Using Cognitive Science to Improve Reading Instruction and Reading Comprehension in School-Aged Learners

Elizabeth R. Albro (elizabeth.albro@ed.gov)
Institute of Education Sciences
U.S. Department of Education, Washington, DC 20208
Carol McDonald Connor (cconnor@fcrr.org)
Florida State University
Florida Center for Reading Research Education
Tallahassee, FL 32301
Frederick J. Morrison (fjmorris@umich.edu)
Department of Psychology, University of Michigan
Ann Arbor, MI 48109
Barry Fishman (fishman@umich.edu)
Learning Sciences, University of Michigan
Ann Arbor, MI 48109

Thomas Landauer (landauer@k-a-t.com)
University of Colorado
Pearson Knowledge Technologies
Boulder, CO 80309
Michael R. Vitale (vitalem@mail.ecu.edu)
Curriculum & Instruction, East Carolina University
Greenville, NC 27858
Nancy R. Romance (romance@fau.edu)
College of Education, Florida Atlantic University
Boca Raton, FL 33431
Jim Collins (jcollins@buffalo.edu)
Graduate School of Education
University at Buffalo, Buffalo, NY 14260

One of the greatest success stories in bringing knowledge gained from cognitive science into the real world has occurred in describing the early trajectory of learning to read and elaborating the influence of instruction on that process. Basic research completed in psycholinguistic, developmental, and cognitive laboratories around the world has provided a well-elaborated understanding of how young children learn to read and what component skills and knowledge need to be in place for reading success. This knowledge influences instruction, and our ability to ensure that children are able to "break the code" has been increased by this translational work. However, our knowledge of early reading development and how to support instruction in the code-based aspects of reading exceeds what we know about how to improve children's reading comprehension. The interdisciplinary research presented in this symposium addresses this important question by examining a series of theoretically-driven interventions designed to improve comprehension outcomes for young readers. *Elizabeth Albro* is the moderator for this symposium.

Child-by-Instruction Interactions in Early Reading: Examining Causal Effects of Individualizing Student Instruction

Aptitude-by-treatment interactions were proposed in the late 1960s (Bracht, 1970). However, experimental studies yielded only equivocal findings in support of these interactions. Recent descriptive and correlational research indicates that there may be child-by-instruction interactions such that the effects of particular reading instruction strategies depend on children's language and reading skills (e.g., Connor et al., 2006).This new evidence relies on analytic strategies such as hierarchical

linear modeling and multidimensional conceptualizations of instruction and suggests that observed interactions are fairly skill specific and include interactions with both reading and vocabulary skill. Such interactions may help to explain the substantial individual student differences observed in reading achievement. However, the causal nature of these interactions remains unclear. In this cluster randomized field trial we *(Connor, Morrison, & Fishman)* are investigating whether providing individualized student instruction, which takes into account child-by-instruction interactions, causes stronger student reading outcomes.

The intervention incorporated web-based Assessment to Instruction (A2i) software, which used students' fall vocabulary and letter-word reading scores and desired reading outcomes in algorithms to compute recommended amounts and types of reading instruction for each child in the classroom. Teachers used A2i to plan instruction.

By the end of the year, children in the treatment classrooms demonstrated significantly stronger reading comprehension scores than did children in treatment classrooms. Moreover, analyses using classroom observation of both treatment and control classrooms revealed that the recommended, rather than total, amounts of instruction predicted reading outcomes. Thus, child-by-instruction interactions appear to be an underlying causal mechanism for the widely varying achievement levels observed within and between classrooms but are more complex and nuanced than the originally proposed construct of aptitude-by-treatment interactions.

Back and Forth Between Real World Problems and Cognitive Theory with Latent Semantic Analysis and Friends

Humans can express the same meaning in a wide variety of ways. The Latent Semantic Analysis (LSA) theory models this phenomenon mathematically using large amounts of text to mimic student language experience. Its

resulting ability to measure semantic similarity of whole passages is now being used to automatically assess thousands of essays each day with accuracy equal to human readers. In another application of LSA, students read articles, write short summaries, and receive instant suggestions for revision. More rapid improvement in both knowledge acquisition and expression has been found in controlled studies.

A different cognitive model is needed when vocabulary, rather than overall meaning is the target. Here, a variant on the language models behind spoken language understanding machines is used to evaluate and tutor the use of individual words to create meaningful sentences and paragraphs.

In this talk, I *(Landauer)* will describe these uses of LSA in supporting vocabulary growth. I will also discuss new work exploring how such cognitive models can simulate individual student knowledge, vocabulary, comprehension and composition growth, with the goal of selecting readings and writing assignments that maximize literacy learning.

A Research-Based Instructional Intervention for Accelerating the Vocabulary Acquisition of At-Risk Students in Grade 4

Vocabulary knowledge and comprehension are highly intercorrelated. Huge differences exist in vocabulary knowledge between good and poor readers, and attempts to directly teach vocabulary words have not closed the vocabulary gap. Can we accelerate student vocabulary acquisition through the inductive broadening of vocabulary taught directly using semantic-based (indirect) learning? We *(Vitale & Romance)* will present findings from an experimental evaluation of a classroom-delivered vocabulary intervention that combines: (a) adaptations of vocabulary research findings with both younger and older students and (b) cognitive science models (e.g., Kintsch, 2005) that together emphasize the central role of prior knowledge in comprehension and in inductive vocabulary development.

The intervention was a four-part enhancement to each of six regular basal reading stories in grade 4 and focused on 17 semantic word families. The enhancement was designed to systematically introduce learners to a set of semantically similar key vocabulary words. In later lessons, students were asked to inductively derive the meaning of new words that were semantically similar.

Results of the study showed that compared to controls, experimental students (a) inductively generated greater numbers of words with similar meanings in response to 3-sentence story passages (e.g., multiple words that could be substituted for novel words in a sentence) and to word family pairs, and (b) displayed greater achievement on the ITBS Vocabulary subtest. Implications for understanding how students learn new vocabulary words and for enhancing curricular approaches for student vocabulary development are presented.

Re-thinking Writing-to-Learn Interventions

The Writing Intensive Reading Comprehension (WIRC) study uses Bereiter and Scardamalia's (1987) dual-space model of knowledge transforming to examine the theory that the cognitive processes involved in writing make it an excellent mode of learning content and comprehension. I *(Collins)* will present results from a large experimental evaluation that generally support the claim that school-based writing-about-reading interventions contribute to academic achievement. At the same time, the results challenge several related aspects of writing-to-learn cognitive theory: that writing is more suitable as a mode of learning for higher ability students (the WIRC students are generally poor readers and writers and are all in low-performing schools); that self-regulation is a key component of writing-to-learn (WIRC relies on assisted writing in the form of thinksheets and classroom discourse); and that writing-to-learn is best used to learn course content (WIRC focuses instead on grappling with content to learn reading and writing skills and strategies).

This paper examines these theoretical issues in light of the findings from experimental and process studies in the WIRC research. Students in fourth and fifth grade classrooms benefited from the WIRC intervention, outpacing their counterparts in the control group. Statistically significant advantages for the experimental group were found for grade 5 only. The data strongly suggest the need for a third problem-solving space to stand midway between Bereiter and Scardamalia's content space and rhetorical space. This third problem space is described as involving knowledge appropriation processes crucial to the development of independent writing-about-reading abilities. With lessons learned from this experiment, future experiments will examine the theory that sociocognitive approaches are best for examining writing as a mode of learning content and comprehension.

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