by the IDA

The International Dyslexia Association (IDA) formed a committee in 2009 to establish knowledge and practice standards for teachers of reading. The IDA board had determined that existing sets of standards, notably those already generated by the International Reading Association and the Council for Exceptional Children, lacked specificity, clarity, scientific grounding, and were insufficient to guide the preparation of teachers working with reading difficulties. The *Knowledge and practice standards for teachers of reading* (IDA, www.interdys.org) were deliberately titled to address the preparation of *all* teachers of reading, but the more advanced skills of a specialist were identified as well.

Following the adoption of the *Knowledge and practice standards*, IDA invited teacher preparation programs to volunteer for accreditation reviews. Reviews of syllabi, evaluations, assignments, practicum requirements, and any other evidence bearing on the program's alignment with the IDA standards were conducted by independent teams. To date, after two rounds of reviews over the past 3 years, 18 teacher certification programs have received IDA's seal of approval. Accredited programs range from those in a large state university to those in small, private, specialized schools. Institutions who have been accredited report a significant increase in applications from qualified candidates who are seeking substance and value in their training program. The "value added" approach is also stimulating wider interest in accreditation both nationally and internationally.

Also in the works is the development of a certification exam whose content is explicitly aligned to IDA's *Knowledge and practice standards*. This examination should serve as an internationally recognized measure of a teacher's qualifications to work with students with reading difficulties. With aligned coursework, a meaningful professional examination, and clear practicum requirements for specialists, we should be able to establish consistency in the definition of "professional teacher of reading."

To conclude, beginning with my own experience as a teacher, I and many colleagues have documented that both regular classroom teachers and specialists are often unprepared to carry out effective instruction with poor readers. We have verified that teacher

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preparation programs often fail to equip their candidates with knowledge of language structure, knowledge of scientific concepts of reading acquisition, or familiarity with scientifically grounded theories of individual differences in learning. Further, we have exposed the "Peter principle" – that teachers in training cannot learn what their faculty instructors do not know themselves. As a consequence, teachers often report feeling unprepared to work with students who struggle to attain reading and writing skills.

If the remedy for this problem were policy-driven mandates that courses and workshops include the requisite content, however, we might not have continuing controversies about the kinds of programs to deliver in schools, or large segments of the population who fail to learn to read adequately. States such as California and Massachusetts, for example, have long had clear curriculum standards that address the essential components of instruction. Yet in those same states, many students have low levels of literacy and many students with learning disabilities do not receive the instruction they most need. At this juncture, we have better insight into the barriers that prevent improvement in teachers' practices and that might help the field refine its approach to the training of teachers.

One lesson from existing studies of teachers is that experience and exposure have little bearing on what they understand about the students in front of them who are not "catching on." Therefore, experience is only moderately valuable in rating teacher effectiveness, and even experienced teachers should be asked to study and learn content they probably missed in their original training. Periodic, required professional examinations, aligned to clear standards for teacher knowledge, should be tied to continuation of training and advancement through the profession. Some aspiring individuals who want to teach reading to students with learning disabilities may not themselves have the linguistic awareness, verbal and reasoning abilities, or orientation toward research-based practices to continue in this role. We should advise them accordingly.

Second, we know that the adoption or prescription of well-designed instructional programs cannot compensate for a teacher who has little understanding of the content and methodology of the program (Piasta, Connor McDonald, Fishman, & Morrison, 2009). The quality of implementation of an instructional program has everything to do with its success. Quality of implementation, however, is greatly enhanced by mentoring and coaching by individuals who themselves are highly skilled (Carlisle & Berebitsky, 2011; Haager, Heimbichner, Dhar, Moulton, & McMillan, 2008). Even if the teacher knows what ought to be done, actually doing it (managing groups, using materials, pacing the lesson, and so forth) can be daunting for teachers. Unfortunately, current educational policies and funding practices continue to focus on texts and text difficulty, school organization, and student test scores – not teachers, the contexts in which they teach, or the leadership and continuous professional development required to ensure "teacher quality."

Third, we continually underestimate the elusiveness of the foundational content (phoneme awareness, phonics, grammar, spelling, text structure, and so forth) for adult teachers. Teachers often know little more than their students, especially about speech sounds in words, word structure, and its relation to meaning, the organization of orthography, or how to describe the parts of a sentence. None of us are born with these insights; we must learn a substantial amount of disciplinary content in order to help students understand what they are learning so that they can process text automatically. To compound the problem, teachers themselves overestimate what they know – unless they know a lot, in which case they underestimate what they know. Philosophical orientations also get in the way of practicing teachers learning more about what struggling students need from them. It seems that once a schema for the teaching of reading is established,

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either through a first course or through initial exposure to classrooms, it can be difficult to modify.

The adage, "telling is not teaching," applies to teacher education as well as to all else in schooling. Much of our energy is consumed by telling – that is, trying to get the right language and the best content into teacher training requirements, programs, textbooks, and workshops. We have expected that naming what we want will be sufficient to have it happen. We are still, however, in need of a science of how to teach the teachers, since "telling" has had only selective and modest effects. Perhaps more substantive evidence on some crucial questions might help our cause: What combination and sequence of experiences create the most indelible insights for teachers in training? What will engage them so that they persist with challenging students and advocate for them? How can teachers' prior beliefs be surfaced, discussed, and challenged (if necessary) in ways that engender cognitive shifts? How much metalinguistic awareness and verbal skill should be expected before teachers are even admitted to a training program? Within the confines of training programs, what concepts are most important to convey and in what order? What is the difference between knowledge needed by specialists and knowledge needed by regular classroom teachers, and what is the difference in training time? What kind of measures are valid for documenting professional competence?

Teaching reading and related language skills to students with learning difficulties is a complex task under the best of circumstances. To improve teacher quality and effectiveness, we must continue to argue that reading and writing instruction are content-laden teaching disciplines. In addition, we must get better at providing the kind of teacher education and professional development that results in knowledge of language and cognition, understanding of individual differences, and ability to implement effective practices. All teachers of reading should share a basic set of concepts with intervention specialists. Standards for knowledge and practice, meaningful training examinations with international credibility, informative textbooks and courses, expert mentoring, and greater rewards for those who demonstrate expertise are all areas in which we are making progress. A more robust science of teacher education in reading instruction should accelerate that progress in the coming decades.

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