Unpacking and Illustrating Coiro’s Multifaceted Heuristic of Digital Reading Through the Development of the COT-R Assessment

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Unpacking and Illustrating Coiro’s Multifaceted Heuristic of Digital Reading Through the Development of the COT-R Assessment

Jodi Pilgrim, University of Mary Hardin-Baylor
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Abstract

Although much research exists on digital reading, confusion about literacy terminology persists. Inspired by a recent article in Reading Research Quarterly, the authors explore a multifaceted heuristic of digital reading developed by Julie Coiro. The heuristic, which offers a way to systematically organize, label, and define complex terms, concepts, and practices related to digital reading experiences, served as a reference point to examine the authors’ journey of defining digital reading. Highlighting three aspects of Coiro’s heuristic--text, activity, and context--the authors begin by describing the development of an authentic online reading assessment instrument (COT-R), which focuses on elementary students’ processes of online text navigation and evaluation. The authors then unpack the complexities of defining digital reading encountered during the evolution of the assessment instrument. In addition, they argue for increased attention on hyperlinks, which they found to be a defining text feature of online reading.

Keywords: Heuristic, digital reading, Concepts of Online Text and Research, text, activity, context

The complexities of reading in a digital environment have received significant attention over the last 30 years (Coiro, 2003, 2021; Coiro et al., 2011; Dillon, 1992; Leu et al., 2019). Julie Coiro (2021) recently developed a multifaceted heuristic of digital reading to support both researchers and practitioners in using precise terms and developing common language when describing digital reading. This work is important because digital reading takes many forms, and the environment in which the text resides makes a substantial and logistical difference for readers. For example, reading a PDF online differs from reading a networked webpage. When reading a webpage, readers may encounter hyperlinks, which can take them into greater depth of knowledge through related sources or greater distractions in the case that the link, or subsequent links, leads to tangential information or distractions away from the beginning topic (Coiro, 2003; Hartman et al., 2010; Warlick, 2009). When reading an eBook, hyperlinks may serve simply as glossaries and stay within a bounded space. Knowing these various digital environments requires
unique sets of knowledge and skills of expanding text environments.

Coiro’s (2021) heuristic expands on the well-developed RAND Reading Study Group’s (2002) model of reading comprehension, which identifies four aspects of comprehension: text, activity, reader, and context. The RAND group developed this model around traditional paper-bound texts. Coiro used it to ground and expand our notion of texts in the digital age. She sought to describe and define distinctive features of digital reading experiences and engage scholars in an open conversation about this knowledge base and how it “can be used to characterize, measure, teach, and support comprehension across a range of digital reading contexts” (p. 10). Coiro expressed concern about the lack of consistency of terms used to define, describe, and compare digital reading practices as well as how scholars operationalize digital reading. In addition, Coiro invited the literacy community to engage in a conversation around her proposed heuristic and explore not only the complexity of digital reading, but also her goal of promoting precision and clarity. In this article, we enthusiastically respond to the call.

We concur with Coiro’s concerns and her acknowledgment that digital reading involves an array of text types, not just one singular text type, and we agree about the need for careful defining of digital reading and authentic assessments of online reading (Coiro, 2021; Coiro et al., 2011; Dillon 1992). Coiro (2021) and colleagues (Leu et al., 2019) acknowledge that researchers do not know enough about how readers develop competencies needed to read and navigate online texts. The Concepts of Online Text and Research (COT-R; Pilgrim & Vasinda, 2021; Pilgrim et al., 2018) was designed to assess these competencies. As we examined the heuristic, we found connections, agreements, and alignments through our experiences developing the COT-R observational survey. Therefore, in this context, we illustrate the utility of Coiro’s heuristic as we unpack the complexities of defining and assessing these competencies. Throughout this article, we share the narrative of the iterative process used in designing the COT-R assessment instrument. We examine the intersections of the heuristic and the COT-R, deductively analyzing each comprehension element and comparing terminology used in the heuristic to terminology used in the development of the COT-R. This analysis offers and extends an explanation of why careful and precise naming of digital terminology is important for research and assessment.

**Theoretical Perspective**

Traditional assessments of concepts about print align with offline reading skills. Marie Clay (1979) developed the well-known Concepts About Print observation survey to determine knowledge that emerging readers demonstrated about book handling and text-based print. Clay’s assessment provides insight into young children’s interactions with traditional paper-based books as they complete tasks related to text features, orientation, and directionality. The instrument we compare to Coiro’s heuristic specifically focuses on concepts of online text. Just as Clay’s Concepts of Print provides insights into young children’s understanding of book handling and alphabetic text, the COT-R provides insight into elementary students’ understanding of screen handling, the dynamic nature of online print, and multimedia/multimodal aspects of online research and navigation.

When Clay (1979) first coined the term concepts about print, the internet had not yet redefined literacy. The traditional “rules of the road” (Clay, 2000, p. 24) have shifted to a more complex set of rules that extend beyond paper-based concepts of what it means to
read. More recently, Duke and Cartwright’s (2018) DRIVE model of reading applied road types (paved, dirt, smooth, bumpy) as an analogy for text types that complicate reading. Online texts are examples of complicated terrain. In addition to two-dimensional aspects of metacognition, knowledge, and regulation, online readers need locational knowledge (Hartman et al., 2010, p. 147). There are no page numbers or physical indications of how far you might be within a text—the beginning, middle, or near the end. There is no static mapping for this new terrain as, with any road trip, there can be many routes to the same destination.

We find these complexities specifically related to the multiliteracies required of online reading and agree that the internet is “this generation’s defining technology for literacy and learning within our global community” (Leu et al., 2019, p. 326). Although multimodal aspects of literacies (Cope & Kalantzis, 2000; Kress, 2010; New London Group, 1996) are present both offline and online, reading online includes navigating a hypermedia, three-dimensional platform by clicking on images and words that connect to additional pages delivering more information or, possibly, disrupting with extraneous information (Fitzsimmons et al., 2019; Warlick, 2009). The dimensions of multimodal, networked information environments expand the ways readers acquire information, experience a text, and comprehend ideas. Therefore, our focus on the concepts of online text is grounded in both a multiliteracies perspective, which addresses the multimodality of the internet, and new literacies theory, which offers explanations for new ways to communicate due to deictic technologies and the internet (Leu et al., 2019). In addition, our use of Coiro’s heuristic reflects the intersections of these theories as we seek to analyze the application of literacy terminology.

**From Concepts About Print to Concepts of Online Text**

Reading online text presents unique challenges for elementary students as they develop and apply fundamental literacy skills and new literacies to various media on the internet. Just as readers possess knowledge about turning a page and reading from top to bottom, young online readers should possess navigation knowledge such as scrolling on a webpage, clicking or tapping on hyperlinks, and using directional buttons such as back arrows (Pilgrim et al., 2018). This knowledge about online text and media enables readers to effectively navigate the three-dimensional connectedness of hypermedia environments (Warlick, 2009). Readers also need critical thinking skills, as online sources are not as credible as most print resources, which are typically vetted prior to publication. This requires identity knowledge, understanding who wrote the text and on what type of platform or format (e.g., blog, official website; Hartman et al., 2010).

Although emerging readers typically master print awareness and concepts of print in kindergarten (Bear et al., 2015), research indicates knowledge of text features and website navigation occurs during the later elementary years (Pilgrim et al., 2018). Kervin and Mantei (2016) stressed the importance of gathering evidence about skills emergent readers exhibit when reading online texts. Therefore, the COT-R assesses concepts of online text pertaining to navigation and research skills. We piloted our initial version of this assessment in 2016–2017, the results of which have been published in *Reading Horizons* (Pilgrim et al., 2018).
Multifaceted Heuristic of Digital Reading

Heuristics serve as exploratory problem-solving techniques (Merriam-Webster, n.d.). Coiro (2021) cautioned against the oversimplification of digital reading as analogous to a change of text format from paper to screen. Expanding the four elements in the RAND Reading Study Group (2002) report and exploring the tensions in almost 30 years of theory and research, Coiro proposed to work toward clear articulation and shared understanding of important digital literacy terms. She brought together salient terms and aspects of digital reading to create a more complete, complex, and multifaceted heuristic of digital reading (Figure 1). For example, Coiro addressed digital reading as a subcategory of digital literacy. By including “digital reading” in the heuristic title, Coiro situated reading comprehension within digital contexts, defining digital reading as “a range of multifaceted meaning-making experiences whereby readers engage with multiple texts for particular purposes that are situated in diverse contexts” (p. 10). Below, we describe the COT-R, an authentic assessment of digital literacy skills. We then position the heuristic as a thinking tool applied to our work and share an analysis of why careful and precise naming of digital terminology is important for research and assessment.

Figure 1
Coiro’s Multifaceted Heuristic of Digital Reading

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Concepts of Online Text and Research

Our journey of unpacking the complexities of digital reading began during the design process of the COT-R. Drawing foundationally on Clay’s (1979) work identifying Concepts About Print (CAP), Duke et al.’s (2013) work with graphic texts, and new literacies theories focused on changes in literacy fostered by the internet and rapidly changing technologies (Leu et al., 2019), the COT-R explores children’s understandings about online conventions used to find and evaluate information on the internet. Since 2016, we have researched elementary students’ web literacy skills (Pilgrim & Vasinda, 2021; Pilgrim et al., 2018, 2019). To assess these skills, we initially developed the Concepts of Online Text (COT), which measures the knowledge of online navigation and text features of students in Grades 1–5. Traditional assessments of concepts about print inspired the development of the instrument, which includes an observation protocol of online text, like the observation protocol Clay used with book handling and paper-based text. Table 1 provides a comparison of the COT and Clay’s CAP assessment. Whereas the CAP uses a book for assessment purposes in a one-on-one setting, our interview protocol includes the use of a technology device (computer or tablet) in a one-on-one setting. Students complete a series of tasks relating to a preselected webpage that includes distinct features of online text while the teacher observes.

Table 1
Considerations for Concepts of Online Text Based on Concepts About Print

<table>
<thead>
<tr>
<th>Clay’s (1979) Concepts About Print assessment</th>
<th>Concepts of Online Text assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concepts of print-based text</td>
<td>Reader prompts</td>
</tr>
<tr>
<td>Orientation or layout of text/front of book</td>
<td>Where is the front of the book?</td>
</tr>
<tr>
<td></td>
<td>Where is the back of the book?</td>
</tr>
<tr>
<td></td>
<td>Open the book to where the story begins.</td>
</tr>
<tr>
<td>Print, not pictures, carries the message</td>
<td>Show me the picture.</td>
</tr>
<tr>
<td></td>
<td>Show me the words.</td>
</tr>
</tbody>
</table>
### Table 1 (Continued)

<table>
<thead>
<tr>
<th>Concepts of print-based text</th>
<th>Reader prompts</th>
<th>Considerations for COT assessment development</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direction of print</strong></td>
<td>Show me where to start reading. Where do I read after this?</td>
<td>“Page” sequencing: webpages within a site (not necessarily linear)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>How does a reader “turn pages” in a nonlinear format?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Print features particular to online text:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>· Hyperlinks (various formats and purposes, definitions, additional information, graphics, etc.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>· Differences between websites and webpages (one hyperlink can lead to another website, taking the reader to another “book” rather than another page/chapter within the same book); can the reader differentiate?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>· Titles and headings (throughout website/webpage)</td>
</tr>
<tr>
<td><strong>Difference between letter and word.</strong></td>
<td>Show me one letter.</td>
<td>This is requisite knowledge needed for reading online text.</td>
</tr>
<tr>
<td></td>
<td>Show me one word.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Show me the first letter in a word.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Show me the last letter in a word.</td>
<td></td>
</tr>
<tr>
<td><strong>Return sweep</strong></td>
<td>Where do I read after this?</td>
<td>Same skill needed for tracking online text; however, online text may require clicking on “read more” types of links to additional webpages for complete text then navigating back to original page.</td>
</tr>
</tbody>
</table>
One-to-one correspondence

Point to each word as I read this line. This is requisite knowledge needed for reading online text.

Punctuation

Do you know what this is? What is this for? This is requisite knowledge needed for reading online text.

Synthesizing information:

· How does a reader look at the various print components on a website/webpage and synthesize meaning? How do they determine the main idea or topic of a site/page?

· How does a reader determine the author/owner/publisher of a website?

· How does a reader determine the publication date of a website?

Evaluation information:

· What information does a reader need to evaluate the credibility of a website?

· Which components are indicators a website can/cannot be trusted?

Source. Pilgrim et al. (2018)

The COT consisted of seven tasks that align with two main constructs: (1) website orientation and navigation and (2) knowledge of online text features. Construct 1 involves the orientation of a website, including the understanding of principles involving directional arrangement of text and media, and Construct 2 involves the identification and understanding of webpage text features such as author, publisher, titles, headings, menus, captions, graphics, and hyperlinks. While emerging readers typically master print aware-
ness and concepts of print in kindergarten (Bear et al., 2015), research conducted with the COT indicated that knowledge of text features and website navigation develops during the later elementary years (Pilgrim et al., 2018).

As a result of protocol feedback, the COT was expanded to the COT-R (Pilgrim & Vasinda, 2021), which extends the assessment instrument to evaluate knowledge of an authentic internet search. An internet search requires the ability to think critically, which is a key factor in evaluating online information (Leu, 2017; Leu et al., 2019). Readers must become healthy skeptics (Leu, 2017) of online information, developing what we call reliability reasoning (Pilgrim et al., 2019) to determine deceptions and truths found on the internet. The COT-R includes five additional tasks and aligns with two additional constructs: (3) application of research skills and (4) evaluation of online information (Pilgrim & Vasinda, 2021). Construct 3 involves the ability to use digital skills to search, save, cite, and share information. Construct 4 involves the ability to evaluate search results, websites, and content for relevance and credibility of sources.

The intent of our work over the years has been to extend beyond traditional concepts of print to evaluate emerging readers’ skills in an online, hypermedia environment. These complex new literacies represent knowledge necessary for reading, writing, and participating in online environments (Leu et al., 2015). This research is important because the internet is “this generation’s defining technology for literacy and learning within our global community” (Leu et al., 2013, p. 1158). As we reflect on our work in assessing online literacy skills, we relate to and appreciate Coiro’s efforts to systematically organize, label, and define a multifaceted set of complex terms, concepts, and practices associated with digital reading experiences.

**Unpacking Digital Reading Through the Context of Authentic Assessment Development**

In our iterative process of designing the COT-R, we critically analyzed and deliberated over our word choice to ensure our terms reflected the text and activity assessed, which is where we focus our discussion of a heuristic of digital reading. For example, our first iteration of the COT-R was titled Concepts of Digital Print. The instrument sustained several name changes, based on careful and intentional considerations of wording. In the next section, we expand on our thought processes during instrument development and how these considerations align with Coiro’s heuristic.

Our iterative process provided a deeply reflective context to question, identify, and refine our understanding about the concepts of digital reading in online and offline spaces. With the publication of Coiro’s heuristic, we are able to conceptualize our work in terms of the instrument’s alignment with online reading. As we unpacked Coiro’s heuristic, we deductively analyzed each comprehension element and compared terminology used in the heuristic to terminology used in the development of the COT-R.

**Comprehension Elements: Text, Activity, and Context**

In response to Coiro’s (2021) call to “embrace and unpack the complexity of digital reading while also working to promote greater clarity” (p. 27), we describe our struggle
with capturing the nature of digital reading as we identified concepts of web-based text. We first struggled with the word print. Our inspirational work, Clay’s (1979) Concepts About Print, explored children’s book handling and identification of text features. As Coiro cautioned, we were not trying to make a one-to-one match from paper pages to internet pages. We sought to identify what online reading entailed. We discovered that the space in which the text resides is critical to the type of skills and page handling a reader needs to understand in addition to decoding and meaning making. This acknowledgment aligned with Hartman et al.’s (2010) work, in which they explained that the combination of multiple text types complicates the characterization of text as a part of reading in digital spaces. In the section, we elaborate on the text types in the multifaceted heuristic.

**Text**

In Coiro’s (2021) heuristic, the element of text is surrounded by a circular graphic identifying the following text types: literary text, informational text, hybrid text, multimedia, multimodal text, onscreen text, hypertext, hypermedia, internet text, and augmented text (Figure 2).

**Figure 2**

*Multifaceted Heuristic of Digital Reading: Text*

These text types are linked by arrows, symbolizing an “overlapping ring of possible text features available in digital spaces” (Coiro, 2021, p. 20). Because Part A of the COT-R evaluates knowledge about web navigation and online text features, we needed an authentic website that included online text features students could navigate during assessment tasks.
We looked for informational text with multimedia and multimodal features. In our initial version of the COT, we used a website about Groundhog Day developed by Factmonster. It included a photograph of a groundhog and hyperlinks that led to more information about groundhogs, Pennsylvania, and additional history. We appreciated the relationship of the photo to the topic, as it augmented the topic without giving it away. When asked what the page was about, a student not attending to the print might answer “groundhogs” rather than “Groundhog Day.” After our initial study, we discovered the Factmonster webpage had been updated with minor changes made to its format, including no related photograph. Due to the dynamic and sometimes unstable nature of websites, we developed our own webpage for long-term use. We carefully constructed the photo and print relationship for our page based on the layout of the origial site, working with a scientist we knew who keeps an updated website. Figure 3 presents a screenshot of the COT-R text.

Figure 3
Webpage Used With the COT-R (www.cot-r.com)
The COT-R text includes informational text about a scientist. The multimedia components in the website include graphics such as the photo and an ad. The inclusion of multimedia text was intentional, as the COT-R is grounded in research related to concepts about print (Clay, 1979, 2000, 2005), concepts about graphics (Duke et al., 2013), and graphics reflect multimedia. Because we did not include a video on the webpage, the multimodal component of the text depends on the use of technology tools, such as text-to-speech capabilities in which readers can access the content by listening to it rather than decoding it. Coiro (2021) recommended delineating between the terms multimedia and multimodal, which are often used interchangeably. She cited Mayer (2001), who identified multimedia as static texts that include alphabetic print, images, and graphics; she differentiates multimodal texts as more dynamic including animations, video, sounds, and music as well as alphabetic print, citing Selfe (2007).

Our internet page also includes onscreen text, hypertext, hypermedia, and internet text, which, as Coiro (2021) suggested, overlap. We began instrument development with the plan to label the idea Concepts of Digital Print, to mirror Clay’s (1979, 2005) work with Concepts About Print. However, we quickly determined that onscreen, or screen-based, text did not reflect skills required during online reading activities. Therefore, we were cautious about using the term digital. We transitioned to the term web-based text briefly before settling on online text to represent what we considered to be the context of the reading activity. Our thought processes align with Coiro’s suggestion that digital texts can be static or dynamic and that, in addition to format and genre, digital texts are differentiated by where they are found and how readers engage with them. Coiro used web-based (p. 22) only once to describe a media literacy activity. The review of current literature influenced our choice of online text instead of web-based. We drew heavily on researchers’ use of online reading and online comprehension (Castek et al., 2015; Coiro, 2015; Coiro & Dobler, 2007; Hartman et al., 2010; Leu et al., 2019) and the development of the ORCA (Leu et al., 2008) and ORA (Kervin & Mantei, 2016).

As a defining feature of online texts, we and others have found hyperlinks to be a confusing feature for elementary students (Dalton, 2013; Dodge et al., 2011; Hartman et al., 2010; Pilgrim et al., 2018). Hyperlinks are the linkage system that creates hypertexts, hypermedia, and internet texts. Coiro (2021) defined hypertexts and hypermedia as digitally networked texts within a bounded, or closed, system, which some referred to as “walled gardens” (Technopedia, n.d.). She differentiated these from internet texts, which are unbounded and open-ended. Not only do hypertexts create personal pathways of reading and accessing information, but they also require navigational savvy in both closed and open digital environments (Hartman et al., 2010; Warlick, 2009). In the open, unbounded digital environment of the internet, which we have referred to as the “wild wide web” (Vasinda & Pilgrim, 2019, p. 97), readers accessing hyperlinks may find themselves engrossed in deeper and deeper layers of meaning and perspective or off target moving into distraction (Coiro, 2003; Fitzsimmons et al., 2019; Warlick, 2009). Not only do readers have to determine if the new webpage content is reliable, using critical literacy skills they also need to know how to return to their original starting point and possibly create a trail of breadcrumbs if they wish to return to a site. Hartman and colleagues (2010) referred to these digital reading interactions as identity knowledge (knowing who) and location knowledge (knowing where). They also identify goal knowledge, an understanding reading purpose, as a navigation strategy that helps readers stay focused. Therefore, the hyperlink is a navigation element of both hypertext and hypermedia as well as an online digital text feature.
and requires navigational strategies to stay the course.

**Hyperlink as a digital text feature.** Hypertext, hypermedia, and internet texts share several similar features with static, print-based informational texts. Their authors and publishers use traditional informational text features such as titles, headings, tables of contents or menus, captions, and graphics to organize and supplement information. The unique text feature specific to digital texts is the hyperlink. It is also a text feature that children in Grades 1–5 find confusing during online research (Pilgrim et al., 2018). Words or phrases distinguished by a distinctive blue color, underlined, and sometimes bolded, indicate a hyperlink. When encountered in eBooks and some bounded digital texts, such as children’s news magazines, the hyperlink serves simply as a glossary. In other hypermedia and on the internet, the hyperlink creates a three-dimensional reading of “across and down” processes leading to supportive and related texts that extend the reading experience (Warlick, 2009, p. 22). Additionally, when asked about the function of a hyperlink in the COT-R assessment, students often responded that it is an “important word.” This response may be related to their background knowledge about boldfaced text in static texts and the glossary-type hyperlinks in eBooks and news magazines. In our 2018 study of 80 first through fifth graders responses to the COT question about hyperlinks, only 22% overall understood the dynamic nature of the hyperlink in internet texts, with fifth graders demonstrating understanding at 45%.

Hyperlinks as a navigational element. Because hyperlinks in hypermedia and internet texts take readers to additional content on a new page or other multimedia, they are also a navigational element. Readers not only need to attend to the logistics of moving back and forth from different parts of a document in hypertext, but also, more commonly, they need to learn to navigate from new pages or media back to their original starting point. Additionally, they need to develop locational metacognition that includes retrospective awareness and an understanding of where they have been and what they have read. They also need prospective awareness to consider next locations and texts, images, or media to investigate as they continue reading (Hartman et al., 2010).

With internet text, readers need to engage in the additional task of critically assessing the validity and reliability of the sources opened during a search, using other informational text features, such as the author, date, publisher, and “about” tabs as well as checking multiple sources for confirmation of information. Hartman and colleagues (2010) referred to this as “identity knowledge” (p. 146). With the overabundance of online authors, readers need to understand how and why authors create their online identities. Therefore, hyperlinks and hypertexts create navigational elements that add layers of complexity both in keeping track of where you are as a reader and in what we call “reliability reasoning” (Pilgrim et al., 2019, p. 85). The need for an understanding of this concept is part of what led us to extend the COT to the COT-R.

**Activity**

The activity component of comprehension “entails the purpose, process, and consequences of an activity” (Coiro, 2021, p. 20). We read for a variety of purposes, and being metacognitively aware of our goals supports focused, sustained effort to comprehend online (Hartman et al., 2010). Paper-based activities, even when involving multiple texts, do not require the same type of navigation skills as online reading. In Coiro’s (2021)”
heuristic, the element of activity is surrounded by a circular text graphic with ideas listed in a more direct order, starting with a single text activity, progressing to more complex activities of multiple texts activity, multiple texts activity across multiple media and/or platforms, critical media literacy activity, online research and inquiry activity, and ending with digital creation activity (Figure 4). As we continued to develop the COT, expert feedback led to the inclusion of an authentic internet search (Part B). Forzani suggested that we include an advertisement, as young children often do not know the difference between an ad and content. This change reflected a need to extend our investigation of online literacy skills beyond only web-based navigation and to include evaluation of content, including distinguishing informational text from advertisements. We added a Part B to the COT, which led to the renaming to Concepts of Online Text and Research. The activity assessed in Part B of the COT-R is online research, which in alignment with Coiro’s commentary entails the ability to search, locate, and evaluate online information (p. 23). We appreciate her comment on the power of online research and inquiry activity to “push readers further into ever-changing open networked environments” (p. 23), which we also recognized from our work with children in earlier iterations of developing this assessment when we included a hoax website (Pilgrim et al., 2019). Therefore, Part B of the instrument requires readers to “navigate, evaluate, and integrate ideas that they encounter from narrative or informational hypertext, hypermedia, or internet text” (p. 21). During online research and inquiry, readers must make sense of online resources and determine the credibility of information, which adds to the complexity of reading comprehension.

Figure 4
Multifaceted Heuristic of Digital Reading: Activity

Context

Our experiences with the COT-R development led us to consider the importance of the location of text during reading activities. Initially, we considered paper-based reading versus screen-based reading. As we worked with children developing this instrument, we delineated the screen-based settings to the features of the screen
unique to internet activities. Coiro (2021) referred to these spaces when she discussed the internet texts’ unique context, the fourth element of her heuristic of digital comprehension. Coiro described four sets of contextual elements: response format, contextual design considerations, contextual features of community, and medium/platform. Purposefully, she positioned medium/platform near the text element of comprehension “as a reminder of the context(s) in which certain kinds of texts may be found” (p. 23). Our experiences mirror the careful identification of internet space and its influence on digital texts and the need to place text types near the medium/platform. The heuristic provides examples of platforms that range from the printed single page to augmented reality platforms (Figure 5).

Figure 5
*Multifaceted Heuristic of Digital Reading: Context*
The COT-R studies have taught us that the text features in these spaces matter. Many traditional concepts about paper-based text continue to apply in web-based formats. The concept of a letter, a word, or a sentence has not changed in online environments. In addition, features such as titles, headings, authors, and copyrights are easily transferable from paper to an online format. However, webpages incorporate dynamic text features such as menus and hyperlinks, which are not possible in traditional print resources.

A webpage, like the one used with the COT-R (Figure 3), differs from a single paper page, as it is not limited in terms of space and dimension. Therefore, the bounded pages platform of the heuristic caught our attention. The layout of a webpage is sometimes like a newspaper with separate headings, advertisements, and images, but the flow of the text is not necessarily linear and sequential. As readers proceed to locate specific content, they encounter menus and hyperlinks, which may lead to multiple webpages within the website and beyond it. While there are many benefits to readers for accessing additional information, some may become distracted as hyperlinked resources may have different or contradictory aims. For example, by clicking on hyperlink text or an advertisement, the reader can inadvertently open another website. A reader who is unaware of the navigation process or change in space may not realize which page is currently open. This may cause the reader to lose focus on their goals and purposes and follow unrelated, tangentially related, or nonproductive information. Online text features affect the navigation of text in complex ways and should be investigated to support comprehension instruction. Just as text features contribute to the difficulty of informational text (Ankrum et al., 2016–2017; Duke, 2000; Hoffman et al., 2015), online text features add to the complexities of comprehending information found on the internet (Coiro, 2003; Hartman et al., 2010; Pilgrim & Vasinda, 2021; Pilgrim et al., 2018).

Table 2 presents our digital terminology deliberations and considerations. The four contextual elements of comprehension, which provide the organization for the heuristic, are used for the basis of the comparison. The terms bolded in the second and third columns are concepts the heuristic defined and the COT-R instrument addressed. As noted in the COT-R column, our considerations for the medium/platform, briefly referred to by Coiro (2021) as “multivariate space” (p. 25), extend beyond concepts presented in the heuristic. These online text features and their impact on internet research are worthy of further discussion.
Table 2
Digital Terminology Comparison: Terms, Concepts and Practices

<table>
<thead>
<tr>
<th>Coiro’s (2021) heuristic</th>
<th>COT-R</th>
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<tbody>
<tr>
<td><strong>Contextual elements</strong></td>
<td><strong>Heuristic</strong></td>
</tr>
<tr>
<td>Text</td>
<td>• Literary</td>
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<td></td>
<td>• <strong>Informational</strong></td>
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<td></td>
<td>• Hybrid</td>
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<td>• <strong>Multimedia</strong></td>
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<td>• <strong>Multimodal</strong></td>
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<td>• Onscreen</td>
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<td>• Hypertext</td>
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<td>• Hypermedia</td>
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<td>• <strong>Internet</strong></td>
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<td>• Augmented</td>
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</tbody>
</table>
### Table 2 (Continued)

<table>
<thead>
<tr>
<th>Coiro’s (2021) heuristic</th>
<th>COT-R Considerations for survey development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contextual elements</td>
<td></td>
</tr>
<tr>
<td>Activity</td>
<td>• Single text</td>
</tr>
<tr>
<td></td>
<td>• <strong>Multiple texts</strong></td>
</tr>
<tr>
<td></td>
<td>• Multiple texts across multiple media and/or platforms</td>
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<td></td>
<td>• Critical media literacy</td>
</tr>
<tr>
<td></td>
<td>• <strong>Online research and inquiry</strong></td>
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<td></td>
<td>• Digital creation</td>
</tr>
<tr>
<td>Reader</td>
<td>• Cognitive capabilities</td>
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<td></td>
<td>• <strong>Sociocultural identities</strong></td>
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<tr>
<td></td>
<td>• Reading and language competencies</td>
</tr>
<tr>
<td></td>
<td>• Reading dispositions and motivations</td>
</tr>
<tr>
<td></td>
<td>• Reading and language competencies</td>
</tr>
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<td></td>
<td>The survey (Part B) assesses online research across multiple texts and multiple media.</td>
</tr>
<tr>
<td></td>
<td>The survey assesses emerging skills related to digital reading. Prior knowledge of these skills may depend on the multiliteracies readers bring to the classroom, or their sociocultural identities.</td>
</tr>
</tbody>
</table>
Assessment development highlighted the need to consider the medium/platform. Considerations around space included the following:

- paper-based vs. screen-based
- multivariant space (Coiro [2021] discussed in article)

**Medium/platform** for the survey required knowledge of online text features:

- Titles
- Headings
- Author/publisher
- Copyright
- Menus (home button)
- Hyperlinks
- Ads
- Back arrows/scroll features
- Webpage (bounded, unbounded)
- URL

### Table 2 (Continued)

<table>
<thead>
<tr>
<th>Coiro’s (2021) heuristic</th>
<th>COT-R</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Context</strong></td>
<td><strong>Heuristic</strong></td>
</tr>
<tr>
<td><strong>Medium/platform</strong></td>
<td>• (single page, object, bound pages, multiple pages of objects, digital device, software or app, virtual world, headset-based virtual reality, augmented reality)</td>
</tr>
<tr>
<td><strong>Response format</strong></td>
<td>• (multiple choice, selected response, short constructed typed, audio recorded responses, video recorded responses, extended constructed typed, extended constructed design)</td>
</tr>
<tr>
<td><strong>Contextual design considerations</strong></td>
<td>• (timed or untimed; individual, partner, or group; engagement with real people or avatars; face to face, remote, or virtual reality; self-selected or other-selected; personal or task goals)</td>
</tr>
<tr>
<td><strong>Contextual features of community</strong></td>
<td>• (school-based experience, after-school experience, home-based experience, community-based experience)</td>
</tr>
</tbody>
</table>
Discussion

As we unpacked Coiro’s (2021) heuristic and analyzed concepts defined in her work (italicized in this section for emphasis), we found the heuristic to be incredibly comprehensive. We also recognized the significant overlap Coiro describes during internet research and inquiry:

Digital texts introduce additional complexities to a number of digital reading activities. These complexities make it harder for learners to perform at least three kinds of reading tasks: access and retrieval tasks, which require use of searching skills in more abstract spaces; integrate and interpret tasks, which require more reliance on short-term memory to simultaneously read across multiple documents; and reflection and evaluation tasks, because fewer filters demand critical reading skills to establish the credibility of content needed to solve even simple reading tasks. Here, we begin to see complex overlaps among texts, activities, and reader. (p. 16)

Our prior work in this area indicated that knowledge of text features may also contribute to a reader’s ability to establish credibility of online content. This finding reflected an overlap between the aspects of activity and context (Table 2). Consider online text features such as copyright or publisher (medium/platform). These text features provide important information and assist the reader in determining the credibility of a website based on why and when the website was created. In our previous study (Pilgrim et al., 2018), we assessed first through fifth graders’ ability to locate the copyright and publisher on a website. Out of 80 first through fifth graders, only 12% of the students in Grades 1–3 were able to locate the copyright. Fourth and fifth graders were more successful, with 40% of fourth graders and 60% of fifth graders locating the copyright. Locating the publisher proved even more difficult, with 0% of first graders, 7% of second graders, 12% of third graders, 13% of fourth graders, and 55% of fifth graders successfully completing the task.

A 2021 study of 354 students in Grades 1–5 used the COT-R (Pilgrim & Vasinda, 2021) to evaluate students’ ability to conduct a search and determine website credibility. The research tasks began with a prompt in which students were asked to search for an animal, specifically a dolphin. Two tasks were assessed. The first task was evaluated with the following prompts: (1) Show me how many websites your search provided. (2) Show me how you could narrow the dolphin search to find what dolphins eat. The second task was evaluated with the following prompts: (3) How do you know which website will provide the best information about your topic? (4) Click on one of the websites you found. How can you tell if this website is relevant to your search? In other words, how can you tell if this website will give you the kind of information you need? (5) How can you tell if this website will provide correct information that is true or accurate?

These survey tasks overlap across text, activity, and context in many ways. For example, the first prompt requires students to understand that a web search typically results in millions of website suggestions. Overall, 20.1% of the participants earned credit for their response to Prompt 1. It was noted that in most cases students either counted the number of results on each page or did not know how to determine the answer. The internet research overlapped with a reader’s ability to identify website results, which may be considered a text feature.
Test administrators noted that students often referred to images (multimedia) with Tasks 2–5. The second prompt required narrowing the search to determine what dolphins eat, and 81.9% of the participants earned credit for their response. The third prompt required students to locate a relevant website. In this case, because they typically relied on images, many students were unsuccessful with the task, and 40.9% of the participants earned credit for their responses. Overall, 74.6% of the participants earned credit for their response to Task 4, which required finding a relevant website. Because students searched what dolphins like to eat, many students were able to use images on the website they selected to confirm they had found what dolphins like to eat. Images seemed to catch a child’s attention more easily than other text features. When asked about reliability through Task 5, only 18.9% of the participants earned credit for their response. Observation notes indicated many students believed websites had correct information because the pictures were real. This is a significant problem, uncovered through assessment, when students inaccurately applied knowledge of text (multimedia). (For more information on this study, see Pilgrim & Vasinda, 2021).

In 2010, the Common Core State Standards articulated the need for students to “use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently” (para. 1). Over 10 years later, scholars suggest that we still do not know enough about the development of online readers and the literacies they need to navigate and evaluate the texts they encounter online (Coiro, 2021). They also charge that there is a need for context-rich assessments that include authentic and unique features of online texts (Leu et al., 2019). In response to the needs from both the public and scholars, COT-R provides insight into the online literacy development of elementary students using an authentic online context with connected, context-rich texts.

Authenticity

Through our research, we have discovered that the text, context, and activity matter in assessing concepts about online text and research. Therefore, authenticity matters. As Dillon (1992) noted and Coiro (2021) reiterated, when research strips away the unique features of networked digital texts in attempting to control variables, much is lost. Because internet reading is one of the defining features of our current global culture (Leu et al., 2019), we developed an assessment that focused on authentic internet skills in an authentic context. Although we did not include the role of the readers as we unpacked Coiro’s heuristic, we learned from them. Defining and understanding this “space” and text matters. Hyperlinks as digital text features function differently in closed and open systems. In addition, the hyperlink changes the activity of the reader, from a multiple text activity to a multiple text activity across multiple media and/or platforms to a critical media literacy activity.

Multivariate Space

This illustration of the iterative process in the development of COT-R and our juxtaposition with three aspects of Coiro’s (2021) heuristic—text, activity, and context—provide a snapshot of the complexities of online reading tasks and text “handling.” Although our work began prior to the unveiling of the heuristic, we shared similar goals in using precise wording to reflect the assessment goals of COT-R. Our work also provides an authentic context illustrating the usefulness of the heuristic to “explicate the constraints
and affordances of different arrangements as different constellations of reading in this multivariate space” (Coiro, 2021, p. 25). Through this comparison, we developed better understandings of digital texts and text handling, leading to more precise labels. The initial use of digital print in our original title did not reflect the dynamic network of online text, particularly online hypertext and hypermedia. Our use of web-based print and media in our next title iteration was more precise but did not align with the work of other assessment developers who were using online reading. The use of online text as a complement to online reading seemed to encompass both print and media as well as align with other scholars working on assessments of digital reading using the term online to represent internet text. Coiro (2021) and colleagues (Leu et al., 2019) acknowledged that we do not know enough about how readers develop the competencies needed to read and navigate online texts. Therefore, in this context, we illustrated the utility of Coiro’s heuristic as we unpacked the complexities of defining digital texts encountered during the development of the COT-R (Pilgrim & Vasinda, 2021; Pilgrim et al., 2018). We applaud the potential of Coiro’s heuristic to support scholarly work in precision of terms in the context of the development of an authentic assessment.

Conclusion

Coiro (2021) concluded with a question: “Where do we go from here?” In addition to making recommendations for research, practice, and policy, she joined others in offering suggestions for assessment. Although she referred specifically to digital reading comprehension, she recommended studying digital reading contextually situated, which we see as in the multivariate space of the internet. She also advocated for authentic contexts and the use of design-based research methods. Our aims are the same for COT-R.

We found that our experiences of grappling with naming exactly what we were studying and assessing caused us to think more deeply about the nature of texts in terms of where they are located and the boundaries of those locations. Readers need to know if they are researching in a walled garden or on the wild wide web. In these deep deliberations during the development of an assessment initially designed for foundational concepts, we found that knowledge of these concepts could not easily be separated from aspects of comprehension and critical thinking.

The COT-R assessment corroborates and informs Coiro’s (2021) heuristic. Our struggle with precise naming of the nature of the digital text type confirms the complexity of terms used to define, describe, and compare digital reading practices as well as the need to promote precision and clarity in these terms. Our findings from previous studies using COT-R also support the overlap across comprehension elements, using examples that provide insight into text features that affect students’ reliability reasoning. Research conducted thus far using the COT-R also informs Coiro’s heuristic, specifically in regard to text features. Even though the heuristic examines text, which alludes to text features, our COT-R findings indicate a potential need to delve deeper into specific text features students use to determine website credibility.

Where do we go from here? As we continue to gather data from COT-R results, we seek developmental insight into elementary students’ proficiencies in conducting internet research, such as what is reasonable and appropriate to expect from first graders through fifth graders. This insight would not only inform Coiro’s heuristic but also provide input to teachers for targeted instruction.
About the Authors

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Sheri Vasinda is a professor of literacy education at Oklahoma State University. She researches ways technology affords authentic self-assessment opportunities, the challenges and affordances of online reading, and new literacies.

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