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ANALYZING TEXT COHESION IN ONLINE LEARNING ENVIRONMENTS: IMPLICATIONS FOR STUDENTS WITH READING DIFFICULTIES

Análisis de la cohesión de los textos en los entornos de aprendizaje en línea: implicaciones para estudiantes con dificultades lectoras

MARY F. RICE
University of Kansas

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Autora de contacto / Corresponding Author: Mary F. Rice. E-mail: mary.rice@ku.edu

INTRODUCTION. As online learning increases, making text comprehensible to all learners presents challenges online course designers and teachers. The purpose of this study was to determine the cohesion properties of text from English language arts courses from three large online learning vendors. **METHODS.** Analysis of variance (ANOVA) was conducted to determine congruence between the environments with respect to the five indices in the Coh Metrix 3.0 text measurement tool (Narrativity, Syntactic Simplicity, Word Concreteness, Referential Cohesion, and Deep Cohesion). **RESULTS.** Vendors may have calibrated their text using traditional tools like the Flesh-Kincaid scale. However, each of the courses had aspects of cohesion that needed improvement to provide an optimal advantage to students with disabilities or who have reading comprehension difficulties. Further, the two biggest factors that explained the variance in this study were Word Concreteness (the degree to which the words can be pictured) and Deep Cohesion (whether the connectives support inference). Importantly, these are also two aspects of texts that present the most challenges for students with disabilities. **DISCUSSION.** If all students are going to be successful with online courses, then vendors should move beyond simple reading level as a measure of text difficulty and plan course texts for students with more and different kinds of support for students who have reading difficulties that affect comprehension. Future research should perform similar analyses on content areas such as social studies and science. Additional studies should also look carefully and qualitatively at the complexity of the content itself and not just the text. Finally, additional research might look at how students with various reading challenges engage with online course texts using multiple data collection and analysis techniques.

Keywords: *Online learning, Students with disabilities, Text complexity, Cohesion, Online reading comprehension, Online English language arts courses.*

Introduction

comprehension is the goal of reading (Durkin, 1993). Gaps in comprehension skills have been linked to underachievement in school (Mason and Hagman, 2012). Indeed, even as literacy educators grapple with providing instruction in New Literacies, comprehension of text, including, although not limited to, linguistic text is still part of reading online (Hull, 2003; Leu, *et. al.,* 2013). This is true because reading is a knowledge-using and knowledge-building activity (Willingham, 2006).

When students cannot read the texts in front of them, they cannot participate in activities and knowledge-building with their peers and therefore, rendering the environments in which they read those texts less inclusive. Supporting text comprehension is especially important in online coursework — that is completed with a high degree of learner independence over the Internet (Means, Bahkia and Murphy, 2013). Since the teacher-learner and peer interaction is already less in many cases when course work is completed online (Smith and Rice, 2016). Therefore, the curriculum materials must be appropriate for students at a range of reading levels (Greer, Rice and Deshler, 2014; Rice and Greer, 2014).

The characteristics of the learning materials and their appropriateness for a variety of learners is an especially relevant issue considering that the largest growth in online learning clientele is students who have been labeled "at risk" (Miron, 2016). Regardless of the number of students with disabilities enrolling in online learning, IDEA (2004) protects these students' right to a Free and Appropriate Education in an environment that is inclusive. If online learning is going to be an opportunity extended to all, then researchers, designers, and developers need to take a closer look at not only the design and formatting elements of online courses, as well as the more fine-grained and subtle elements of the linguistic texts presented to the students.

Unfortunately, determining the appropriateness of text for students is difficult with traditional readability formulas because these formulas cannot anticipate what readers bring to texts in terms of background knowledge and they cannot anticipate the task students are trying to do with the texts (Valencia, Wixson and Pearson, 2014). Therefore, it is difficult to match text to readers in ways that promote achievement through rich tasks that include support for comprehension of complex texts (Pearson, Valencia and Wixson, 2014; Kennedy and Ihle, 2012).

When general education teachers do not have access to reliable information about text and its complexity, historically a special education teacher was often left with substantial responsibilities for helping students with disabilities access texts (Mastropieri, *et. al.,* 2005). However, parents and other on-site mentors who lack both preparation and support to teach reading are now working with students as much or more often than teachers (Ortiz, Smith, Rice and Mellard, 2017). Instead of expecting these unprepared individuals to provide extensive, intensive instruction, vigilance regarding the complexity of the text is one potential inclusive solution. While it is ideal for well-prepared instructors to create curriculum that merges reader and task, attention must still be paid to the linguistic characteristics of the instructional materials, themselves because online much course curriculum is developed by course designers and not teachers or anyone who regularly interacts with the child.

To this end, a study was conducted analyzing the text complexity of English/Language Arts (ELA) lesson content from three major online learning course vendors. The research question was, "Is the ELA lesson content from major course development vendors comparable in terms of the five main measures of cohesion (Narrativity, Syntactic Simplicity, Word Concreteness, Referential Cohesion, and Deep Cohesion)?".

Online content material and readability

the New London Group (1996) described *New Literacies* to conceptualize the move away from an information gathering focus in schools and toward using texts from a variety of sources presented in a variety of modes and media for problem-solving and processing tasks. Text in the online courses, even when supplemented with visual images and multimedia graphics, still closely resembles textbook formats in many cases and still has considerable text for students to read. In fact, many courses direct students offline to read portions of a printed textbook for ELA classes and/or use traditional texts, such as the text of Shakespearean plays in digital formats as instructional materials. Since most of the online material is structured like traditional text or has been merely brought digitally to online formats, the focus for the review of literature attends to historic issues of reading comprehension with special attention to reading comprehension for students with disabilities.

When considering what makes reading linguistic text difficult for students with disabilities or who have other difficulties, it is important to consider reading as a cognitive mental model. Two popular cognitive views of reading include the Simple View, which has dominated research on reading comprehension for some time (Hoover and Gough, 1990). However, there are more modern views of reading as being comprised of many skills, rather than being a skill unto itself (Catts, Nielsen, Bridges and Liu, 2016; Willingham, 2006). In these more complex models, metacognition, content/subject matter focus, and knowledge creation are paramount. Even so, regardless of the complexity of the cognitive model used, the way in which the text is constructed internally either supports or inhibits reading comprehension processes, especially for students with disabilities.

The simple view of reading comprehension

historically, researchers described reading comprehension processes using The Simple View (Hoover and Gough, 1990). In the Simple View, reading comprehension is the interaction between two skills: decoding and language. *Decoding skill* is the process of seeing a letter or combination of letters and being able to produce the correct sounds for the letters. *Language skill* is the ability to recognize what was decoded as a word with a meaning in a specific context. Language skill is linked to vocabulary knowledge because it is possible to decode a word correctly and not realize it is a word or what word it is. It is also possible to decode a word incorrectly and attach an incorrect meaning to a set of sounds represented by a set of letters. Readers, especially novice ones, can know a lot of words through oral language exposure that they may not know the letter pattern for if they had to decode it when written.

When students decipher sounds and meanings of individual words, they are then positioned to assemble the words into strings of meaning and then assemble those strings of meaning into increasingly complex ideas. Consequently, when children exhibit problems learning to read, one of two these skill sets (decoding or language) or the interaction between the two is responsible for those difficulties in the Simple View (Hoover and Gough, 2001; Scarborough, 2005).

Carlson, Jenkins, Li, and Brownell (2013) reviewed research on reading and found that many reading researchers agree that students who become fluent readers develop the orthographic, phonological, and semantic knowledge of words and word parts simultaneously. It is these simultaneous connections that cause readers to develop stronger connections between knowledge bases rooted in oral language and allow them to rapidly retrieve words and

understand them when they are seen printed in texts. In other words, reading comprehension is facilitated by the ability to perform the discrete tasks of decoding and connecting decoded words to language knowledge simultaneously and rapidly.

Students with certain kinds of disabilities have difficulty paying attention during reading tasks and therefore they are less able to perform on common measures of reading than their peers (e.g., Cain and Bignell, 2014). The inability or the difficulty of paying attention while listening may impair a child's ability to learn decoding and word recognition skills, as well as make it difficult to learn receptive and later productive vocabulary. To maintain students' attention, it is the text itself can be designed to be coherent and easier to follow.

When considering the Simple View with two pathways to reading, it is important to realize that these pathways are typically studied in children, often as young as three years old (Catts, Adlof and Wismer, 2006; Carlson, Jenkins, Li and Brownell, 2013). For older readers, the texts they encounter are much more sophisticated in terms of length, vocabulary, and background knowledge required for engagement, and therefore require even more skills in decoding and language than those necessary to succeed in the reading tasks germane to elementary school (Shanahan and Shanahan, 2008).

Reading comprehension complex set of skills

Many models of reading stress that comprehension involves a coherent mental model of text (Kendeou, van den Broek, Helder and Karlsson, 2014). With every new piece of information that is introduced in a linguistic text, a new set of cognitive processes are set into motion. While reading is considered a cognitive activity, reading comprehension instruction does not focus on cognition itself, but metacognitive strategies and skills. These skills are more complex than decoding letters into words and then recognizing the words.

The implications of embracing cognitive models of reading that consider comprehension to involve bundles of constantly changing strategies used to meet shifting demands in a text for various purposes is that instruction should use coherent series of texts. These texts should reflect the content knowledge that students need to develop to perform specified tasks (Kendeou, van den Broek, Helder and Karlsson, 2014). Another implication is that reading instruction — especially for students with reading difficulties should focus on what is happening for students *during* reading, which means that rather than preparing students to read or guiding the students through the ideas in the text afterward, reading instruction must be closely tied to the text at hand. This is greatly facilitated when text is designed where critical ideas are organized and the text itself refers to the critical ideas in it (McNamara, Ozuru and Floyd, 2011). In short, the linguistic features of texts — and whether they are likely to facilitate a coherent mental model of content are critical to supporting the comprehension work that students are asked to do in coursework online where they mostly work on their own or with mentors who are not experts at reading comprehension, content/subject matter knowledge, or even disability support.

Textual cohesion as support for reading comprehension

if reading comprehension is a cognitive activity, the notion of cohesion is informative for looking at texts that have disciplinary content. Cohesion refers to the subjective internal grammatical structure that supports readers in forming more subjective coherent understandings about a text. The Coh Metrix Indices (Graesser, McNamara, Louwerese

and Cai, 2004) allow for analysis of cohesion using multiple linguistic characteristics, but for students with disabilities that affect reading comprehension, the cohesive elements that are critical, especially for readers of advanced texts dealing with academic subject matter, are the syntactic arrangements of the words, since that determines the cognitive load placed on the attention span and working memory (Fajardo, Ávila, Ferrer, Tavares, Gómez and Hernández, 2013), the ability to recognize and decode key vocabulary for these content area texts when it is surrounded by qualified noun phrases or obfuscated by negation, and the ability to see the relationships — negative or positive — between the ideas that the decoded vocabulary represent (Dočekal and Strachoňová, 2013; Vender and Delfitto, 2011). This means that the connectives that bring about cohesion in a text, even though they often make the text longer, are desirable for students with decoding and language deficits if the students are familiar with the connectives being used (Fajardo, Tavares, Ávila, and Ferrer, 2013). The creators of the Coh Metrix analysis tool note that for many years, textbook companies and other such entities have desired to lower the difficulty of texts and their strategy for doing so was to remove words to make the text shorter overall or to eliminate multisyllabic words. Unfortunately, the connectives that gave text cohesion were removed during this process. Thus, many supposedly modified texts were made more difficult for students with disabilities to understand rather than easier.

Linguistic texts from various content areas have different properties and therefore, function optimally with different types of connectives to support cohesion (see table 1). Social studies

Table 1. Definitions of linguistic characteristics for content area texts

Cohesive Feature	Definition	Example Sentence	Content Area of Relevance
Causal Relations	Ideas that are linked in a text through causal means (some event or action led to a new event or action).	The DNA divides *so that* it can replicate	Science, Social Studies, ELA
Temporal Relations	Ideas that are linked in a text through words that illustrate time (the words tell when something happened)	The colonists rebelled *when* the British leveed taxes	Social Studies, ELA
Feature of Academic Text			
Nominalizations	Using a noun as another part of speech (verb, adjective, or adverb)	The *legalization* of marijuana is a controversial topic	Science, Social Studies, ELA
Abstract Verbs	Action verbs that are multidirectional, indirect, and repeated (actions that happen in more than one time and place)	The pilgrims *came* to Plymouth Rock, Massachusetts	Science, Social Studies, ELA
Abstract Metaphors	A target (abstract word) and a domain (concrete word) are brought together with the word "is"	Life is a journey	ELA only

linguistic text features causal relations, abstract verbs, and nominalizations (Coffin, 2004, 2006; Martin, 2002; Schleppegrell, Achugar and Oteiza, 2004). Linguistic text in science also focuses heavily on causal relations, abstract verbs, and nominalizations, but in addition, it employs temporal relations related to reporting procedures in experiments (Esquinca, 2007; Fang, 2005). Finally, linguistic texts in ELA feature causal relations, nominalization, abstract verbs, and temporal relations (for narratives only), but these texts are also filled with abstract metaphors (Christie, 2002; Swiderski, 2007). The features of texts in social studies, science, and ELA content areas demonstrate the importance of using connectives in text, especially for children who lack the language or decoding skill to do the inference work necessary to make up for missing connectives. It is because the ELA content has all the major features that are problematic for young readers, especially students with disabilities who have poor reading comprehension, that this content was targeted for analysis.

These features are considered by each of the measures of cohesion in the Coh Metrix 3.0 series of indexes. The names of the five specific indexes are Narrativity, Syntactic Simplicity, Word Concreteness, Referential Cohesion, and Deep Cohesion. These indices are based on aspects of texts that are regarded to be independent of one another (Graesser, McNamara and Kulikowich, 2011).

Narrativity. Narrativity is the degree to which a text is story-like. This means that the text captures sequences of actions involving animate beings (Graesser, McNamara and Kulikowich, 2011). The sequencing should be high in narrative texts and lower in informational ones. Consider the following sentence: *The scientist conducted an experiment using soil samples and then he presented his findings*. This sentence has a higher Narrativity than the sentence: *An experiment using soil samples was conducted and presented*. The first sentence is easier to understand, even though it is longer because it has a clear animate actor but and because it more closely resembles oral language.

Syntactic Simplicity. Syntactic Simplicity is the degree to which a text uses common structures for sentences. One simple structure is subject-verb-object. It is present in the sentence *Rex kissed Debbie*. Rex is the subject; kissed is the verb; Debbie is the object or receiver of the object. A more complicated syntactical construction of the same idea would be Debbie received a kiss from Rex. In this sentence, Debbie is the subject of the sentence and Rex is the object of a preposition. The word "kiss" is a direct object. This is a more difficult sentence to describe grammatically and it is also longer. Syntactical complexity was determined to be the most highly correlated with measures of grade level using samples from several different sources, including national standards college entrance examinations in the United States (Nelson, Perfetti, Liben and Liben, 2012). Syntactic simplicity is achieved when the sentences in a text contain few words and use simple, familiar syntactic structures, which have been found to be less challenging to process (McNamara, Louwerse, Cai and Graesser, 2005).

Word Concreteness. Word Concreteness is the degree to which words can be visualized in real terms. It is also a measure of the number of other ways to communicate an idea. If a sentence has fewer words that can convey the same meaning, it is more concrete. A sentence like, *The teacher wrote with chalk* is more concrete than *The student could chalk up his grade to effort.* The word *chalk is* being used in a far more concrete way in the first sentence. The second sentence also features *chalk* as part of a compound verb, *chalk up,* which is more abstract as well. Finally, this example demonstrates that the word *chalk* has at least two meanings, with one being more concrete than the other.

Referential Cohesion. Referential Cohesion is the degree to which ideas in a passage of text are related and referred to across text. The sentences *Hannah liked ice cream. She liked ice cream since she was a baby. The flavor of ice cream she liked the best was chocolate* refer to one another and recycle keywords like *ice cream* and *liked*. There is also only one pronoun, *she,* which only refers to *Hannah* and not anyone or anything else across the text.

Deep Cohesion. Deep Cohesion is the ability of a text to use connectives that are temporal (time), logical (organized using reason), and causal (results and/or effects). These words include *after, next, meanwhile* (temporal), *thus, therefore, nevertheless* (logical), and *because, since, owing to* (causal). The sentence: *The student worked hard and therefore learned much* has a logical connective in it (therefore). The sentence: *The student worked hard and learned* is much less explicit about the connection between the effort of working hard and the result of learning.

Word Concreteness, Referential Cohesion, and Deep Cohesion were not correlated with grade level in the work Nelson, Perfetti, Liben and Liben (2012) performed with text from American national standards and college entrance exams. Nevertheless, support for making inferences using connectives have been identified as vital for helping students with learning disabilities comprehend text (Fajardo, Tavares, Ávila and Ferrer, 2013; Sanders, Land and Moulder, 2007).

Methods

The purpose of this study was to determine if the linguistic characteristics of the texts in three ELA environments were conducive to comprehension for students with disabilities. The exact names of the environments have been withheld as per the agreements made with the creators of these materials. They will be referred to in the findings section as Learning Environment (LE) A, B, and C.

These environments were chosen because they are distributed by some of the largest vendors of online learning in the United States (Barth, Hull and St. Andrie, 2012). While these environments may not be generalizable to all environments, it could be said that they represent the collective thinking of the online learning instructional material industry in terms of their attention to the readability of their linguistic materials since they are the some of the largest and the most likely used by students with learning disabilities across the United States.

Research design

this study employed content analysis to determine whether the linguistic text in the environments was structured to support students with disabilities using the five major Coh Metrix 3.0 indexes (Narrativity, Syntactic Simplicity, Word Concreteness, Referential Cohesion, and Deep Cohesion). The Coh Metrix system performs a random analysis using a series of complex algorithms. A randomly or strategically chosen section of text is copied from a source and pasted into a box in the tool. When users are ready, they click on the analysis button and the formulas are applied to the text. When the analysis is complete, a report of text cohesion features and general readability information appears. To make large-scale comparisons, spreadsheets of analysis reports can be aggregated and further analyzed using statistical packages. In this study, the text selected by the user was random to provide the best analysis on the course text generally.

Data sources

the data analyzed in this study were samples of the texts from ELA courses for secondary

students from three top online learning environments. The data were defined first by their appearance in online learning environments by means of origination or linkage on the Internet. Next, they were defined by the number of topics present in the environments. The environments were then analyzed to identify organizational patterns. Most of the courses had some organization pattern terms a unit or an overarching topic, a lesson, and then sub-lesson pieces that users were supposed to use in a sequence for a class. Maps of this content were made before analysis and then used to determine how to sample the online material.

Much of what is known about high-quality content analysis suggests that researchers must know exactly how much content they are working with to derive a workable sample (Sandelowski, 2000). The study took place even as online content became visible and invisible without much notice. Unlike a textbook or trade book, whose content was fixed, this content was constantly shifting. To assuage these issues, the researchers kept fastidious records of the date and time when the text from the lessons was mapped and based the randomized sampling off the map obtained on that date. Then, right before analyzing the sample, the map was checked against what content was currently available to make sure there were no major changes and that the selected samples were intact. Data was collected as quickly as possible and measures were applied. Again, it was very important to keep track of the samples as well as the dates the text was accessed.

Data analysis

the attention in this study was focused on the ELA content area. The text from the lessons in the environments was of such size that a sampling of 30 lessons per environment was deemed reliable for a valid and reliable analysis of the data. The boundaries of the analysis had to be established prior to the sampling. For the linguistic analysis of the material, the online text being read by students within the environment was used. That meant that the linguistic aspects of the learning objectives, the captions on the pictures, or any other extraneous linguistic text were not used. Linguistic text that could be linked to directly on the site was analyzed, but linguistic text that was referred to or assigned if there was no link, was not. An example of the kind of excluded text was William Shakespeare's *The Tragedy of Romeo and Juliet*. The environment gave information about William Shakespeare's life and about plays in general and then assigned students to read the play. Since there was no link to *The Tragedy of Romeo and Juliet*, it was not included in the analysis.

The target of the inferences was to determine which (if any) of these environments were linguistically appropriate for students with disabilities that affect reading comprehension. Therefore, the selected readability tools had to consider learners who were adolescents and had various documented barriers to learning. This target guided the selection of the Coh-Metrix indices (Graesser, McNamara, Louwerse and Cai, 2004). These indices were selected because they corresponded to areas that had been previously identified in the literature as linguistic aspects that interfered with comprehension of texts in the content areas selected for study (Christie, 2002; Coffin, 2004; Fang, 2005). The Coh Metrix 3.0 tool holds 15,000 characters. The tool itself determines what of that corpus it will sample independently of the researcher using the tool. It was not often that a sample lesson contained more than 15,000 characters, but when it did, the text was sampled in multiple pieces and then the results were compared. Where there was agreement, one of the sampled pieces was dropped. Where there was disagreement, both sections were included in the analysis. The Coh Metrix 3.0

tool also calculates Flesch-Kinkaid reading level so the traditional measure of average grade level was also collected. The Flesh-Kincaid reading level is reported in terms of mean, median, and mode in table 2.

After obtaining the ELA data from each online learning environment, separate ANOVAs were conducted — one for each index (see tables 2 through 6 in the results section). Effect size (R^2) was then calculated for each index (see table 7 in the results section). The assumptions of normality and homoscedasticity were satisfactory — i.e., scores forming a normal distribution with a skewness value less than 0.70 and residuals aligned diagonally in a normal probability plot within each environment; Levene's test results of a *p*-value greater than .05. Although Levene's test results were significant for syntactic simplicity, word concreteness, and referential cohesion, ANOVA is fairly robust against inequality of variances in a balanced design (i.e., equal sample sizes).

Results

in this section the results of the study are reported. The first results reported are that of the Flesch-Kincaid grade level. Subsequent results reflect the data from the five ANOVAs.

General readability

Table 2. Flesch-Kincaid Grade Level

	Mean	Median	Mode
LE A	7.0	7.2	7.1
LE B	6.1	6.0	6.1
LE C	8.5	8.5	8.5
Total Mean	7.2	7.2	7.2

These grade level statistics reveal that the mean, median, and mode for all three vendors are highly consistent (i.e., normally distributed). The median reported is the mean median and the mode reported is the mean mode. The range of the grade level in all the learning environments is 1.5. LE B contained the sampled text with the highest reading grade level.

LE C contained the text with the lowest grade level. LE A's grade level is the almost perfect average of LE B and LE C. The results of ANOVA are reported in the rest of this section, including descriptive statistics, an explanation of significance where it appeared, and an effect size.

Narrativity

Table 3. ANOVA Results for Narrativity

Descriptive Statistics	Mean	*SD*	
LE A	-0.007	0.440	
LE B	0.179	0.356	
LE C	-0.181	0.539	
Type III Test	*F*	*p*	Partial η^2
Vendor	4.769	0.011	0.099
Post-hoc Comparisons	**Bonferroni-*p***		
LE A vs. LE B	0.341		
LE A vs. LE C	0.420		
LE B vs. LE C*	0.008		

Results for Narrativity revealed that the learning environments were significantly different. Post-hoc tests revealed that LE B was significantly higher in Narativity than LE C but not LE A.

Syntactic simplicity

Table 4. ANOVA Results for Syntactic Simplicity

Vendor	Mean	SD	
LE A	0.829	0.465	
LE B	0.737	0.235	
LE C	0.671	0.596	
Type III Test	*F*	*p*	Partial η^2
Vendor	.914	0.405	0.021

Post-hoc Comparisons	Bonferroni-*p*
LE A vs. LE B	1.000
LE A vs. LE C	0.548
LE B vs. LE C	1.000

Word concreteness

Table 5. ANOVA Results for Word Concreteness

Vendor	Mean	SD	N
LE A	-0.504	0.45	30
LE B	-0.78	0.516	30
LE C	0.224	0.808	30

Type III Test	*F*	*p*	Partial η^2
Vendor	21.56	0.000	0.331

Post-hoc Comparisons	Bonferroni-*p*
LE A vs. LE B	0.251
LE A vs. LE C*	0.000
LE B vs. LE C*	0.000

Referential cohesion

Table 6. ANOVA Results for Referential Cohesion

Vendor	Mean	SD	N
LE A	-0.491	0.679	30
LE B	0.043	0.534	30
LE C	-0.637	0.719	30

Type III Test	*F*	*p*	Partial η^2
Vendor	10.45	0.000	0.194

Post-hoc Comparisons	Bonferroni-*p*
LE A vs. LE B*	0.003
LE A vs. LE C	1.000
LE B vs. LE C*	0.000

Results for Syntactic Simplicity revealed that the learning environments were not significantly different (table 4).

Results for Word Concreteness revealed that the learning environments were significantly different. Post-hoc tests revealed that LE C is significantly higher in Word Concreteness than LE A and B (table 5).

Results for Referential Cohesion revealed that the learning environments were significantly different. Post-hoc tests revealed that the text in LE B has significantly higher Referential Cohesion than LE A and LE C (table 6).

Deep Cohesion

Table 7. ANOVA Results for Deep Cohesion

Vendor	Mean	SD	N
LE A	0.177	0.493	30
LE B	0.897	0.677	30
LE C	-0.109	0.495	30
Type III Test	***F***	***p***	**Partial η^2**
Vendor	25.595	0.000	0.370

Post-hoc Comparisons	Bonferroni-*p*
LE A vs. LE B*	0.000
LE A vs. LE C	0.156
LE B vs. LE C*	0.000

Results for Deep Cohesion revealed that the learning environments were significantly different. Post-hoc tests revealed that the text in LE B has significantly higher Deep Cohesion than LE A and LE C.

Effects sizes are reported as partial eta-squared. The environmental differences were small for Narrativity and Syntactic Simplicity, and moderate for Word Concreteness, Referential Cohesion, and Deep Cohesion. These effect sizes indicate that where significance was found, it was meaningful. The smallest variability accounted for by the environments was in Syntactic Simplicity, which was most highly correlated with reading level.

Limitations

The major limitation of this study is that the Coh Metrix 3.0 tool samples randomly from within the inputted sample. This means that researchers cannot say for sure exactly which text was analyzed once it has been imported into the tool. Not only does this put limitation on individual analyses, but it also limits what comparisons between studies that all use the Coh Metrix 3.0 indices can say about text difficulty across studies of various texts.

Discussion

The ELA courses from three popular vendors of online ELA courses were analyzed to determine their linguistic features in five categories: Narrativity, Syntactic Simplicity, Word Concreteness, Referential Cohesion, and Deep Cohesion. None of the learning environments had an ELA course that was a clear "winner"; each had linguistic limitations and affordances in these five domains.

Comments on the major findings

lE A had higher Narrativity than the other two LEs, but it was not better overall. This is something to consider because ELA coursework might be expected have high Narrativity because the story-like structure is common to language arts texts. Further, a text need not be a story per se, to proceed in a logical order that lends itself to high Narrativity. It is also worth considering whether the work it takes to craft a text with high Narrativity makes it more difficult to attend to the other four aspects tested in this study.

Learning that there was no significance in Syntactic Simplicity between the environments was unsurprising to us since Syntactic Simplicity has been correlated with more traditional grade level formulas for text (Nelson *et al.,* 2012). Vendors are easily able to calibrate their text intentionally to grade level using traditional tools like the Flesch-Kincaid scale. In this case, the online materials were all found to be at consistent grade level in mean, median, and mode. This substantial alignment suggests it was alignment across all three-course vendors.

Each of the ELA courses had aspects of cohesion that needed to be improved to provide optimal

advantage to students with disabilities. Not all texts in an online learning course were equally attentive to cohesion, even though the vendors seem to have paid attention to the reading level of the text. The major finding from these data is that the text in the learning environments is difficult because of Deep Cohesion and Word Concreteness, both of which are factors that (a) are important for reading comprehension in students with disabilities that affect reading ability or have reading difficulties for other reasons, and (b) do not show up on traditional tests of readability, and (c) are not accounted for on the measures of text complexity endorsed by the CCSS (Nelson *et al.*, 2012). The texts in the courses that were most cohesive for students with disabilities were often loaded with guiding words such as "after," "therefore," "in order that", and so forth. These connecting words are not as important for advanced readers.

The two biggest factors that explained variance were Word Concreteness (the degree to which the words can be pictured) and Deep Cohesion (whether the connectives support inference). These were also two aspects of texts that present the most challenges for students with disabilities (Cain and Nash, 2011; Fajardo, Tavares, Ávilla and Ferrer, 2013), although they are not as critical for highly skilled readers (McNamara and Kintsch, I996; O'Reilly and McNamara, 2007).

It should also be noted that Referential Cohesion and Deep Cohesion (two factors that should make text easier to read for students with disabilities) were highest in LE B where the grade level average was found to be the highest. This finding highlights the importance of considering more than grade level as singular text selection criteria since this more difficult text had the most internal support for reading it.

Implications of this study

this study has the potential to open conversations about how to provide students access to multiple texts with multiple degrees of cohesion to ensure that all learners have opportunities to read text that is optimal for them. There are implications for both practice and research.

Implications for Practice. If all students are going to be successful with online courses, then practitioners need to move beyond reading level as a measure of text difficulty and concede that students who have disabilities that affect comprehension need different kinds of support for using online text and potentially even different texts. In addition, if parents and other on-site mentors who are not prepared to support reading comprehension in students with disabilities are going to be working with students, they might benefit from some information about text complexity in their mentor materials and training.

Specifically, parents and on-site mentors might benefit from information about reading as a cognitive activity that hinges and metacognitive strategy use as well as information about how to use basic readability tools and how to identify words and phrases that support cohesion (Deshler, Rice and Greer, 2014). However, providing this information to parents and mentors will also mean that course developers should pay greater attention to the text complexity of both the text they write as part of the course and the texts that they link students too. In addition to strategic writing of the text, course designers could embed support in the form of guiding questions, provided models of inference making, and/or scaffold discussion among peers in the course.

Implications for Research. Future research should perform similar analyses on more content areas, such as social studies and science. It should also take a more careful look at the complexity of the content itself and not just the text. Finally, there needs to be more research on the cohesion properties in online environments specifically. This study relied on a research base mainly focused on cohesion as it is understood

in traditional print text and because of the text in the environments, was mainly focused on online texts that closely resembled print text. There needs to be more work done that considers features like hyperlinking and perhaps even cohesion as it emerges in mental models of non-linguistic text. To be sure, it is critical that students in online learning courses have support for reading comprehension that not only allows them to leverage the skills they bring to the online learning environment but also that they can continue to become better readers and by extension knowledge builders using online texts.

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Resumen

Análisis de la cohesión de los textos en los entornos de aprendizaje en línea: implicaciones para estudiantes con dificultades lectoras

INTRODUCCIÓN. En la medida en que se aumenta la oferta de formación *online*, haciendo comprensibles los textos a todos los estudiantes, se realizan cambios en los cursos *online* por parte de los diseñadores de estos y de los profesores que los imparten. La propuesta de este estudio fue la de determinar las propiedades de cohesión de los textos en los cursos de lengua inglesa que ofrecen los tres mayores proveedores de aprendizaje *online*. **MÉTODO.** Se realizó un Análisis de Varianza (ANOVA) para determinar la congruencia entre los entornos formativos y los 5 índices que la herramienta Coh Metrix 3.0 ofrece (narrativa, simplicidad sintáctica, concreción de palabras, cohesión referencial y cohesión profunda). **RESULTADOS.** Los proveedores pueden haber calibrado los textos empleados tradicionalmente a través de escalas como la Flesh-Kincaid. Sin embargo, cada uno de los cursos tenía aspectos de cohesión que necesitaban mejorar para proveer unas óptimas ventajas a los estudiantes con discapacidades o quienes tengan dificultades de comprensión lectora. Además, dos grandes factores que explican a través de la varianza en este estudio son la concreción de palabras (grado por el cual las palabras pueden ser representadas) y la cohesión profunda (si la conectividad apoya la inferencia). Es importante destacar que estos dos aspectos en los textos son los que presentan mayores cambios para los estudiantes con discapacidades. **DISCUSIÓN.** Si todos los estudiantes van a tener éxito en los cursos *online*, será necesario que los proveedores de formación vayan más allá de la oferta de un nivel de lectura medio con una media de dificultad del texto y planificar los textos para estudiantes que tengan dificultades de lectura que afectan a la comprensión. Las futuras investigaciones deben realizar análisis similares en áreas de contenido tales como sociales y ciencias. Trabajos adicionales deberían también mirar con cautela y desde una perspectiva cualitativa la complejidad del contenido en sí mismo y no solo el texto. Finalmente, se deberían proponer futuras investigaciones que señalen cómo los estudiantes afrontan los retos de lectura vinculadas a los textos empleados en los cursos *online* utilizando técnicas de recogida y análisis de datos.

Palabras clave: *Aprendizaje online, Estudiantes con discapacidades, Complejidad del texto, Cohesión, Comprensión lectora online, Cursos de lengua inglesa online.*

Résumé

Analyse de la cohesion des textes dans l'aprenstissage en ligne: implications pour les étudiants handicapés

INTRODUCTION. Dans la mesure où l'offre de formation en ligne augmente, il est nécessaire de faire des changements concernant la complexité des textes de la part des dessinateurs des cours et les professeurs qui dispensent les cours afin de les rendre plus compréhensibles. L'objectif de cette étude a été déterminer les propriétés de cohésion des textes utilisés dans les cours de langue anglaise proposés par les trois plus grands fournisseurs de services d'apprentissage en ligne. **MÉTHODE**. Il a été effectué une analyse de variance (ANOVA) pour établir la convergence entre les environnements éducatifs et les 5 indices qu'offre l'outil Coh Metrix 3.0 (Narrative, Simplicité syntactique, Précision des mots, Cohésion référentiel et Cohésion profonde). **RÉSULTATS**.

Jusqu'à présent, les fournisseurs de formation peuvent avoir calibré les textes utilisés grâce aux échelles comme le Flesh-Kincaid. Néanmoins, chaqu'un des courses avait des aspects de cohésion qui avaient besoin d'être améliorés pour apporter des avantages considérables aux étudiants handicapés ou tout simplement ayant de difficultés à la compréhension de l'écrit. Par ailleurs, les deux grands facteurs qui expriment la variance dans cette étude sont la concrétion des mots (le degré par lequel les mots peuvent être représentées) et la cohésion profonde (si la connectivité soutienne l'inférence). Il importe de noter que ces deux aspects sont qui reçoivent les plus grands changements vis-à-vis des étudiants handicapés. DISCUSSION. Si on veut que toutes les étudiants réussissent les cours en ligne, il est nécessaire que les fournisseurs de cours éducatifs tiennent également compte des étudiants qui ont des difficultés à la compréhension de l'écrit en programmant des textes différentes de ceux de niveau intermédiaire présentant une difficulté intermédiaire. Dans le futur la recherche devra exécuter la même analyse dans le cadre des sciences sociales et les sciences naturelles. Des autres travails complémentaires devront regarder avec prudence et d'après une perspective qualitative le contenu en lui-même et non pas seulement le texte. Finalement, il faudra proposer des futures recherches afin de mettre en évidence, à l'aide des techniques de collecte et d'analyse des donnés, comment les étudiants font face aux défis de la lecture des textes utilisés dans les cours en ligne.

Mots-clés: *Apprentissage en ligne, Étudiants handicapés, Complexité du texte, Cohésion, Compréhension de l'écrit, Cours de langue anglaise en ligne.*

Perfil profesional de la autora

Mary Frances Rice

Is an affiliated researcher at the Center for Research on Learning at the University of Kansas. She is also an Assistant Professor of Literacy at the University of New Mexico. She began her career in education an English language arts, English as a Second Language, and reading support teacher. Her current research focuses on teachers as they co-make curriculum with students in technologized settings. She has also conducted studies on text complexity and visual support in online learning courses. Mary is a fellow at the Michigan Virtual Learning Institute (MVLRI) where she participates in research on standards development, pedagogical thinking for online courses, and curriculum accessibility. Mary is also a collaborator in the International Scholarly Association on Teachers and Teaching (ISATT) where she works on problems of teacher education in settings of low technological infrastructure. She is the editor of *Exploring Pedagogies for Diverse Learners Online* (2015, Emerald Press).

Correo electrónico de contacto: mary.rice@ku.edu

Dirección para la correspondencia: Center for Research on Learning. University of Kansas. 1450 Jayhawk Blvd, Lawrence, KS 66045, EE. UU.