Text Complexity

Accurate Estimates and Educational Recommendations

Renaissance Learning™
Advanced Technology for Data-Driven Schools

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Introduction

Recent trends in U.S. labor statistics indicate that those industries with high levels of projected growth and better salaries require postsecondary education (Executive Office of the President Council of Economic Advisors, 2009). According to the National Center for Education Statistics, in an effort to prepare for promising careers, more and more Americans are pursuing a college education (Radford, Berkner, Wheeless, & Shepherd, 2010). Although the number of students enrolling in postsecondary programs has been steadily increasing, many of those students are not adequately prepared for the challenges associated with higher education. A large proportion of college students need remedial courses, and many students are not able to graduate in a reasonable timeframe, if at all (Radford et al.).

Materials Gap

The difficult transition from high school to college may be exacerbated by a substantial "gap" in text complexity[1] between secondary and postsecondary materials (Common Core State Standards Initiative [CCSS], 2010). Research suggests the reading materials students encounter in college and career settings are significantly more difficult than materials students are required to read in high school.

Student capacity: Challenging young readers
As noted in a report by ACT, Inc., "Students who can read complex texts are more likely to be ready for college. Those who cannot read complex texts are less likely to be ready for college" (2006, p. 11). To address potential problems stemming from this materials gap, various education advocates have recommended that K–12 standards be adjusted to encourage reading more complex texts (e.g., ACT, Inc., 2006; CCSS, 2010). The hope is that incorporating more difficult reading into elementary, middle, and high school curricula with instructional supports will ultimately help high school graduates be more successful and comfortable with college and career texts.

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>
> ACT, Inc. (2006)

Text Complexity Measures

Given new information about the materials gap and responses suggesting we need to increase students' capacity for comprehending challenging text, there has been renewed interest in the accuracy of existing text analysis tools. Text analysis tools can be used to calculate estimates of the quantifiable aspects of text complexity. Such tools can be extremely useful in assisting educators to accurately judge the complexity of various reading materials and in setting appropriate developmental guidelines for student reading; however, text analysis tools are only useful if they can provide valid (i.e., accurate) and reliable (i.e., consistent) estimates of the quantitative dimension of text complexity.

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[1] The terms *text difficulty* and *text complexity* are often used interchangeably.

ATOS

Renaissance Learning developed the accurate and user-friendly text analysis tool ATOS.[2] The product of an intensive research process, ATOS takes into account the most important quantitative predictors of text complexity—average sentence length, average word length, word difficulty level, and total number of words in a book or passage. ATOS is provided by Renaissance Learning as a free text analysis tool. Information about the development of ATOS is available in a published technical report (Milone, 2009), and text may be analyzed at no charge at http://www.renlearn.com/textcomplexity/default.aspx. More than 145,000 books have already been analyzed, with ATOS book levels and other information (e.g., author, interest level, student ratings, fiction/nonfiction) available using the AR BookFinder (http://www.arbookfind.com) online search tool.

ATOS is typically reported on a grade-level scale so that both student achievement and books share the same easy-to-interpret metric. There are two versions of ATOS: ATOS for Text and ATOS for Books. ATOS for Text is designed for use with short text passages. ATOS for Books is for use with books and expands on ATOS for Text by adjusting for book length and variations in internal structure. As the text analysis tool for the Accelerated Reader (AR) program,[3] ATOS is arguably the most widely used system for matching books to students in the United States (Resnick, Sanislo, & Oda, 2010).

Independent evaluation of ATOS as a text complexity measure

In an objective evaluation of text complexity measures, Student Achievement Partners[4] and researchers from the University of Pittsburgh conducted a study assessing the validity of ATOS and five other text complexity metrics: Lexile (MetaMetrics), Degrees of Reading Power: DRP Analyzer (Questar Assessment, Inc.), REAP (Carnegie Mellon University), SourceRater (Educational Testing Service), and the Pearson Reading Maturity Metric (Pearson Knowledge Technologies) (Nelson, Perfetti, Liben, & Liben, 2011). The evaluation involved obtaining text complexity ratings for reference measures of both text grade level[5] and student performance.[6]

As an initial step in the study, mean ATOS levels were computed for a sample of exemplary grade level, college, and career text passages specified by Student Achievement Partners (see Figure 1). The trend for mean ATOS levels was consistent with previous research indicating a gap between secondary and postsecondary text complexity levels.

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[2] ATOS has also been referred to as a *readability formula*. The terms readability formula and *text analysis tool* can be used interchangeably; we use text analysis tool in this paper to refer to a system for estimating the quantifiable dimension of text complexity.

[3] To learn more about AR and the CCSS, see *Accelerated Reader, ATOS, and the Common Core State Standards* (Renaissance Learning, 2012).

[4] A nonprofit organization founded by three of the contributing authors of the Common Core State Standards.

[5] Grade level reference measures included passages from Appendix B of the Common Core State Standards, standardized state tests, Stanford Achievement Test (SAT-9), Gates-MacGinitie Reading Test (GMRT), and MetaMetrics Oasis platform.

[6] Rasch scores reflecting student performance were obtained for SAT-9 and GMRT passages.

Figure 1: Mean ATOS Level Estimates for Reference Text Examples
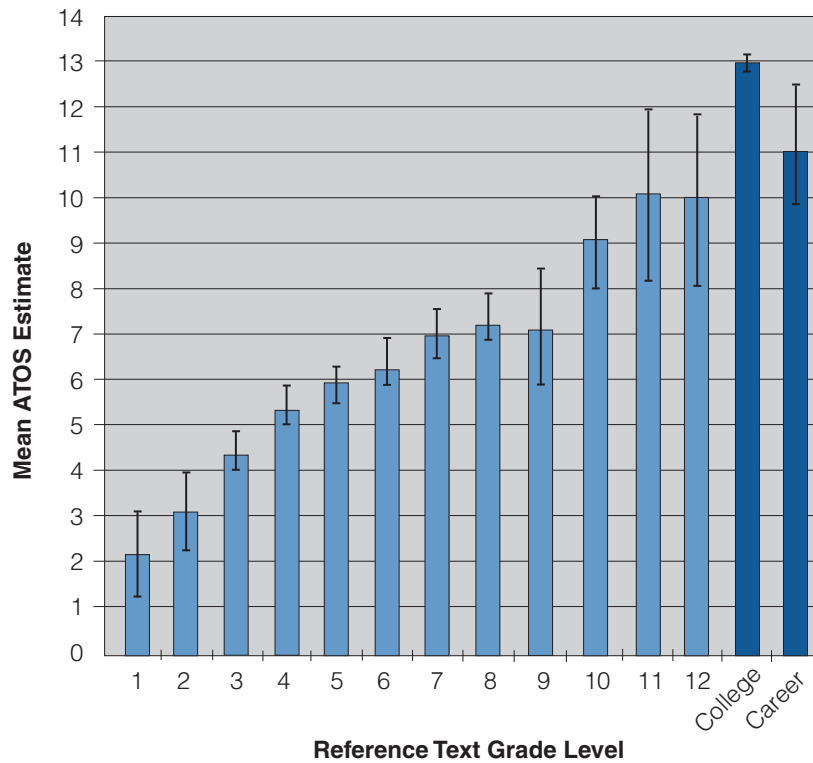
Note: In addition to mean values, standard deviations are depicted using error bars (I) to reflect the variance in complexity estimate of the example reading materials in each grade level.

Nelson et al. (2011) then compared the text complexity estimates generated by ATOS and the five other metrics to the predetermined text complexity rating of the reference passages. The results indicated that all six metrics were similarly capable of accurately and reliably predicting the reference measures of text complexity (see Figure 2). Specifically, the report concluded that "All of the metrics were reliably, and often highly, correlated with grade level and student performance-based measures of text complexity across a variety of text sets, and across a variety of reference measures" (p. 46).

Figure 2: Text Complexity Measures Studied Provide Valid, Reliable Correlations to Reference Text Difficulty
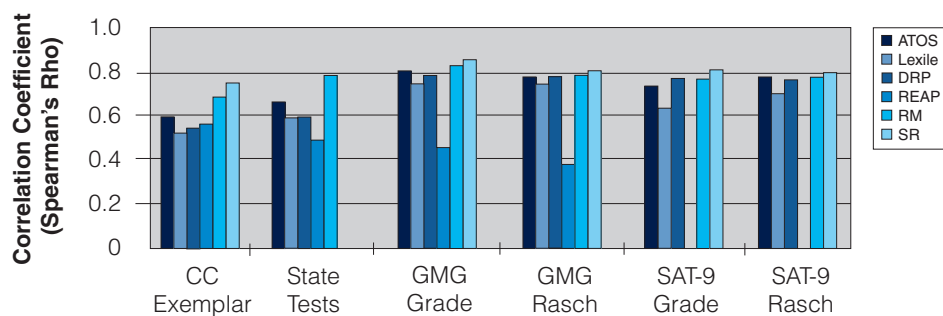
Note: Data from Appendix A of Nelson et al., 2011, p. 53. Explanation of scores not shown: REAP for SAT-9 texts—Access "required a legal agreement between institutions" (p. 25). SR for state tests texts—"Did not meet ETS criteria for valid grade level (see notes); classified by ETS as mixed genre" (p. 21).

Text Complexity Recommendations

Having verified the validity of ATOS and other widely used measures, Nelson et al. (2011) included a practical extension of the initial results. Following guidelines from the study authors, and working backwards from the estimates of college and career reading expectations, Renaissance Learning staff computed new Text Complexity Grade Bands to indicate the ranges of text complexity needed throughout schooling for students to be college and career ready by the end of high school.

For each grade, a Text Complexity Grade Band estimate was computed for the 25th, 50th, and 75th percentiles (see Table 1). Students able to comprehend text with ATOS levels between the 25th and 75th percentiles would be reading within the recommended Text Complexity Grade Band range.

Table 1: ATOS Text Complexity Grade Bands: Recommended Reading Levels for College and Career Readiness

Grade	Bottom (25th Percentile)	Middle (50th Percentile)	Top (75th Percentile)
1	1.57	2.52	3.30
2	2.75	3.62	4.21
3	3.89	4.69	5.14
4	4.97	5.74	6.08
5	6.01	6.75	7.03
6	7.00	7.74	8.00
7	7.93	8.70	8.98
8	8.82	9.64	9.98
9	9.67	10.55	10.99
10	10.46	11.42	12.01
11	11.20	12.28	13.05
12	11.90	13.10	14.10

These Text Complexity Grade Bands represent a new approach to evaluating whether students are on the pathway to college and career readiness (CCR) in terms of being capable of comprehending sufficiently complex text. Development of the Text Complexity Grade Bands involved making a small adjustment to the expectations for each grade, with the cumulative result by the end of grade 12 being sizable (see Figure 3). The pattern of Text Complexity Grade Bands inherently suggests that the gap between secondary and postsecondary materials cannot be resolved by addressing grade 12 curriculum alone; rather, students at every grade level need to comprehend more difficult text than what is currently required.

Figure 3: Adjusting Text Complexity Goals for Each Grade Level: ATOS Level Ranges for Reference Texts Versus New Text Complexity Grade Bands
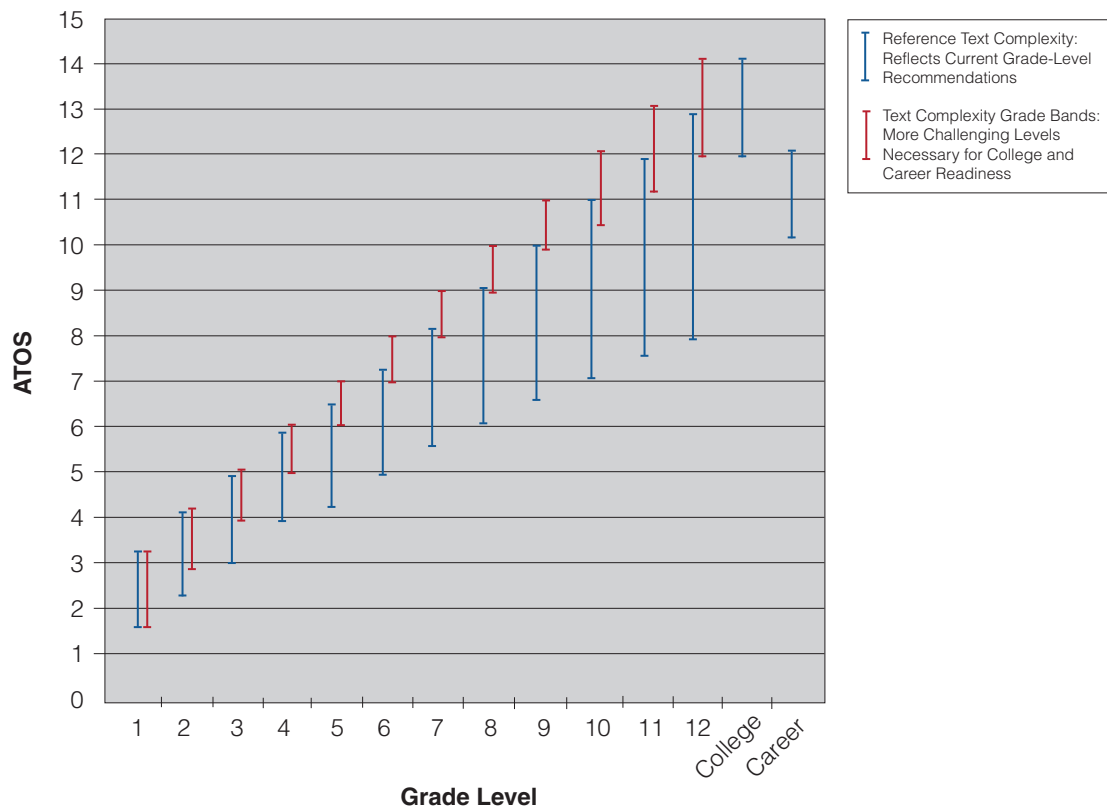
A second set of specifications was developed to correspond to the Common Core State Standards (2010) by condensing the Text Complexity Grade Bands from Table 1 according to CCSS grade band as shown in Table 2.

Table 2: ATOS Text Complexity Grade Bands for Common Core State Standards Grade Bands

CCSS Grade Bands	Recommended ATOS Level Ranges
2nd to 3rd grade	2.75 to 5.14
4th to 5th grade	4.97 to 7.03
6th to 8th grade	7.00 to 9.98
9th to 10th grade	9.67 to 12.01
11th grade to CCR	11.20 to 14.10

In general, the Text Complexity Grade Bands that relate to the CCSS grade bands suggest that students should be able to read and comprehend texts that ATOS would define as approximately at or above grade level; however, the CCSS intend for this recommendation to be an end-of-year goal achieved with scaffolded **instructional** supports, and not a guideline for daily, independent reading practice. The CCSS point out that a key component of text complexity is "reader-task considerations," which means taking into account a student's current reading achievement level, motivation, and background knowledge as well as the purpose of the reading and any associated tasks.

Likewise, Renaissance Learning recommends matching appropriate books to students using zone of proximal development (ZPD) ranges that reflect grade equivalent scores provided by a standardized test of general reading achievement such as the norm-referenced STAR Reading assessment. Based on STAR Reading performance, students receive a ZPD range (expressed in ATOS levels) meant to encourage them to read books that are neither too easy nor too difficult given their current reading achievement level (Renaissance Learning, 2012). Reading within an individualized ZPD makes it more likely that students will be able to derive the meaning of new words and understand unfamiliar concepts by using the known portions of text (Paul, 1996). In other words, when guiding students to independent reading that will be most beneficial, Renaissance Learning suggests that educators consider a student's reading performance level more so than their current grade level.

ZPD Study: What Happens if Students Read Above or Below Their Zone?

Little research has been conducted on the consequences of having students read more challenging text. To better understand this recommendation, Renaissance Learning conducted a study of the reading patterns of more than 2 million students using the Accelerated Reader program during the 2009–2010 school year.

The Reading Practice Quizzes featured in Accelerated Reader are a quick and effective means of determining whether a student has read and understood a book. Analyses of the study data indicated that most Reading Practice Quizzes taken (54%) were for books within the student's recommended ZPD. Fewer quizzes were taken for books below (34%) or above (12%) a student's ZPD. As expected, students were less likely to pass quizzes for books above their ZPDs compared to books within or below their ZPDs (see Table 3).

Table 3: Accelerated Reader Quiz Frequency and Performance as a Function of ZPD

ZPD	Comprehension Quizzes Taken	Comprehension Quizzes Passed
Below	53,495,097 (34%)	49,960,512 (93%)
Within	84,027,239 (54%)	74,553,773 (89%)
Above	18,356,447 (12%)	13,102,316 (71%)
Total	**155,878,783**	**137,616,601 (88%)**

Multiple regression analyses were conducted to explore the effect of reading below, within, or above ZPD on growth in STAR Reading performance over the course of the school year.[7] The results of the analyses are summarized below:

- Less STAR Reading growth occurred when students read a higher percentage of books below ZPD.[8]

- Increased STAR Reading growth occurred when students read a higher percentage of books within ZPD.[9]

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[7] Regression analyses were conducted controlling for initial STAR Reading performance and the total number of books read. Passing a quiz with a score of 60% was considered reading the book. Findings were similar whether considering proportions of quizzes passed with a score of 60% or higher.

[8] ($\beta = -.17$, $SE = .001$, $t = -178.51$, $p < .001$)

[9] ($\beta = .08$, $SE = .001$, $t = 81.91$, $p < .001$)

• Even greater STAR Reading growth occurred when students read a higher percentage of books above ZPD,[10] but only if students were able to understand the book well enough to answer most of the comprehension questions correctly. Students are more likely to succeed with above-ZPD reading if they are motivated to read the text and have sufficient instructional supports.

In summary, the study findings suggest that Renaissance Learning's existing ZPD recommendations are appropriate. Most students are reading within their recommended ZPD, which is associated with increased STAR Reading growth. Those students who read a higher percentage of books below ZPD have less STAR Reading growth. The results also suggest that there are benefits to reading more challenging books, as long as students demonstrate comprehension of what they are reading by passing Accelerated Reader quizzes. Although a low percentage of students read books above their ZPD, those who did experienced especially high STAR Reading growth.

These findings are consistent with recent trends in education advocating that students read more complex texts. As stated in English Language Arts Appendix A of the Common Core State Standards (2010),

> One of the key requirements of the Common Core State Standards for Reading is that all students must be able to *comprehend* [emphasis added] texts of steadily increasing complexity as they progress through school. By the time they complete the core, students must be able to read and *comprehend* [emphasis added] independently and proficiently the kinds of complex texts commonly found in college and careers. (p. 2)

An important caveat, however, is that reading more difficult text is beneficial only as long as students understand what they are reading. The ZPD study examined this notion in two ways. A statistical test found that failing AR quizzes taken for books above a student's ZPD (i.e., failing to adequately comprehend more difficult books) was actually associated with decreased growth on STAR Reading.[11] Similarly, in Figure 4, a descriptive analysis shows that students with an average percent correct (APC) of less than 60% on above-ZPD quizzes exhibited essentially zero growth on STAR Reading. In fact, passing quizzes for books within ZPD seems to be more beneficial for reading achievement than failing quizzes for books above ZPD.

Figure 4: STAR Reading Performance on AR Comprehension Quizzes for Books Below/Within/Above ZPD
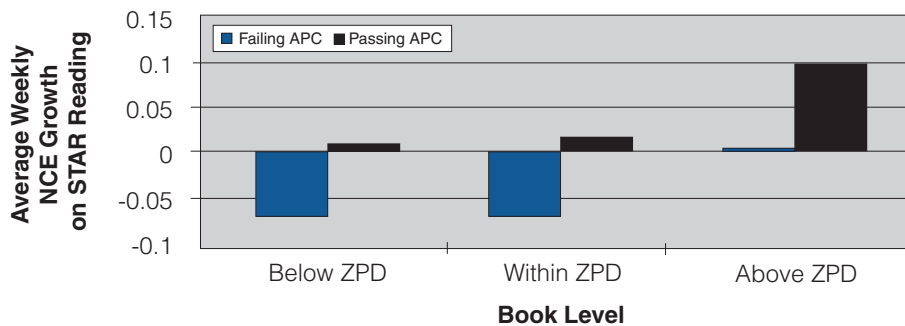
Note: Because the normal curve equivalent (NCE) score is norm-referenced, positive gains indicate that the reading achievement of the students who tested increased relative to their same-grade peers in the national norm samples for STAR Reading.

[10] (β = .24, SE = .001, t = 159.08, p < .001)

[11] (β = -.18, SE = .001, t = 193.22, p < .001)

Educational Implications

Estimating text complexity: More than a number

Although text complexity metrics such as ATOS are invaluable in estimating the challenge associated with different reading materials, these metrics represent only the quantifiable dimension of text complexity. In addition to the quantitative factors estimated by ATOS, text complexity is also thought to be affected by qualitative factors (e.g., structure, language conventionality) as well as reader and task considerations (e.g., motivation, background knowledge, purpose for reading) (see Figure 5). Ultimately, not every aspect of text complexity can be represented by a single number. Determinations of text complexity, although aided by quantitative measures, rely heavily on human evaluation, professional judgment, and context.

Figure 5: How ATOS Supports the Common Core State Standards Model of Text Complexity
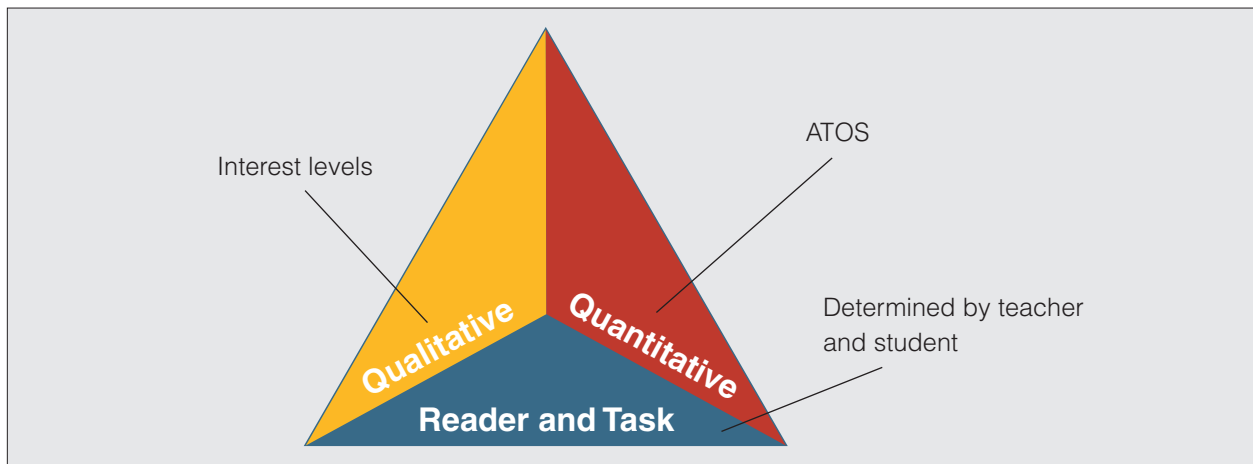
Model of Text Complexity from Appendix A of CCSS for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects © Copyright 2010. National Governors Association Center for Best Practices and Council of Chief State School Officers. All rights reserved.

Estimating text complexity: Available tools

As part of its mission to accelerate learning, Renaissance Learning offers several tools for estimating text complexity and encouraging adequately complex reading.

- **AR BookFinder.** Using the free online book search tool AR BookFinder (http://www.arbookfind.com), students and teachers can search for books based on a number of factors, such as the quantitative dimension of text complexity (i.e., ATOS book level), grade range, topic, and type. Each book is assigned an ATOS book level (BL) reflecting its ATOS text complexity estimate. In addition, interest levels (IL) are provided to assist in identifying books with age-appropriate content. Interest levels are divided into four categories: LG for lower grades (K–3), MG for middle grades (4–8), MG+ for middle grades plus (6 and up, for more mature middle-grade readers), and UG for upper grades (9–12). Together, ATOS book level and interest level represent a considerable amount of text complexity information, and users can search by additional criteria such as topic and literature type (fiction versus nonfiction) to also promote variety and breadth in what students read.

- **ATOS Analyzer.** Although more than 145,000 books are available in AR BookFinder, there may be additional texts, or select portions of text, for which educators and publishers would like to have an ATOS level. For such instances, Renaissance Learning offers a free online ATOS Analyzer where users can enter any text and receive an ATOS text complexity estimate within minutes (http://www.renlearn.com/textcomplexity/default.aspx).

- **Accelerated Reader.** The AR BookFinder and ATOS Analyzer tools can help teachers guide students to appropriately complex text; however, it is equally important to monitor students' reading comprehension. With AR Reading Practice Quizzes, teachers can quickly and effectively assess whether students understand what they are reading. Although students should be encouraged to read increasingly sophisticated text, reading books that they cannot comprehend adequately will be both frustrating and unproductive.

- **Core Progress for reading.** The Core Progress learning progression for reading (Renaissance Learning, 2011), available as part of STAR Reading Enterprise, can be used to locate aspects of text complexity within a learning continuum based on the CCSS, which can help to identify the prerequisite skills students need to engage with a given text.

Recommended reading: Considering grade level in conjunction with student achievement

Increasing students' reading capacity will require providing opportunities for interacting with more complex text. It is important to bear in mind, however, that the Text Complexity Grade Bands presented by Nelson et al. (2011) represent the upper bound of student reading achievement; not all reading needs to be done at such demanding levels.

Text Complexity Grade Bands do not represent new guidelines for independent reading. Renaissance Learning's ZPDs still play the same important role in matching books to students for independent reading practice that they always have. ZPDs describe the range of text complexity in which students should do the majority of their reading. Students benefit most from independent reading done within their ZPD ranges because they are matched to books that are neither too simple nor too complex. The individualized goals represented by ZPD ranges foster enjoyment of reading, maximize the academic benefits students receive from reading, and encourage students to read frequently and broadly.

> Text Complexity Grade Bands do not represent new guidelines for independent reading, but they can help guide choices for instructional reading.

Although independent reading levels should be based on individual reading achievement, Text Complexity Grade Bands can help guide choices for instructional reading. Determined by grade level, Text Complexity Grade Bands include texts that may be too difficult for many students to read independently. Students whose reading achievement levels are not within the Text Complexity Grade Bands can benefit from exposure to more difficult text during instructional periods when scaffolding, coaching, and discussion are available. To help monitor not only what students are reading, but also the level of assistance required for them to achieve comprehension, Accelerated Reader quizzes offers options for tracking whether books were *read to* students, *read with* students, or *read independently*.

Because Text Complexity Grade Bands represent difficulty levels well beyond many students' ZPDs, materials read within these new ranges will likely result in some frustration, even when done in an instructional setting. Thus, a major factor in transitioning to more rigorous standards will be to help students deal successfully with challenge and frustration in academic settings. Reading within the Text Complexity Grade Bands will represent a considerable hurdle for many students; as a consequence, teachers may need to adjust instruction and emphasize intensive reading of a smaller amount of text. Also, because most readers will not understand the material at first, teachers and students should anticipate re-reading as a natural step in comprehension. By doing so, students will learn how to grapple with text in order to understand it. A large part of teaching reading within the Text Complexity Grade Bands will be to help students learn to appreciate a degree of productive tension and practice perseverance, as well as to value the increasingly more sophisticated understanding that comes with re-reading challenging material.

Fidelity of best practices: Consistency with new recommendations

Using the research-based Accelerated Reader Best Practices (Renaissance Learning, 2007), which work to ensure fidelity of implementation, will be even more important as students are encouraged to read more complex text. As always, teachers need to (1) provide instruction, guidance, and time for practice; (2) know what students are reading; and (3) know how well they are reading it. Reports generated by Accelerated Reader present straightforward, but comprehensive, data summaries crucial for monitoring key aspects of student reading such as comprehension, level of text complexity, balance of fiction and nonfiction, and whether books were read independently or with assistance.

Monitoring reading comprehension is vital for making sound decisions related to text complexity. Information about how well students understand what they read can help teachers make adjustments to both their instructional practices and the ZPD ranges guiding students' independent reading. ZPDs represent good estimates of appropriate ranges for independent reading, but students can benefit from reading above ZPD as long as they receive support and can demonstrate understanding by scoring well on AR Reading Practice Quizzes. In addition to guiding students to the appropriate level of independent reading, teachers can increase students' capacity for comprehending complex texts by incorporating more difficult materials into students' repertoire through instructional reading, reading to students, reading with students, or having students read together. More structured reading activities provide opportunities to expose students to complex text they might not be able to comprehend independently, as well as to teach skills and strategies they can transfer to independent reading.

Conclusion

Recent research suggests that students do not graduate high school prepared for the sophisticated levels of text required in college and career settings. This conclusion has prompted a focus on the role of text complexity recommendations in education reform. Specifically, there has been renewed interest in how to accurately estimate text complexity and at what level of difficulty students should be reading. In a fitting response to these concerns, Nelson et al. (2011) conducted a study that (1) verified the accuracy of existing text complexity measures (including ATOS), and (2) generated recalibrated pathways to college and career text complexity levels that are more challenging than traditional recommendations.

> Findings suggest that students should read more challenging text as long as they are able to accurately comprehend what they are reading.

In an effort to understand the potential impact of more rigorous text complexity recommendations, Renaissance Learning analyzed how independent reading below, within, and above recommended ZPD ranges affects the development of students' general reading achievement. Findings suggest that students should read more challenging text as long as they are able to accurately comprehend what they are reading—but pushing students to read difficult texts at the expense of comprehension could actually be detrimental.

These analyses have practical implications for student reading practice. They suggest that educators need to consider both general developmental goals for the pathway to college and career success as well as individual student reading achievement. To ensure students are reading at appropriate levels, measures of comprehension such as those provided by the Accelerated Reader program should be a key component of any effort to promote reading more complex text. Although there are major potential benefits associated with reading more complex texts, those benefits will be lost and frustration may occur if students are pushed to read at a level so difficult as to be incomprehensible. As students are encouraged to read increasingly complex texts, it will be more important than ever to accurately assess comprehension in order to accelerate achievement and avoid crossing the fine line between difficult and unintelligible reading material.

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