

Reading Research for Writing: Co-Constructing Core Skills Using Primary Literature

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ABSTRACT

Synthesizing academic literature into new knowledge through writing is a core skill that doctoral students engaged in research must learn. However, developing efficacy in synthesis skills as an academic writer is a culturally and cognitively demanding process that occurs over many years, requires abstraction, and draws upon critical reading skills. Doctoral reading is an invisible part of training, despite large reading loads in doctoral coursework. Further, reading, writing, and researching skills are co-constructed at the doctoral level as previously described by Kwan (2008). The purpose of this essay is to describe how the primary author used her experience as an EdD student, science teacher, and writer to develop a method that addresses doctoral reading challenges. The novel method described here combines categorical reading strategies with social collaborative annotation (SCA). This method centers on active, categorical reading to deconstruct arguments in the primary literature by identifying claim, evidence, reasoning, implications, and context (CERIC), which can serve as a critical reading pedagogy in existing courses, reading clubs, and seminars. Combining CERIC with SCA tools—ranging from homemade variations of Google Suite to purposeful annotation software, such as Hypothes.is—can support an efficient doctoral reading process. This essay illustrates several worked examples and explores how this process supports retrieval, engagement, collaboration, inclusion, and community, particularly in online learning environments. Significant implications of this work are to make hidden reading expectations explicit and transform professor-centered transmission models of learning to student-centered sociocultural models of learning. The essay proposes next steps for testing the approach's effectiveness in online doctoral learning.

KEYWORDS

critical reading skills, categorical reading method, doctoral education, reading for writing, sociocultural theory, social collaborative annotation,

In graduate education, writing to create new knowledge is a primary learning objective most often assessed by a written dissertation. The process of reading, interpreting, and writing scholarly work requires considerable time, effort, and abstraction (Alexander et al., 2009). Critical reading skills are the basis for doctoral students' critiques of primary research literature, which is fundamental to developing academic writing skills. Doctoral students' writing skills, including reading, interpreting texts, and literature synthesis, are central to student progress (Council of Graduate Schools, 2010). Analyzing and synthesizing research is crucial to understanding a field's ideas and choosing a productive dissertation topic (Aitchison et al., 2012). Students then formulate their logical arguments, conduct research, and communicate their findings in papers and dissertations (Cotterall, 2011). Ongoing engagement with

the primary literature as a reader and writer is essential for doctoral scholars. The programmatic assumption is that doctoral students can locate and evaluate scholarly arguments, synthesize the research in the field, and apply that understanding to a dissertation topic (Boote & Beile, 2005).

However, not all doctoral students develop these core reading and writing skills because critical reading skills are assumed and unaided at the doctoral level (Kwan, 2009) and are, therefore, a hidden expectation. In a seminal article, Boote and Beile (2005) note the "dirty secret known by those who sit on dissertation committees is that most literature reviews are poorly conceptualized and written" (p. 4). Critical reading is not limited to understanding the text but also includes the abilities to (a) evaluate facts and opinion; (b) recognize



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the author's purpose, biases, and points of view; and (c) make assessments and inferences (Darch & Kameenui, 1987). Thus, critical reading involves readers thinking deeply about a topic, going beyond what the text concluded to consider the author's methods and accuracy (Wheeler, 2004). Critical reading of the primary research literature, whose context and methods beginning doctoral students may be unfamiliar with, is a particularly challenging skill set to acquire.

Little scholarly work focuses on critical reading skills at the doctoral level, where scholarly reading is a precursor to knowledge creation through writing and research. One entry point to critical reading is the use of annotations, defined as making notes on a text, an act that mediates reading and writing (Kalir, 2020). Annotations become more potent as learning tools when combined with new technological affordances, such as social collaboration and online databases.

This essay demonstrates how an individual Ed.D. student's struggle with managing a heavy reading load, combined with research and writing, generated a creative solution in the form of a categorical reading method combined with social collaborative annotation (SCA) tools. This approach allows for the development of multiple core doctoral skills, beginning with critical reading of the primary research literature. The first author has taught her method to other doctoral students, and the second author includes the method in tutorial sessions, an Ed.D. writing clinic, and in coursework. The third author uses the method to scaffold journal clubs, seminars, and research group discussions. The method can be integrated into existing instruction with primary literature to increase student engagement and build a learning community.

THEORETICAL AND CONCEPTUAL FRAMEWORK

Sociocultural theory provides a sound theoretical framework to investigate the relationship between language and learning at the doctoral level (Vygotsky, 1978). Doctoral learning occurs primarily from participating in discursive activities between professor and student or between students in a collaborative discussion that culminates in a written dissertation (Brown & Renshaw, 2000). Students develop and refine their thinking through reading, writing, and feedback from more knowledgeable others, such as advisors, professors, and peers. Written discourse is critical and serves as an act of authorial identity in which students align themselves with socioculturally shaped positions within the discipline (Ivanic, 1998). A successful paper expresses an understanding of relevant knowledge situated in the disciplinary activities, contexts, literature, and culture in which it is developed and used (Brown et al., 2007). In addition, students experience and learn disciplinary, cultural norms through coursework, during lectures and presentations, at conferences, and from reading the primary literature.

Primary research literature is a unique genre of writing. Primary literature articles are not meant to be read from the ground up, start-to-finish like novels, and beginning graduate students tend to be unaware of this academic norm (Lie et al., 2016). This situation is not surprising because English courses rarely focus on strategic reading skill development for non-narrative texts to the same extent as narrative texts (Zywica & Gomez, 2008). Likewise, many doctoral students are unaware that reading primary literature is "inextricably entwined with effective writing" (Sverdluk et al., 2018, p. 368). Moreover, without strong reading skills, writing and research skills do

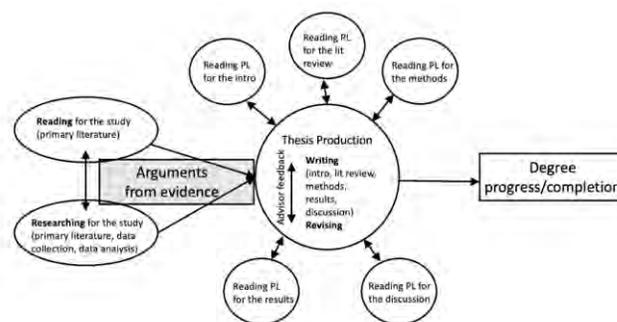
not fully develop because "reading and writing do not stand in a functional relationship with inquiry [i.e., research] but are constitutive of it—essential elements of the whole" (Norris & Phillips, 2003, p. 226).

Doctoral instructors often fail to take advantage of this interconnection between reading and writing (Gay, 2004). The ability to read critically and funnel information is crucial for graduate and professional students because those who possess good critical reading skills can go "beyond the information given by asking questions, making hypotheses, seeking evidence, and validating assumptions" (Anuar & Sidhu, 2017, p. 164). Hudson (2009) maintains that students exposed to critical reading strategies can identify and synthesize main points or compare texts critically.

Unfortunately, many graduate and professional students rely on reading strategies taught in high school or college for their academic work. One example is taking notes only during lectures and highlighting passages of academic texts. Current technological tools allow for highlighting online text in apps such as Additor (Walnut, CA) and HyLighter (Tallahassee, FL). Even with interactive features, highlighting does not require active engagement with the text, such as paraphrasing or summarizing, which help to consolidate learning (Brown et al., 2014). More effective structured note-taking systems, such as Cornell Notes or REAP, increase students' critical reading skills, including synthesis, analysis, and evaluation (Ahmad, 2019). However, the ongoing struggle to develop literature synthesis at the doctoral level suggests that students' critical reading skills are not sufficiently developed with commonly used strategies and methods (Aitchison et al., 2012; Boote & Beile, 2005).

This essay suggests a conceptual framework of critical reading pedagogy combined with social, collaborative annotation (SCA) tools to build doctoral students' core skills. Research on doctoral reading practices indicates that multiple sub-processes contribute to doctoral reading, such as reading for the literature review, reading for methodology, and reading for courses (Kwan, 2009). These dynamic, constitutive interactions form the conceptual framework shown in Figure 1. Each of these reading processes using the primary literature (PL) is abstract and cognitively demanding, such that engaging with one causes the others to fade into students' mental backgrounds (Kwan, 2009). Finally, reading connects to researching and writing, moderated by arguments from evidence published in the primary literature.

Figure 1. Conceptual Model of Reading Research for Writing at the Doctoral Level



Note. This conceptual model displays the nexus of co-constructed core skills at the doctoral level, adapted from Kwan (2008). PL indicates primary literature.

The primary motivation behind categorical reading methods is to dissect each paper's structure and central argument using the above conceptual model (Figure 1). This process begins with published research papers arguing from evidence (not arguing from rhetoric, which is a different domain that necessitates other approaches). Dissecting an argument from evidence involves collecting/curating papers, iteratively reading each paper, comparing/categorizing the main arguments and methods, and writing. As Kwan (2009) showed, these steps can happen sequentially, but students are more likely to use them dynamically as needed.

LITERATURE REVIEW

Doctoral students spend most of their program time reading. For example, in a study of first-year medical students, self-reported estimations of studying activities involved 60% reading, 25% group work, and 15% lectures (van Pletzen, 2006). In a study of Ph.D. students in social sciences, students reported an even split between the frequency of reading and writing as learning tasks (McAlpine, 2012). However, students in the study expressed ambivalence about the value of reading, reporting it as a time-consuming hurdle to writing papers, which was a more urgent task because of deadlines and grades. Other studies report that graduate students struggle in many dimensions with reading primary literature, including understanding the paper's central arguments, background and terminology, techniques, experimental data, and conclusions (Abdullah et al., 2015; Lie et al., 2016).

Course Discussions

One immediate consequence of the combination of heavy reading loads and variable critical reading skills at the doctoral level is low-quality course discussions. Second only to writing papers, formal disciplinary discussions, or discourse, are a central activity for making meaning of the primary literature, constructing new disciplinary knowledge, and making social connections (Levine, 2001; Tirado et al., 2015). Before the COVID-19 pandemic forced education online, a common practice in graduate and professional education was to form journal clubs, where professors and students sat around a table and critically reviewed the primary research literature. A review of journal clubs in medical education showed that students with critical appraisal skills reported paying more attention to the methods and conclusions, which increased their content knowledge. However, a review of research failed to demonstrate that the students who participated in journal clubs read more critically than students who did not (Alguire, 1998).

In online learning environments, threaded discussion forums appear via asynchronous interfaces, such as Blackboard and Canvas learning management systems. These forums are the most common forms of online, academic collaborative knowledge construction (Galikyan & Admiraal, 2019). However, some researchers question if discussion should be required at all in online courses because of formulaic responses and weak evidence about learning gains (Cho & Tobias, 2016). Threaded discussion forums have myriad failures and pitfalls and "often fall short in supporting networked learning and collaborative discourse" (Chen, 2019, p. 195). This evidence suggests that current tools for supporting course discussions may not be sufficiently supporting graduate student reading and writing skill development.

Reading and Writing

The intersection between reading and writing informs the suggested approach to doctoral reading. One report of doctoral students reading published papers critically in the context of a course showed that critical engagement with primary literature helped students develop a framework of knowledge helpful in self-assessing their writing (Matarese, 2013). Only a few studies consider the role of reading interventions as a means for improving writing. A meta-analysis of reading interventions at K-12 showed improvement in both reading and writing resulting from various reading interventions (Graham et al., 2018). No such analyses exist for graduate and professional education.

The bidirectional relationship between reading and writing is moderated by constructing an argument (Krummheuer, 1995). Kwan (2008) examined the relationships among these doctoral student activities and proposed a nexus approach to developing doctoral students reading, researching, and writing skills, where the three processes are co-constructed. McAlpine (2012) outlined pedagogies for supporting core skill development by, for instance, embedding seminar discussions with field-specific epistemologies.

Faculty take multiple approaches to developing critical reading skills in different disciplines/fields. The undergraduate level is an active area of current innovation. One strategy researched in undergraduate education focuses on teaching undergraduate students how to navigate and understand primary literature: the Evaluating Scientific Research Literature (ESRL) method (Letchford et al., 2017; Lie et al., 2016). Another strategy improves critical thinking skills using "think like a scientist" methods, such as the CREATE method that focuses on a learning sequence, Consider, Read, Elucidate hypotheses, Analyze and interpret data, Think of the next Experiment (Gottesman & Hoskins, 2013; Hoskins et al., 2007; Kararo & McCartney, 2019). More broadly, the Toulmin model is prominent for teaching evidence-based argumentation in many disciplines (Osborne et al., 2004). The Toulmin model centers on the factual basis for an argument, resulting claims, and counter-claims. Despite these methods, the reality is that pre-doctoral training in critical reading varies widely, and without solid reading skills, writing and research skills do not develop properly (Kwan, 2009).

Annotation

At the doctoral level, most students have not directly experienced critical reading instruction or assessment. Scholars have noted that reading appears time-consuming yet without much value; throughout an individual's schooling, the activity of reading lacks a coherent or explicit relationship to work that is assessed, unlike writing (Du Boulay 1999; Saltmarsh & Saltmarsh, 2008). Reading assessment would provide essential support, and annotations can serve as such an assessment, including text or video notes that help "mediate reading and writing" (Kalir & Garcia, 2021, p. 182). Practically, it is challenging to generate a quality annotation without reading critically. Nonetheless, the internal process of reading makes it difficult to measure directly. A common measure of reading skill using annotations assumes that the reader is also skilled at expressing ideas in writing.

Still, annotations for doctoral instruction could function as an integrated resource and strategy for learning disciplinary content (Zywica & Gomez, 2008). Annotations are a cognitive reading strategy that increases student engagement with and conceptual

understanding of reading (Zywica & Gomez, 2008). Annotations offer students practice with considering a paper's key elements and then writing a summary in their own words. Summarizing can seed more sophisticated thinking processes, such as elaboration and compare/contrast, which precede literature synthesis (Anuar & Sidhu, 2017).

Prompting readers to identify specific types of information through annotation acts as a sociocultural guidepost by supporting novice readers through unfamiliar terrain, making explicit hidden expectations of what information is most important at the intersection of reading, research, and writing. By chunking reading into smaller tasks using scaffolding strategies (Vygotsky, 1978), students' reading compliance and comprehension improve (Ritchey & List, 2021). Examples of task-oriented reading activities include reading quizzes, journals, and annotations. These practices recursively layer reading, writing, and reaction by others to create meaning, exchange, and engagement with the text. Annotation prompts can further reduce the overwhelming feelings students can experience regarding the level of detail available within articles, what information to include or exclude, and how to organize their ideas. Embedding annotation into existing seminars and workshops, in-person or online, provides explicit support (McAlpine, 2012) and does not require faculty to design new courses.

Social Annotation

The highly interactional nature of current learning technology can facilitate student development and pedagogical innovations (Larreamendy-Joerns & Leinhardt, 2006; Moore & Diehl, 2018), including social collaborative annotation. Social annotation is defined as "mak[ing] reading visible and thinking collaborative for...knowledge production" (Kalir & Garcia, 2021, p. 1). In addition, collaborative annotation is a literacy strategy that engages students through a shared problem space in critical reading, thinking, writing, and co-construction of knowledge in one activity (Kalir & Garcia, 2021). Combining strategies to form social collaborative annotation (SCA) changes the situation to "require learners to establish shared goals and sustain a problem space whereby common understandings guide collective negotiation, meaning-making, and other group cognition processes" (Kalir, 2020, p. 247). The following review considers both social annotation and social collaborative annotation.

A review of the early scholarship on social annotation concluded that the benefits to learners are positive overall (Cohn, 2018). A more recent comprehensive review of social collaborative annotation in the published literature included 249 studies, of which the authors analyzed 39 studies with empirical designs. Most of these studies focused on undergraduate or K-12 classrooms, and only two studies focused on graduate students (Chen, 2019; Hollett & Kalir, 2017). Interestingly, both studies with graduate students compared, in different ways, two social app tools, Slack (San Francisco, CA) and Hypothes.is (San Francisco, CA), for annotation generation and management. Both studies found increased engagement with academic texts and high quality discussions related to use of the social app tools.

Increased engagement with texts through social annotation can lead to skill and motivation improvement in higher education. In a study of 122 undergraduate students, social annotation increased engagement with course readings and community building (Gao, 2013). Reid (2014) also found improvements in reading

comprehension, motivation, and mental effort required to read following the use of synchronous, collaborative annotation in 32 community college students. Further, a review of 16 empirical studies in higher education by Novak and colleagues (2012) concluded that the learning gains associated with social annotation included critical thinking, meta-cognitive skills, reading comprehension, and improved motivation and positive feelings.

In addition to facilitating student skill development, social collaborative annotation is a tool for building a learning community that is not possible with individual reading activities. Faculty can instruct students to take categorical reading notes in combination with one or more SCA tools, such as One Note (Microsoft; Seattle, WA), Google Suite (Alphabet, Inc; Mountainview, CA), or Hypothes.is. The notes become rich resources for retrieval practice. When shared with a group, annotations transform into socially constructed learning opportunities that generally have positive outcomes (Cohn, 2019), such as improving student compliance and increasing engagement in course activities (Berry, 2017; Martin & Bolliger, 2018).

Further, web-based platforms can be used together to "provide opportunities for learners to interact with rich web objects in different spaces, contribute ideas from different contexts, and move ideas freely to serve varied, shifting learning purposes" (Chen, 2019, p. 196). For instance, Google Forms and Sheets allow users to annotate using customizable tools. Google Forms offers a graphic organizer that can prompt student-determined categorical input and then feeds the information into a Sheets database. Sheets databases are taggable, shareable, and exportable to other software, such as Overleaf (London, UK) for writing and Python for coding. The result is a flexible, dynamic knowledge base with many learning applications for individual and group work.

Students can also share annotations of texts, including tagging and conversations, using a combination of social collaborative technology platforms (Novak et al., 2012). In a pilot graduate course, Chen (2019) replaced the online discussion forum with Slack, a team communication tool, and Hypothes.is, a social annotation tool. Participants most frequently used Slack for public conversations and Hypothes.is for social annotations. This finding suggests that, for collaborative discourse about academic texts, real-time channels generate high activity. One important limitation to this research is student privacy. The student participants accessed the software platforms using their university's single sign-on system, which kept usage data private.

Finally, learning complex skills—such as reading, writing, and research via primary literature at the doctoral level—requires high levels of self-efficacy, self-regulation, and other mature learner characteristics (Kelley & Salisbury-Glennon, 2016). These characteristics are present collectively within working groups (Koschmann, 1996). However, to the extent that these properties of group learning are beneficial to individuals, the nature of doctoral assessment through an individual thesis means that individuals also need to develop the group attributes to use when working alone. Thus, group benefits of collaborative social annotation at the doctoral level are insufficient unless the individual can use the experience to develop core skills further and make degree progress.

IMPROVING READING RESEARCH FOR WRITING SKILLS

In the Ed.D. program at Johns Hopkins University (JHU), I (Genevive) face a significant challenge with an intensive reading load for coursework and dissertation, averaging 20-30 articles per week. Speed reading for 30 minutes on each article requires dedicating 10-15 hours per week to only reading. This reading volume feels overwhelming and makes it impossible for me to process the information from readings in any meaningful way.

Initially, I did what many doctoral students do and tried to read everything, taking notes using the gold standard annotation. This annotation took the form of a paraphrased summary stored in a Word document, shown in Figure 2. However, this approach proved untenable, as weekly article counts increased and competing time demands mounted. In response, I changed strategy and skimmed abstracts, taking notes on methods and findings. My notes were then a fragmented mess. This approach proved ineffective for drawing comparisons between papers when writing.

Figure 2. Example of a Traditional Annotation

Connolly, S., & Burn, A. (2019). The Story Engine: Offering an online platform for making "unofficial" creative writing work. *Literacy*, 53, 30–38.

Describes the development and implementation of Story Engine, an online, mentor-assisted digital writing platform. Uses theories of creativity to interrogate discourses surrounding the teaching of creative writing, both in and outside of the classroom. Examines the implementation of a beta prototype of Story Engine with 120 adolescents in four British schools. Uses case studies to investigate whether an online creative writing platform develops creativity and complements school-based writing programs. Finds that Story Engine promotes schooled aspects of creative writing but can potentially allow for more creative freedom. Concludes that the Story Engine environment provided a variety of opportunities for students to draw on cultural resources to produce texts for specific audiences. Suggests that teachers can combine digital writing tools and offline engagement to bring together progressive classroom teaching techniques and online, playful pedagogies.

Note. Annotation was adapted from Frederick and colleagues. (2020). This annotated bibliography is organized as a paragraph in a word processing document.

Further, without a way to archive thoughts and notes for quick retrieval and comparison, producing written work on time was fraught. I quickly found the limit of Microsoft Word (Seattle, WA) for annotation retrieval after scrolling through hundreds of pages of annotations, which sometimes caused the software to crash. A better alternative was storing annotations in an online database, such as Sheets, with a good Sort function, even though the interface is not

great for reading. With faster retrieval and less crashing, having my own words and thinking readily sortable and searchable routed around the mentally paralyzing block of not knowing where to start. Sorting and seeing every previously paraphrased summary of a particular topic bridged the tender transition between thinking and first draft. Thus, the sorted annotations served as first draft thinking for papers. Later I added keyword tags to enhance the sorting process.

The first significant course assignment in the JHU Ed.D. program was an annotated bibliography, for which I read more than 100 research articles. About halfway through, the process became tedious and repetitive. The pain of heavy reading made obvious a need for a more effective reading and note-taking system. An informal survey of Ed.D. professors defined the essential elements for each article, such as study design, findings, and theoretical and conceptual frameworks. Then I applied learning theory from the Ed.D. coursework to prior experience as a secondary science teacher and science writer to develop a more efficient process that I share below. Combining theory and practice exposed that primary literature forms a unique genre with specific formatting useful for efficient information retrieval and retention. I used this insight to generate sentence frames to capture critical information, much like math teachers use sentence frames to help children learn word problems (Bresser et al., 2009). The language of categorical reading would come in later coursework, but the concept was developing in practice. I had begun to consider what categorical reading might mean at the doctoral level.

The categorical reading method evolved in subsequent courses and teaching. A core set of argumentation concepts emerged from the primary literature, which I refer to as "CERIC" (for Claim, Evidence, Reasoning, Implications, and Context, and rhymes with "cleric"). CERIC categories reflect high-order argument categories customizable to any academic discipline, including interdisciplinary fields like education (Krishnan, 2009). Shown in Table 1, each CERIC element is located in predictable sections of primary research literature, such as the introduction, results, and discussion (Lie et al., 2016). For instance, the claim is the answer to the research questions and is often found in the title, abstract, and discussion sections. Identifying and then annotating a paper's main claim is critical because the claim is the center of the argument, and thus, the basis for comparing arguments. Using this interdisciplinary lens expanded my clinical understanding of helping students argue from evidence at the secondary science level (Bjorn, 2018) to reading critically at the doctoral level.

Table 1. Summary of the CERIC Method for Categorical Reading

CERIC Element	Definition	Location in the Primary Literature	Annotation Prompt
Claim	A plain language, declarative answer to a research question that defines the discovery, new method, specific relationship between variables, or rebuttal to prior findings.	Often found in the title, abstract, and discussion. There may be secondary claims found in the results section.	What is the main claim? Are there secondary claims?
Evidence	Data, test results, measurements, or observations that are either quantitative or qualitative. For theoretical research, additional evidence can include assumptions, model components, and theoretical framework.	Presented in tables, charts, graphs, or paragraphs in the results section. The methods section, including study design and research questions, build to evidence.	What evidence supports this claim? Be specific.

CERIC Element	Definition	Location in the Primary Literature	Annotation Prompt
Reasoning	Theory or prior research that links the evidence to the claim and provides the logical basis for inferences and argument. Reasoning is a series of logical steps in the analysis that connects the evidence to the claim. Different types of reasoning include inductive, deductive, and counterfactual to rule out other interpretations.	Generally located in the discussion section and sometimes found in the results or abstract.	What theory, methodology, and/or prior research connects the evidence to the claim?
Implications	Answers at least two questions: (1) How is the result significant beyond the immediate findings? (2) Where do we go from here?	Can be its own section or part of the discussion. Sometimes located in the abstract.	What is the significance of the results beyond the immediate findings? What are the limitations, and how can future work address them?

The struggle with reading-for-writing transformed into a pilot study research question, *How do doctoral students approach reading academic articles as they prepare to write?* The question was part of a national survey of U.S. doctoral students ($n = 270$) conducted in October 2020 (Bjorn, 2020). The findings indicate that the top academic challenges for doctoral participants included writing in the discipline (50%), research (49%), writing papers/proposals (37%), and reading research papers (28%)—precisely the nexus of core skills described by Kwan (2008). Doctoral participants who reported support to develop these essential skills ($n = 83$) received it primarily through feedback and use of mentor texts (62%) with little or no instruction, strategies, or programmatic support. These findings suggest that dynamic, co-constructed skills of reading, researching, and writing become more intensive as students engage with dissertation work, reinforcing a need for pedagogical support appropriate to this level.

These results motivated the creation of an accessible and inclusive process to better support core skill development. While developing the CERIC method, the first author discovered powerful

online social collaborative annotation tools, shown in Table 2. Among these options, Google Suite is attractive because it is free and useful. A Google form can prompt CERIC categories and feed the responses into a spreadsheet with tag, search, export, and share functions. This effort consolidated several essential processes, including:

1. Focusing on what is most important in each paper using CERIC prompts, while reflecting situated field norms and sub-purposes (i.e., reading for literature review, methods, argument elements, and more, shown in Figure 1).
2. Prompting and organizing reading notes to compare/contrast arguments efficiently, including claims, findings, implications, and tags.
3. Generating a social collaborative annotation archive with search, tagging, export, sharing, and teamwork functions.

Table 2. Comparison of Software Applications' Functions for Managing Categorical Reading Notes

Software Application	Best Use	Interface	Rearrange	Collaboration	Export
Word*	writing	low distraction	copy paste text	only cloud versions of documents	no
Evernote (Like Bear and Nimbus Note)	note-taking	moderate distraction	drag drop notebooks; copy paste text	share notebooks; tags	cloud apps
Google Suite	file-sharing	high distraction	drag drop files; copy paste text	all files and folders; tags in files	CSV, PDF, XLS
Hypothes.is	private and social annotations	high distraction	copy paste text	browser integration	API tool for various formats
Notion	integration of desktop	low distraction	drag drop blocks; copy paste text	all files and folders; programmable; tags	CSV
One Note	file-sharing	moderate distraction	drag drop files; copy paste text	all files and folders; tags in files	CSV, PDF, XLS
Trello	project management	moderate distraction	drag drop cards; copy paste text	all boards	CSV, JSON

Note. *Word appears first out of alphabetical order because it is the gold standard for annotations in a word-processing environment.

Evernote, Bear, Nimbus Note, and One Note are similar software applications that are searchable and organized into social collaborative notebooks, but they lack advanced collaborative functions. Further, many tools have distractive environments, referring to the intrusion into the reading/writing screen environment by other social collaborative activities, such as checking email, social media, web browsing, and receiving computer alerts (Johannsen & Sun, 2017). High distraction screen environments, such as Google Suite, operate with most or all intrusions on attention, while low distraction screen environments, such as Notion, operate with few or no intrusions.

Natural Learning Laboratories

The first author began piloting the CERIC method with Google Suite annotations during scientific writing courses at universities in the U.S. and Europe. For instance, the method was a popular topic at a series of doctoral writing workshops in 2019 at the University of Bern, Switzerland. The participants explained that many doctoral students in Europe speak English as a second or third language and must publish in English without formal or institutional support. Thus, the perceived need for support was tremendous, and engagement was high. Many participants revised and customized the tools to meet their contexts better.

One participant in these workshops, a postdoc in Physics, bemoaned using Google Sheets because of the hard-to-read output interface. During the session, he wrote some Python code in a jupyter notebook (Kluyver et al., 2016) that exported his Sheets data to Overleaf, a collaborative authoring software standard in Physical Sciences. Before the end of that workshop, several other students were using Overleaf to practice the CERIC method, building a shared, collaborative annotations database. This clinical experience underscored how perceived usefulness and perceived ease are critical factors for an innovation's adoption (Davis et al., 1989). This insight led the first author to explore how to make annotation more useful and easier by combining CERIC with current SCA tools.

Meanwhile, the second author (Laura) supports a writing clinic for doctoral students in the JHU Ed.D. program as part of her teaching responsibilities. In this writing clinic, doctoral students have needed support with issues as varied as developing effective note-taking systems to difficulty with literature synthesis. Drawing on Schunk (2012) and the need for students to have effective information retrieval systems, she often begins writing consultations by asking students about their note-taking systems. Students share that, in many of these consultations, they do not have note-taking systems beyond highlighting, including highlighting in digital texts. Annotations are an ongoing challenge. However, students increasingly rely on Microsoft OneNote provided to JHU students for a searchable and fileable note-taking system for coursework.

Finally, the third author (Adam) uses the CERIC framework to train doctoral students to use and analyze primary literature in the physical sciences. This training occurs in the academic setting of topical graduate courses, where primary literature provides the core knowledge base; and in the research setting, where primary literature supports project and publication development. He has also applied CERIC with various annotation methods, including those shown in Figures 6a and 6b, to develop novel teaching methods. Examples include using CERIC as a structure for scientific presentations of the primary literature in formal settings (e.g.,

required course components) and informal settings (e.g., journal clubs, seminars, and research group discussions).

Worked Examples in Graduate and Professional Education

Using SCA tools differs from collecting citations with notes into a citation manager, such as Mendeley (London, UK), RefWorks (Bethesda, MD), and Zotero (Washington, DC). Popular citation tools archive citations with some tagging and note-taking functions. However, they cannot replicate the custom prompts that students need to capture essential information consistently. Further, citation managers allow for database export but not synchronization with other users. By comparison, categorical reading methods combined with SCA tools, shown in the following worked examples in Figures 3-6, are flexible and can accommodate endless cycles of customization as students advance.

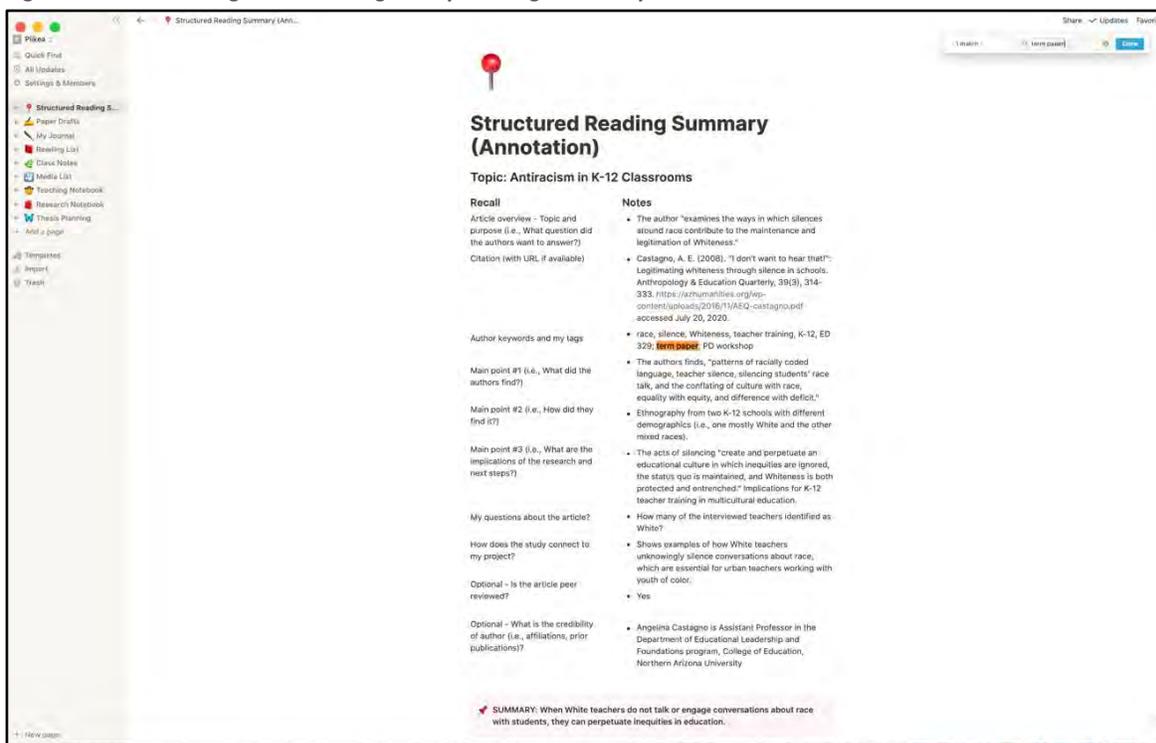
General Research Examples

For novice students in graduate and professional education, research papers in every field share the same basic categorical information, including author, year, title, article type, digital object identifier (doi), methods, findings, and conclusions. Students can add questions about the article, how the article connects to a research project, and topical tags, and then share or export the information.

An example using first-year Ed.D. coursework appears in Figures 3a and 3b. In Figure 3a, each article's basic categorical information generates the input form fields, such as title and main points. Then inputted information populates to a spreadsheet for editing, sharing, and export, shown in Figure 3b. The specific categories can be prompted by instructors or determined by students. Relevant prompts vary by discipline, field, doctoral level, and sub-purpose, and this tool's customization features allow for the variation.

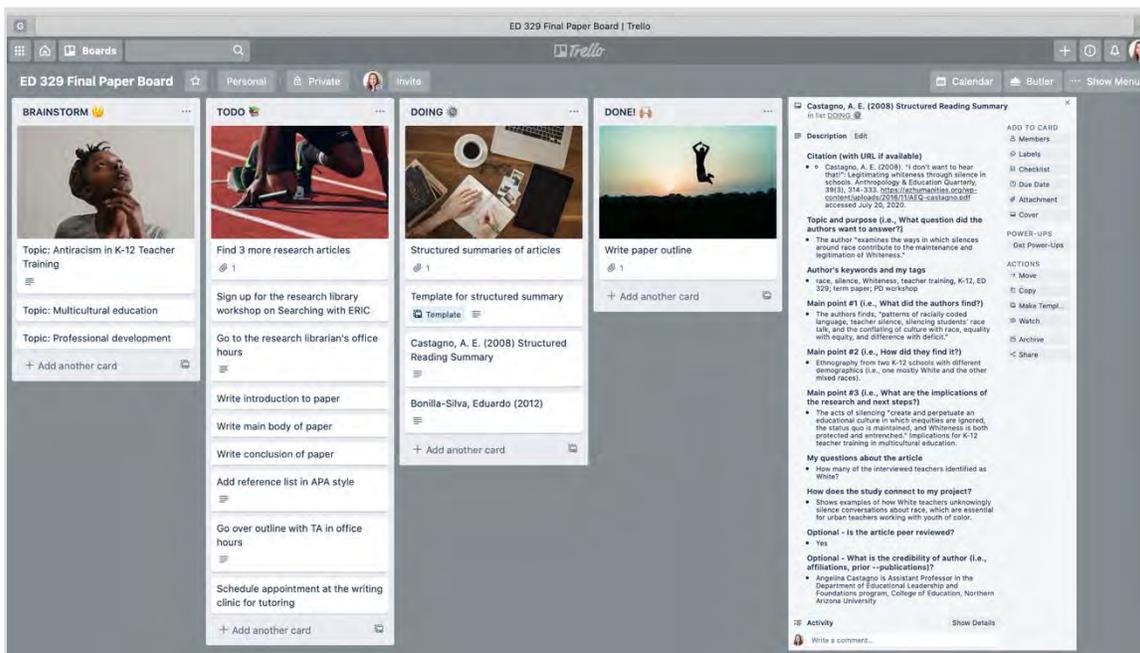
The approach, shown in Figures 3a and 3b, offers several affordances. Categorical reading notes can be added to and edited in a social collaborative tool by an individual, a group, or a combination. For instance, the first author created a personal archive of first-year readings for the JHU Ed.D. program and then later shared it with a study group preparing for the comprehensive exam. The group members added and edited a combined total of two years' worth of crucial information about course readings. This process created discussion points for making meaning, clarifying misunderstandings, healing learning breakdowns, and generating a searchable archive for fast retrieval.

Figure 4. General Categorical Reading Prompts using CERIC Inputted into Notion



Note. This example shows Notion as an SCA tool customized for general research using the primary literature. There is a custom template with the search function highlighted (top right) and notebook organization (left).

Figure 5. General Categorical Reading Prompts using CERIC Inputted into Trello



Note. This SCA example with Trello was customized for general research using the primary literature.

Advanced Research Example

As students advance in their programs, they need more breadth and depth of understanding of the primary literature. This work includes efficiently deconstructing arguments and critical points in a growing body of research papers, storing large amounts of information for quick retrieval, and synthesizing new knowledge. Traditionally, doctoral students are expected to implicitly absorb this argument structure through repeated reading or casual discussion. In reality, many students focus on the publication sections, such as abstract, methods, results, and discussion, instead of evaluating the main argument, which is the root of poorly constructed literature reviews described by Boote and Beile (2005). Without cognitive strategies to deconstruct an argument from evidence, students struggle to apply and synthesize arguments into new knowledge, as is required for a literature review, proposal, and dissertation thesis. CERIC concepts form every research paper's core. Figure 6a shows the Google Forms input modified to an advanced research level. This advanced form includes CERIC and other important, nuanced information, such as research design, theoretical and conceptual frameworks, and peer-review status. Again, the input form fields are fully customizable by disciplinary and project needs.

Figure 6b shows the output to a spreadsheet for editing, sharing, and export. The level of detail is much higher in this worked example, reflecting a more advanced understanding of the primary literature. A unique affordance of this combination is flexibility and capacity for growth and expansion as students' needs and conditions change.

Another application of the advanced research approach shown in Figures 6a and 6b is creative problem-solving. The following example emerged from interviews of 12 doctoral students concerning academic challenges and support conducted by the first author in October 2020 (Bjorn, 2020). One participant, a fourth-year doctoral student in mathematics, explained that exporting CERIC-SCA data in Sheets to Overleaf allowed for real-time peer editing. Two or three students joined synchronously in the same document, shared CERIC

Figure 6a. Advanced Categorical Reading Prompts using CERIC Inputted into Google Forms

Note. This example of a Google Form illustrates customization for an advanced level of reading detail typical of doctoral research showing claim, evidence, reasoning, implications, and context (CERIC), the core components of arguing from evidence in research sciences.

notes, tags, citations, and databases. With these tools open to all, they wrote and then edited each other's work in real-time. The participant explained that the process of live peer editing is "slower than writing on my own, but there is a big upside of not learning my mistakes for a month while waiting for my advisor to give me feedback on a section." This insight underscores the power of creatively combining categorical reading with SCA tools to draw upon more capable others and solve problems, such as long lag time for feedback. This work also suggests a future where live collaboration is the norm, particularly for students already immersed in the milieu of social media, sophisticated smartphone apps, and group work.

Figure 6b. Output of the Form Shown in Figure 6a as a Social Collaborative Annotation in Google Sheets

Note. The resulting data file (CSV or XLS) can be exported to other applications, such as Overleaf and shared with collaborators. Sheets can also export data to jupyter notebooks for further analysis, such as programming in Python.

Tags

In addition to promoting critical reading and storing notes for quick retrieval, the SCA tools shown in this essay utilize tags. Tags are simple yet powerful forms of categorizing used in social media that further organize categorical information according to user needs and preferences (Shimic, 2008). Tags help people find and situate ideas, providing a mode of peripheral social collaborative participation (Lave & Wenger, 2012). Tags also create flexible search tools, not available with traditional annotation tools, that support reading-for-writing by making the process of retrieval faster and more straightforward. Table 2 provides a comparison of SCA tools offering tags, such as Evernote, Google Suite, Notion, One Note, or Trello. Many commonly used note-taking tools, such as Bear, Evernote, and Nimbus Note, offer tag functions. By comparison, commonly used storage tools, such as OneDrive and Google Drive, lack the granular functions of tagging and exporting available in many SCA tools. Whichever tools are selected, critical reading skills, like other cognitive skills, benefit from spaced and interleaved practice (Brown et al., 2014). After students complete their SCAs, they can tag and archive the annotations for later retrieval using the preferred tool(s).



IMPLICATIONS AND NEXT STEPS

The possibilities and empirical research described above carries several implications. Critical reading methods, such as CERIC, make hidden expectations of doctoral programs explicit. A structured approach to reading the primary literature creates a more equitable learning environment when integrated into existing coursework and learning activities. In combination with SCA, CERIC offers freedom from the transmission model of learning, where the professor lectures and the students regurgitate. SCA can help build learning communities that increase students' agency and power in constructing knowledge, realizing something closer to a constructivist learning ideal. Thus, SCA generates a unique opportunity to make classrooms more equitable by subverting the historically marginalizing higher education practices centered on the professor. Another implication of SCA is to challenge artificial academic course timelines and research silos to create a sustained community of contributors within research groups and department systems. SCA can be integrated into coursework, but the learning community is not limited by calendars or enrollment.

The immediate next step is that the first author is developing a dissertation study that incorporates the CERIC method with SCA tools as part of an online skills intervention with doctoral students. This project aims to investigate the relationship of CERIC plus SCA to critical reading skills, engagement, and competence. The second author guides this work as a dissertation committee member and director of JHU's Ed.D. Writing Clinic. The third author is exploring scaffolded applications of CERIC in both classroom and research group environments. Future studies should explore skills interventions at the doctoral level that focus on the co-construction of reading, writing, and research skills.

CONCLUSION

Learning writing in a doctoral discipline exposes the socially situated field norms of arguing from evidence in the primary research literature. Using a categorical reading method that makes explicit the essential claim, evidence, reasoning, implications, and context (CERIC) supports students' critical reading skills and learning to deconstruct arguments from evidence. Further, the method provides a pedagogy for synthesizing and applying evidence-based arguments to create new knowledge. Students' annotations can prompt first draft thinking, avoiding a blank page when writing and reassuring students that they have captured the critical information about the main argument from the reading. The main implication of categorical reading combined with SCA tools is that reading-research-for-writing becomes an efficient way to deconstruct scholarly arguments while potentially increasing engagement, collaboration, and inclusion, particularly in online learning environments. Future studies should assess categorical reading methods, such as CERIC, in combination with SCA tools, and the relationship between reading primary literature, annotation, writing, and research.

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