Demonstration of an Innovative Reading Comprehension Diagnostic Tool

Sarah E. Carlson[1][0000-1111-2222-3333], Ben Seipel[2][1111-2222-3333-4444], Gina Biancarosa[3][2222-3333-4444-5555], Mark L. Davison[4][3333-4444-5555-6666], and Virginia Clinton[5][4444-5555-6666-7777]

[1] Georgia State University, Atlanta, GA 30303, United States of America
[2] California State University, Chico, CA 95929, United States of America
[3] University of Oregon, Eugene, OR 97403, United States of America
[4] University of Minnesota, Minneapolis, MN 55455, United States of America
[5] University of North Dakota, Grand Forks, ND 58202, United States of America
Corresponding Author's email: scarlson@gsu.edu

Abstract. This demonstration introduces and presents an innovative online cognitive diagnostic assessment, developed to identify the types of cognitive processes that readers use during comprehension; specifically, processes that distinguish between subtypes of struggling comprehenders. Cognitive diagnostic assessments are designed to provide valuable information by measuring specific processes emphasized during learning, and can provide instructionally relevant results aligned with curriculum that other large-scale, standardized assessments cannot provide (e.g., [1]). This hands-on session includes information behind how the technology of MOCCA ([2]) was developed, as well as how a reader would experience taking this assessment, how a teacher/educator would find the results of a user's assessment, and which instructional techniques to then use. Interpretation of assessment results and instructional recommendations are obtainable online. Future directions for the continued development of online digital learning regarding how to generate appropriate cognitive processes (e.g., inferences) during reading are ongoing and discussed.

Keywords: Cognitive diagnostic assessment, reading comprehension, cognitive processing, online instructional recommendations.

1 Pedagogical Background

Reading is a complex process comprised of many components, and students have been shown to struggle with reading for various reasons (e.g., decoding, fluency, comprehension; e.g., [3]). Therefore, knowing the specific reasons why some students struggle with such components would provide valuable information for intervention development. The following assessment (i.e., MOCCA) is a classroom-based cognitive diagnostic assessment designed to identify *WHY* students struggle specifically with the cognitive processing of reading comprehension ([1] [2]).

Previous research has established two types of struggling readers: Those who struggle with lower-level (e.g., decoding) and those who struggle with higher-level (e.g., comprehension) reading skills ([2] [3] [4]). The latter group is commonly termed *poor comprehenders*: Readers who exhibit poor comprehension compared to peers with similar word-reading and vocabulary skills (e.g., [4]). Moreover, research has revealed that poor comprehenders exhibit difficulty with causally coherent inferences (e.g., [4]).

Causally coherent inferences require synthesis of why an event occurs based on relevant goals and subgoals previously identified in the text *and* generate missing information from background knowledge consistent with this synthesis. Although poor comprehenders *do* make these inferences, they do not make them as *consistently* as good comprehenders. Instead, they often use other types of comprehension processes that are strategic and useful, but fail to fill the causal gap in the text. These are either paraphrases (i.e., rephrasing of prior text but does not generate missing information) or lateral connections (i.e., elaborations or personal associations, which use background knowledge but may *not be causally coherent* with the text). These trends have been found repeatedly with intermediate grade readers (i.e., Grades 3-5; e.g., [4]); however, have been found with less efficient methods (i.e., think alouds). Researchers have, thus, been prompted to develop more practical measures of the comprehension process. To date, some measures target specific populations (e.g., adult readers; [5]). Others look at inferences in the presence or absence of supportive illustrations ([6]). Some use texts that are a series of logical, relational statements rather than more common narrative and expository forms ([5]). Critically, none offer diagnostic information about what poor comprehenders *are doing* when they read, just what they are *not doing successfully*. Thus, an efficient assessment that distinguishes which processes poor comprehenders rely on would help deliver more targeted instruction.

2 Technological Background

MOCCA is such an assessment as described above. There are currently three versions available to educators at different levels: An original, a-Lite, and a college version. Both the original and Lite versions are designed and validated to be used with students in Grades 3-5. The Lite version can also be used for benchmarking. All three versions include narrative texts, and the college version now also includes expository texts. All versions are administered online. Each item is a discourse-level maze task where students complete a missing sentence with one of three choices to best complete a 7-sentence text. Examinees choose among three multiple-choice responses to complete the text: (1) causally-coherent inference, (2) paraphrase, and (3) elaborative inference. Causally-coherent inferences are the best response to complete the text in a comprehensible manner. Paraphrases are an incorrect response and involve reiteration of the main goal or a summary of the main idea, mimicking what one group of poor comprehenders does while reading ([4]). Elaborative inferences are also an incorrect response and involve connections based on background knowledge that may be tangential, mimicking what another group of poor comprehenders does during reading ([4]). There are 40 items on the original and Lite versions, and 50 items on the college version per form.

MOCCA uses innovative scoring of response types to guide the propensity of the types of comprehension processes readers use during reading. Response type patterns of not only the correct responses are calculated, but the incorrect sentences chosen are also calculated based on the number of times a reader chooses a particular response type. An item response type model consistent with a three-response type structure of items is used for the propensity of error patterns ([1]).

The assessment, scoring system, and session reports are built into the system that is delivered online with a state-of-the-art encryption and security. The web-based application is built on four Microsoft technologies: ASP.Net, C#.Net, SQL Server/Access database, and ADO; and works with Firefox, Chrome, and Safari browsers. Examples of an online item are displayed below (see Fig. 1 and 2).

Fig. 1. Item 1. Pony Ride demonstrates how an item is displayed to a student before choosing a response type. The sixth sentence is still missing as shown.

Fig. 2. Item 1. Pony Ride demonstrates how an item is displayed to a student after choosing a response type. The sixth sentence is now chosen with the first response type and is inserted into the text.

3   Use Case

Demonstration of MOCCA is interactive where participants can play an active role as a student, teacher, administrator, and/or researcher to work with session reports and interpretation guides. Error propensity scores, number correct, percentage attempt correct, minutes per correct item, and comprehension efficiency scores are reported. Participants are able to access the session reports and the interpretation guide to learn about the classroom interventions recommended based on assessment results. Interventions and related professional development are being further developed to be digitally available to educators. The report and interpretation guide are currently accessible for teachers, administrators, and researchers who use the assessment. An example of the online session report that participants are able to access is displayed below (see Fig. 3).

Student Name	Grade (Assessment Grade)	Form	Number Correct	Percentage Attempted Correct	Error Propensity	Minutes per Correct Item	Comprehension Efficiency
Child, Julia	4(4)	4.1	7	50%	Indeterminate	11:00	Slow and inaccurate
Derry, Tiffany	4(4)	4.2	21	58%	Paraphraser	06:04	Slow and inaccurate
Garten, Ina	5(5)	5.1	15	38%	Elaborator	02:56	Slow and inaccurate
Gump, Forest	3(3)	3.1	28	70%	Paraphraser	02:00	Slow and inaccurate
Puck, Wolfgang	5(5)	5.2	36	90%	Not applicable	00:23	Fast and accurate
Ramsey, Gordon	3(3)	3.2	19	48%	Elaborator	03:40	Slow and inaccurate
Woody, Knute	3(3)	3.3	13	50%	Elaborator	15:06	Slow and inaccurate
Yamaguchi, Roy	4(4)	4.3	3	100%	Indeterminate	12:29	Slow but accurate

Fig. 3. The session report shows the performance for each student based on the type and speed of the response types chosen.

References

1. Davison, M. L., Biancarosa, G., Carlson, S. E., Seipel, B., & Liu, B. (2018). Preliminary findings on the computer administered multiple-choice online causal comprehension assessment (MOCCA), a diagnostic reading comprehension test. *Assessment for Effective Intervention, 43*(4), 169-181. doi: 10.1177/1534508417728685
2. Carlson, S. E., Seipel, B., & McMaster, K. (2014). Development of a new reading comprehension assessment: Identifying different types of comprehenders. *Learning and Individual Differences, 32,* 40-53. doi: 10.1016/j.lindif.2014.03.003
3. Perfetti, C. A. (2007). Reading ability: Lexical quality to comprehension. *Scientific Studies of Reading, 11*, 357–383. doi: 10.1080/10888430701530730
4. McMaster, K. L., den Broek, P. v., A. Espin, C., White, M. J., Rapp, D. N., Kendeou, P., . . . Carlson, S. (2012). Making the right connections: Differential effects of reading intervention for subgroups of comprehenders. *Learning and Individual Differences, 22*, 100–111. doi: 10.1016/j.lindif.2011.11.017
5. Hannon, B., & Daneman, M. (2001). A new tool for measuring and understanding individual differences in the component processes of reading comprehension. *Journal of Educational Psychology, 93*, 103–128. doi: 10.1037/0022-0663.93.1.103
6. Pike, M. M., Barnes, M. A., & Barron, R. W. (2010). The role of illustrations in children's inferential comprehension. *Journal of Experimental Child Psychology, 105*, 243–255. doi: 10.1016/j.jecp.2009.10.006