# Background and Significance

Perhaps the most important job of schools and teachers is to ensure that all children become competent readers, capable of fully processing the meaning of complicated texts from a variety of venues. Reading proficiency in our information-driven society largely determines a child's academic, social, occupational, and health trajectory for the rest of his or her life. In a society that requires increasingly higher literacy skills of its citizenry, it cannot be stated strongly enough that teaching every child to read well is not an option, but a necessity. Every child that can read benefits society by being healthier, fully employed, and better informed.

Sadly, teaching every child to read is a goal we are far from achieving. Further, large portions of our children continue to struggle to become competent readers (National Reading Panel, 2000; Lyon, 2005). By the middle grades (grades 4-8), students are expected to demonstrate the ability to read and comprehend grade-level, content-area texts. Yet, for most middle grade students this is not their reality. The 2007 National Assessment of Educational Progress (Lee, Grigg, & Donahue, 2007) indicates that 74% of 8th graders nationwide struggle to read and gain information from their textbooks, thus, making success in school very difficult. Without adequate reading skills used to comprehend and apply information from text, these students frequently experience school failure. In fact, many students drop out of school as soon as they are able (Alliance for Excellent Education, 2006). Thus, the middle grades may be the last opportunity for older readers to "catch up" (Bryant et al., 2000).

Older struggling readers are often casualties of prior, inadequate reading instruction that insufficiently taught the critical skills necessary for fluent reading and deep processing of text. Many of these students are able to "catch up" in critical reading areas with sufficient and targeted instruction (Torgesen et al., 2007). However, many students in the middle grades have little access to effective reading instruction simply because there are no reliable and valid assessments that can help their teachers to provide targeted instruction tailored to their needs. Without effective assessments to assist teachers to provide data informed instruction, many students make little progress year to year. This lack of progress is particularly damaging during the middle grade years (grades 4-8) where learning content-area subject matter becomes a priority. Put succinctly, children who have not learned to read cannot read to learn.

These are not new findings. Overall reading achievement in the United States has remained flat since 1971 when national data were first reported. Because of this alarming and persistent trend, the National Institutes of Health (NIH) through the National Institute of Child Health and Human Development (NICHD) initiated a comprehensive multidisciplinary effort in 1983 to (1) map the cognitive, linguistic, perceptual, genetic, and neurobiological foundations of reading development; (2) determine the causes of reading failure, and (3) identify and/or develop effective interventions for struggling readers (Lyon, 1985, 1999, 2002; Lyon & Gray, 1992; Lyon & Moats, 1997). Beginning in 1997, and every year until 2005, NICHD program scientists testified on the status of this research in response to requests from Congressional House and Senate Education and Health Committees (Lyon, 1997, 1998, 1999, 2000, 2001, 2002b, 2003, 2004, 2005).

These requests were based, in part, on Congressional concerns that the consequences of reading failure went far beyond difficulties in school. NICHD scientists continue to report replicated data showing that reading failure not only constitutes an educational problem, but a social and public health problem as well. Specifically, low reading performance is the strongest predictor for a dropping-out of school. Consequently, dropouts are more than eight times as likely to be in jail or prison as high school graduates and nearly 70% of prison inmates score at

the lowest two levels of literacy (below fourth grade) with 19% being completely illiterate (Lyon, 1997, 1998).  Equally alarming is that poor reading portends adverse health disparities and outcomes including increased incidence of chronic illness, drug and alcohol abuse, risky sexual behavior, less than optimal use of preventive health services, difficulties accessing medical care, and difficulties understanding health risks (Lyon 2002a).

**The Need for Continuous Progress Monitoring**

While the statics for the long-term outcomes of reading failure are grim, the solution (i.e., reading success for all students) has thus far eluded our schools. While ultimately we want all children to leave the early grades reading, the fact that so many children leave the early grades without a firm foundation for reading suggests to us that teachers in the middle grades require help to better serve their students. Importantly, a number of efficacy studies have demonstrated that middle grade students are able to "catch up" in critical reading areas with sufficient differentiated instruction (Fletcher, Lyon, Fuchs, & Barnes, 2007; Torgesen et al., 2007). However, to receive such targeted instruction, their teachers first must have information about which areas and skills to target for which children.

Teaching that includes frequent monitoring of student progress has been shown to produce higher student outcomes in reading and mathematics than when monitoring is absent (Conte & Hintze, 2000; Mathes, Fuchs, Roberts, & Fuchs, 1998; Ysseldyke & Bolt, 2007). Also, teachers who use continuous progress monitoring (CPM) data to plan instruction have a more realistic conception of the capabilities of their students than teachers who do not regularly use student data to inform their decisions (Fuchs, Fuchs, Hamlett, & Stecker, 1991; Mathes et al., 1998). Thus, in order to differentiate, teachers must have reliable and valid CPM assessment tools to: (a) determine the specific reading needs of individual children at all levels of the achievement continuum; (b) determine which instructional methods and strategies would be most effective, and (c) monitor children's progress frequently (i.e., at least monthly) over time so that instructional changes can be made when necessary. Unfortunately, assessment tools for any grade level meeting all of these criteria are sorely lacking. Further, at the current time the only CPM reading assessments available for students in the middle grades require one-to-one administration by a teacher with a student.

**Continuous Monitoring of Advanced Reading Skill**

The typical infrastructure of the middle grades makes collecting frequent CPM data one child at a time is onerous for teachers and schools. By the middle grades, reading classes are taught typically for 45 minutes to groups as large of 30 students by one teacher. Even if the actual assessment time per child is fairly short, teachers find the process of collecting this data cumbersome and overwhelming (Foorman, Santi & Berger, 2007) Further, just collecting the data doesn't help teachers determine how to respond to the data. Even when provided instructional data on their students, many teachers find it difficult to determine the specific needs shared by several students and group students for differentiated instruction (Foorman, Santi, & Berger, 2007).

This situation is made more difficult because the teacher-administered CPM assessments currently on the market do not actually provide information on all critical areas of reading. Typically, reading fluency is the only area included for middle students (Silberglitt, Burns, Madyun, & Lail, 2006). Recent studies indicate that a more comprehensive assessment of reading ability is required for these students (Torgesen et al., 2007; Roberts, Torgesen, Boardman, & Scammacca, 2008; Scammacca et al., 2007). These syntheses suggest four key

areas of reading in the middle grades are significant in understanding comprehensive reading ability in middle students: (a) word analysis of multisyllabic words, (b) reading fluency that allows attention to be focused on understanding, (c) vocabulary development that helps students recall terms and provides interaction with students' prior knowledge by exploring semantic and syntactic relationships of text, and (d) reading comprehension skills.

**Significance of assessing word analysis**. Accurate and automatic identification of multisyllabic words is critical to comprehension of middle grade content-area texts (Deshler et al., 2001; Gersten, Fuchs, Williams, & Baker, 2001) and distinguishes good and poor readers (Perfetti, 1986). Good readers use word components or parts, such as knowledge of syllable types, prefixes, suffixes, and roots, to identify long, multisyllabic words (Lenz & Hughes, 1990; Perfetti, 1986). Targeted instruction in advanced word analysis can improve reading outcomes by teaching students strategies to effortlessly recognize increasingly more complex words they encounter in text (Scammacca et al., 2007).

A valuable way to assess word analysis is though spelling. Correct spelling requires that a student possess fully specified orthographic representation for each word, thus providing valuable information about the word analysis skilled owned by the student (Bourassa & Treiman, 2001; Ehri, 2000; Ehri & Wilce, 1987; Graham, 2000; Perfetti, 1997). We propose to ask students to spelling multisyllabic words, carefully selected to contain the various aspects of syllables, affixes, and roots. Scoring will occur at the syllable unit, rather than whole word, allowing us to assess not only growth in word analysis, but also provide diagnostic information about which aspects of the structure English words a particular student finds challenging.

**Significance of assessing fluency**. The ability to read connected text with both speed and understanding is the true hallmark of a fluent reader. Successful older readers identify most of the words in text "automatically," allowing them to focus on higher order processes, such as understanding, inferring, and interpreting (Archer, Gleason, & Vachon, 2003; Osborn, Lehr, & Hiebert, 2003). While fluency does not cause comprehension, it does play a facilitative role (Rasinski et al., 2005). Further, measuring fluency has been show to be a good gauge of overall reading health (Deno, 2003; Fuchs & Fuchs, 2008) in much the same way a thermometer measures general physical health. Current CPM measures of fluency consist primarily of oral reading tasks. However, such a task does not measure if students are monitoring meaning. We propose using a Maze task to measure both text processing speed and understanding, as required for assessing comprehensive fluency. In a Maze task, students read text in which every 5th to 7th word is blank. For each blank, students are given 3 or 4 choices with which to fill in the blank. Such tasks have been shown to highly correlate to oral reading tasks as well as to comprehension tasks (e.g., Deno, 2003; Fuchs & Fuchs, 2008). A second aspect of fluency that becomes increasing more important as students matriculate up the grades is their ability to reading text fluency while reading silently. We propose to assess fluency using both Maze and silent reading tasks.

**Significance of assessing vocabulary**. In the past decades, the importance of vocabulary knowledge in the development of reading skills has been extensively established in the literature (National Reading Panel, 2000). Moreover, for children historically at-risk of reading difficulties due to poverty and language background, oral language in general and vocabulary in particular are critical to reading success (Hemphill & Tivnan, 2008; Pearson, Hiebert, & Kamil, 2007). Students need instruction that accelerates their acquisition of new vocabulary and provides deep knowledge about words. Beck, McKeown, and Kucan (2002) suggest breaking words into three tiers. Tier 1 words are words students are likely to know (e.g., sad, funny). Tier 2 words appear frequently in many contexts (e.g., regardless, compromise). Tier 3 words appear rarely in text or are content specific (e.g., irascible, biogenetics). Beck and

colleagues suggest that teachers focus vocabulary instruction on tier 2 words drawn from content area materials that contain words that students are likely both to need (because they are encountered across contexts) and learn well (because students will have repeated opportunities for practice and use). However, Tier 3 words represent a specific challenge to students since these words represent the jargon of the content areas (Bravo & Cervette, 2008). We propose to focus our assessment on both Tier 2 words (general vocabulary) and Tier 3 words (content specific).

      **Signficance of assessing reading comprehension**. Reading well is a demanding task requiring coordination of a diverse set of skills (Irwin, 1991). Struggling readers, even those with adequate word-level skills and acceptable fluency, often fail to use these types of strategies, either because they do not monitor their comprehension or because they lack the necessary tools to identify and repair misunderstandings when they occur. Effective reading comprehension interventions have focused on helping students to become strategic readers by teaching them how to think while they are reading. Effective interventions have included single strategies such as finding the main idea and self-monitoring (e.g., Chan, 1991; Malone & Mastropieri, 1992) and multi-component strategies that targeted reading sub-strategies (e.g., Jitendra, Hoppes, & Xin, 2000; Schumaker, Deshler, Alley, Warner, & Denton, 1982). Additionally, student-led discussions of predictions, text structure, and summary development within interactive small groups have produced improvements in understanding and recall of expository text (Englert & Mariage, 1991). It is important that assessment of comprehension provide information about specific comprehension abilities that area amenable to instruction. We propose to assess four broad areas of comprehension that will allow us to assess general growth in comprehension, as well as provide diagnostic information to teachers to guide instruction. Specifically we propose to assess: (a) main idea, (b) cause and effect (c), inference, and (d) critical judgment. After silently reading passages, students will answer questions representing these four areas of comprehension ability.

## The Foundation for CMARS

      The current proposal represents an upward extension of previous work already completed by our group. We proposed and were awarded an NIH/NICHD Fast Track Grant to design, develop and validate a computerized assessment tool called Continuous Monitoring of Early Reading Skills (CMERS: pronounced SEE-mers). At that time our focus was on the prevention of reading difficulties. Thus CMERS was developed to assess children from kindergarten through grade 3 to provide teachers the capability to feasibly universally monitor reading growth with all children and identify children at risk for reading failure as an integral part the instructional routine. Because this assessment tool had to be easy to use and provide reliable and valid information to teachers, we developed the assessment tool so that even young children can complete the assessment independently within 20 to 30 minute sessions.

      Following the completion of this first NIH/NICHD SBIR product development effort, CMERS has now been successfully commercialized under the name istation's Indicators of Progress (ISIP™) Early Reading (Mathes, Torgesen, & Herron, 2007). Since its release in 2007, it has received wide acceptance in the schools, with over 400,000 children currently being monitored using this technology. Further, ISIP Early Reading has been approved by several agencies, such as the National Center for Response to Intervention (NCRTI) and the Texas Educational Agency (TEA), as a reliable and valid screener and continuous progress monitoring measure. While CMERS/ISIP Early Reading is starting to have a significant impact on the assessment of young children kindergarten through grade 3, it is not an appropriate measure for students in the fourth grade and beyond.

Similar to the assessment of reading competencies in younger children, it is imperative that we develop an assessment tool that targets the measurement of reading skills essential for reading and comprehending text at the fourth grade and beyond. This tool must be reliable, valid, and easy to administer to the entire class in a relatively short amount of time. Because of their extensive teaching responsibilities, it is extremely burdensome for teachers to manually administer and score numerous assessments. To make the process of collecting and using data feasible, teachers need a tool where the assessment data can be acquired independently through computer based assessment and scoring.

Our proposed development of this efficient assessment tool has several additional potential strengths. First, our proposed technology-based assessment will ensure objective and reliable measurement by removing variability associated with teacher administration and scoring. Second, the technology-based system that we propose provides instantaneous information to the teacher about student progress across many domains of reading (i.e. Word Analysis, Text Fluency, Vocabulary, and Comprehension). Third, our technology-based progress monitoring algorithms will have the capacity to link student performance data to customized instruction to ensure proficiency in skills and concepts not yet mastered.

Our development and successful commercialization of CMERS in kindergarten through the grade 3 encourages us to develop a reading assessment for middle grade students with equal reliability, validity, and potential to inform instruction. There is urgency to this goal. National statistics tell us that we need reliable, valid ongoing assessment that can inform instruction. However, such assessment is useful only to the extent that (a) assessment results can be put in the hands of the teacher quickly and interpreted easily to plan instructional objectives, and (b) the results provide ongoing information to parents, teachers, administrators, and policy-makers about the efficacy of different curricular and instructional decisions. Currently, there are no valid reading assessment tools for the middle grades that can precisely identify the reading abilities and deficits in all four critical domains for purposes of continuous and differentiated instruction.