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Enhancing Classroom Instruction with Online News: Understanding Teacher Information Needs and Information Seeking Behavior

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The published title is “Enhancing Classroom Instruction with Online News”.

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Enhancing Classroom Instruction with Online News

Understanding Teacher Information Needs and Information Seeking Behavior

Abstract

Purpose

Investigate how school teachers look for informational texts for their classrooms. Access to current, varied, and authentic informational texts improves learning outcomes for K-12 students, but many teachers lack resources to expand and update readings. The Web offers freely-available resources, but finding suitable ones is time-consuming. This research lays the groundwork for building tools to ease that burden.

Methodology

This paper reports qualitative findings from a study in two stages: (1) a set of semi-structured interviews, based on the Critical Incident Technique, eliciting teachers' information-seeking practices and challenges; and (2) observations of teachers using a prototype teaching-oriented news search tool under a think-aloud protocol.

Findings

Teachers articulated different objectives and ways of using readings in their classrooms; goals and self-reported practices varied by experience level.

Teachers struggled to formulate queries that are likely to return readings on specific course topics, instead searching directly for abstract topics. Experience differences did not translate into observable differences in search skill or success in the lab study.

Originality and Value

There is limited work on teachers' information-seeking practices, particularly on how teachers look for texts for classroom use. This paper describes how teachers look for information in this context, setting the stage for future development and research on how to support this use case. Understanding and supporting teachers looking for information is a rich area for future research, due to the complexity of the information need and the fact that teachers are not looking for information for themselves.

Keywords

Educational search, educational resources, information-seeking behavior

Classification

Research paper

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1 INTRODUCTION

Students in US schools (K-12) frequently engage with educational content through textbooks and commercially-available reading collections. Supplementing or replacing these with *authentic* (that is, created for purposes other than pedagogy), *current* texts, motivate students to more deeply engage with the material (Purcell-Gates, 2007). The potential for significant educational impact motivates helping teachers locate authentic, informational texts for class use. One example of useful texts are age-appropriate news articles: they are current, written to inform, and are about things happening in the world. Introducing such texts provides a context for helping students develop their own information literacy, the ability to identify information needs and effectively locate, evaluate, and use relevant sources (ALA, 2000).

While the value of informational texts is well-established, and there are many ways to incorporate them into teaching (Maloch & Horsey, 2013), there is little research on *finding* such texts. The Web is a vast source of reading material, and resources useful for the classroom likely exist (Kuiper & Volman, 2008; Small et al., 1998). As the K-12 education system in the US faces increasing economic and social inequities (Nasir et al., 2016), it is essential to better understand if and how public-school teachers utilize freely available resources and to support them such use.

Information access technology can support teachers in quickly building diverse collections of texts from the Web to help their students connect learning to life. For any topic, there is a plethora of related writings, some of which may be useful for students. This paper argues that, while powerful, current retrieval technologies like search engines are not well-suited to enable teachers to make full use of the Web for enhancing students' reading and learning, particularly with limited time. Existing literature on information-seeking behavior (Case and Given, 2016) — how people go about finding information to meet some need they have — focuses almost exclusively on users looking for information for themselves; there has been little research on how people find information for others, such as students or patients.

This paper reports the results of a two-stage study exploring teachers' information needs, information-seeking behaviors, and the limitations of existing technologies in supporting their classroom instruction. Stage 1 is a set of exploratory interviews describing why and how teachers use texts from the Web in their classroom, and difficulties they face locating texts with current technology. Stage 2 builds from outcomes from the first stage with a laboratory observation to understand teacher online information seeking behavior using search tools and alternatives that may enable pedagogical search. This design enables comparisons between two different contexts. Findings highlight the difficulties teachers face in using search technologies to locate authentic reading materials that can enhance their students' learning experiences, and opportunities for future research and product development.

2 RELATED WORK

This work relies on prior research on information-seeking behavior and information retrieval, as well as the use and availability of informational texts in educational settings, particularly from online sources.

This study focuses on the informational text needs and informational seeking behaviors of teachers in the US. This is purposeful, as programs such as *No Child Left Behind* (2001) and *Race*

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to the Top (2010) have tied school funding to academic performance. While well intended, many argue that this has perpetuated inequalities as low-performing schools are often those with the fewest resources (Convertino, Brown, & Wilson, 2017). The social and economic inequities in the US place a great burden on individual teachers to foster opportunities for learning (Nasir et al., 2016), and thus teachers are motivated to find quality teaching materials.

2.1 Informational Texts in Educational Settings

The Common Core State Standards (the instructional standards used by the majority of US states) recommend that students as young as kindergarten read a healthy balance of literary and informational texts. While there are many texts that merge these two genres, informational texts can be identified by their (1) purpose, which is to convey information or knowledge; and (2) structure, which is predictable text – organizing information chronologically, to compare and contrast, or to present problems and solutions (National Governors Association, 2010). Research has demonstrated that the degree of text *authenticity,* i.e., whether the text was written for purely pedagogical purposes (e.g. a textbook) or for a wider, real-world audience (e.g., a newspaper article), has a significant impact on learning outcomes. For instance, reading authentic science-related texts improves content engagement (Purcell-Gates et al., 2007). However, students require authentic opportunities to engage with informational texts throughout their educational careers to develop information literacy and become mindful consumers of informational texts (Maloch and Horsey, 2013).

Research related to informational texts also highlights problems related to access (Neuman, 2016), demonstrating the insufficiencies of traditional print books. Moss and Newton (2002) demonstrate the need for publishers to devote more attention to quality informational literature for children. This is not enough, as the quality and quantity of books available in classroom libraries varies greatly (Hodges, Wright, Roberts, et al., 2019). Furthermore, in an analysis of 60 classroom libraries Hodges et al. (2019) found that very few award-winning informational texts (as define by national educational organizations) are actually present in classrooms. Existing research does outline best-practices for incorporating informational texts into the classroom (Bradley and Donovan, 2010); however, it does not address the challenge of actually providing students access to quality, relevant, and suitable informational texts.

2.2 Existing Online Educational Resources

Child-oriented news websites tend to offer highly "curated" articles, e.g., News For Kids[1]. This can result in resources offered being rapidly out-of-date and/or limited in their topic coverage. Product developers have also attempted to filter information to better suit children. In this case, however, the focus is on simply distinguishing "adult" versus "non-adult" resources (Anuyah, 2018). When explicitly on focused filtering information deemed "safe" for children, existing filters have shown to cause problems in educational settings when looking for research on topics, such as breast cancer (Anuyah et al., 2019)

Some websites provide content tailored to a K–12 audience, but at a reading level that makes the content difficult to comprehend. Many sites are either outdated or offer news grouped by grades (e.g. dogonews[2]) instead of reading levels, thus not providing teachers with texts focused on similar content at different levels. For instance, The Guardian sponsors NewsWise[3], aimed at supporting news literacy in children aged 9 to 11, which offers teacher training and links to other "child-friendly" news sites, but lacks an intuitive search interface—beyond the traditional textbox

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on popular search engines—to locate materials at various reading levels. Newsela.com provides teachers content at different text complexities, but the material is necessarily highly curated and thus limited in topic.

In addition to open repositories, teachers turn to platforms such as TeachersPayTeachers.com or Pinterest to share and build on each other's resources. Teachers use these peer-developed sites over those run by professional educational organizations (Carpenter et al., 2016), though the reason for this choice is unclear. These resources may help a busy teacher "stay afloat", but many have critiqued them for being focused on visual appeal versus content (Korbey, 2016).

Consistent with the assessment of Pilgrin (2019), many of the web resources mentioned thus far indeed offer informational texts and other resources that teachers (and parents) can leverage in their instruction. Unfortunately, there are several limitations that emerge from these sites being subscription-based and/or offering curated; most notably that the cost of creating and maintaining them may result in a limited number of materials, overly filtered content, or resources that have not been screened for quality.

2.3 Information-Seeking Behavior

Case and Given provide a useful survey of research on information-seeking, including a number of behavior models (2016, pp. 141–175). No one model, however, captures everything relevant to teacher information-seeking in the classroom. Elements different models account for include situational factors and iterative seek-evaluate processes (Byström and Järvelin, 1995); distinctions in research type combined with user expertise (Freund, 2015); the role of user beliefs, experiences, and interactions in assessing utility (Johnson and Meischke, 1993); and the information seeker's affect throughout the process (Kuhlthau, 1993). This last framework is drawn from educational settings and is the primary lens for this work.

Most existing studies explore users seeking information for themselves, not others. Even when the information seeker is not the ultimate beneficiary of information, research tends to focus on the seeker as its *user*, as in medical professionals looking for information to treat their patients (Davies, 2007). In this problem setting, however, the information seeker (teacher) is looking to shape the student's information experience, so the role of affect and uncertainty may differ from previously-studied settings (Kuhlthau, 1993). The *information scent* framework (Card et al., 2001) is promising; using ant foraging as an analogy, it models users as using 'scents', such as hyperlink text and other information, to determine whether a particular resource looks like it will contain information relevant to their needs. As individual teachers' preferences and internal states will affect how they perceive different 'information scents', the framework itself can be adapted to incorporate non-users' information needs in understanding information and the information-seeking process.

There is limited research specifically investigating how teachers seek information (Virkus and Mathiesen, 2019). Some studies look at limited corpuses, either education resources or teachers' personal collections (Diekema and Olsen, 2012); others include teachers as a user group (Sellen et al., 2002; Stefl-Mabry, 2005), finding source plays a role in assessing relevance and different tasks call for different technological capabilities.

Small et al. (1998) found teachers looking for classroom materials primarily searched for pre-made lessons and specified broad subject areas in their queries. Merchant and Hepworth (2002) found teachers were confident in their information seeking practices, even if they were not

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familiar with formal concepts of information literacy, and they actively sought readings to recommend to students.

2.4 Audience-Tailored Information Retrieval

Information retrieval is concerned with identifying resources relevant to a user's information needs (Croft 2010). In the context of search, information need refers to the starting point for all user information search, which is "is intangible and visceral and thus unknowable and nonspecifiable in a query to an information system" (Cole, 2011). While most research in the area focuses on the needs of traditional users, some work has studied designs and algorithms intended to tailor the functionality of information retrieval systems to particular users or tasks.

Search often begins with a query, but is not limited to retrieving resources that match that initial query. Personalized search considers users' *interests* and *preferences* (Hannak et al., 2013; Sieg et al., 2007). Context-aware search extends personalization to consider time, location, experience, and task (Tamine and Daoud, 2018; Zamani et al., 2017). What these extensions have in common is that they respond to a *particular* user. In this project, the teacher is the main user, but students and classroom requirements also impose context and needs.

Existing works provides useful pieces in building such a solution. Chinkina and Meurers (2016) locate texts rich in particular grammatical constructions; this can help locate suitable resources for curriculum development of second-language teachers. Pera and Ng (2014) present a query formulation strategy that enables teachers to explicitly incorporate certain parameters – reading ability, grade level, and literary elements – to locate books for their students. Vidinli and Ozcan (2016) tailor query suggestions to bias the search process towards resources aligned with K-12 requirements. Other works examine query suggestion, result filtering, and ranking strategies for K-12 audiences (Bilal, 2013; Collins-Thompson et al., 2011; Dragovic et al., 2016); yet they serve students initiating the search, not teachers looking for classroom resources.

2.5 Connecting the Threads

The long-term goal of this project is to connect these different lines of work: to apply the tools of audience-tailored information retrieval, informed by new understandings of teachers' information needs and information-seeking behaviors, to enable better use of online informational texts in classroom instruction. This paper presents first results on teacher information seeking and an early prototype of the information retrieval tool that will form the foundation of such a research agenda.

3 Stage 1 – Pilot Interviews

Stage 1 is a phenomenological study, a study aimed at understanding the common experiences for several individuals (Creswell and Poth, 2018). Here, the goal is to understand why and how teachers utilize (or not) texts from the Web in their classrooms, and document challenges they face with current technology. This stage identifies questions and informs the design of the second, larger stage.

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3.1 Design and Methods

Eight teachers (Table 1) participated in one-on-one semi-structured interviews (Pirolli, 2007) using the Critical Incident Technique (CIT; Choo et al., 1998) and the interview guide in Appendix A. CIT uses a specific, concrete event — the 'critical incident' — as the starting point for understanding the interviewee's experience, rather than asking abstract questions. The interviews took place in the spring of 2018, and lasted for approximately 30 minutes each. The facilitator asked each teacher to reflect on a time in the last year when they tried to locate material online and to articulate the difficulties they faced.

The second author (an education professor) worked with a graduate student (with background in education and computer science) to review interview transcripts and conduct in-vivo coding (Böhm, 2004), allowing themes to emerge from the data. Coders met to discuss findings and identify themes, and conversations continued until saturation was reached (Strauss and Corbin, 1990).

3.2 Observations and Results

Interview analysis revealed four themes. The first three align with interview themes, whereas the fourth one emerged from feedback from veteran teachers (having at least 10 years of experience).

3.2.1 What online resources do teachers use to locate texts for classroom instruction?

Many interviewees use TeachersPayTeachers.com. Teacher S1-F said she relies on this website to supplement district-provided materials:

> *"where I typically find sources is on TeachersPayTeachers… to push them to the next level I look at other resources teachers have created themselves … to then fill either gaps or help with engagement with learners."*

This teacher also explained that her district requires her to use an adopted reading curriculum, but knows that supplementing these materials with other, more engaging texts will motivate her students to be active readers.

Five teachers mentioned using Google, but most highlighted its limitations. Teacher S1-G explained that when searching for class materials teachers are *"not going to find it on Google, right, it won't be there in the first 10 links"*. Teacher S1-E mentioned the time required to find useful materials: *"I try to look online, on Google and stuff like that but there's… a vast array of stuff and you have to really search for it..."*

Teacher S1-A added that *"it seems like a lot of times when you Google something, it's like a site they want you to pay for"*. Many participants explained they had little financial support for purchasing materials, so most purchases would be out-of-pocket.

3.2.2 What text qualities do teachers look for when selecting texts for classroom instruction?

Desired text qualities also depended on a teacher's years of experience. Teachers S1-A, S1-E, S1-C, with a combined experience of less than 15 years, consider convenience key when adopting classroom texts. Many novice teachers used texts inherited from retired teachers, provided by the school, or donated by parents; materials that were frequently outdated. Teacher S1-E, as an

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example, said the science textbook he is required to use was published in 2006 – before his current students were born.

Six teachers stressed the importance of worksheets or other methods to cement knowledge, assess learning, or keep students occupied. For instance, Teacher S1-F preferred texts with an activity at the end so students could get immediate feedback.

Some teachers commented on the need for materials at the right reading level. Teacher S1-F appreciated online resources that provided the approximate reading level so she knew she was choosing texts her students could access. Teacher S1-A shared this concern, describing the challenge of finding *"things they [students] can read and understand."*

By contrast, Teacher S1-B searches for content first and adjusts his instructional approach depending upon the reading level and purpose:

> *"if the material...had lots of words in it that I wanted the kids to know and a lot of knowledge to mine out of it, then I would probably have them annotate. If I wanted to just pique their interest, I would just have them read it for fun."*

Five teachers mentioned the importance of the text including connections to students' lives. Teacher S1-H. said most of her biology students did not intend to enter STEM fields, and she wished she could find appropriate readings to make content more relevant.

3.2.3 What challenges do teachers face when searching online for texts for classroom instruction?

Financial concerns affect resource adoption. Teacher S1-A said she is allocated $200 per year for classroom materials. She described her frustration when finding a link to what she thought would be a great resource, only to discover it requires a subscription. Teacher S1-F had similar experiences; even though she frequents TeachersPayTeachers she only downloads the free resources.

Time is another limitation. Teacher S1-A described an engaging unit on the solar system, where she put together informational packets and had students become "planet experts". Her students loved the experience and learned a lot, but the time required to curate those resources makes similar activities unlikely. Even Teacher S1-B, who used a variety of online sources, said it took him years to discover them and learn to use them effectively.

3.2.4 What are the differences between novice and veteran teachers?

Compared to newer teachers, veteran teachers reported fewer obstacles. Veteran teachers are comfortable going directly to sources to supplement previously assembled curriculum materials. Newer teachers, however, expressed a desire for curated, prepared materials, and stressed factors such as money or time.

Veteran teachers considered online materials significant sources for their classroom readings, and included a greater variety of sources in their curriculum. Teacher S1-B used various discipline-specific resources, choosing websites based on the instructional need. Teacher S1-G emphasized that, as an English teacher, he has *"never used the texts that the school districts bought."* Instead, he relied on texts such as news articles and essays found in his own daily reading.

Surprisingly, most teachers mentioned a desire to address politically-charged topics. However, many newer teachers explicitly said they felt incapable of doing so. Teacher S1-F explained that

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her students came to the classroom with limited knowledge, saying *"what I hear from them, there's not a home base where they're getting valid information really. I don't even know if they're talking about it at home."* Teacher S1-C said she felt comfortable discussing some of the content with her students, but *"some of it's hard to talk about"* and thus avoided specific issues.

The two who felt competent were veteran teachers with 18 and 21 years of experience. Teacher S1-D frequently uses pieces from National Public Radio in her 5th grade classroom, stating (with regret) that she only avoided topics when the language would be inappropriate for fifth graders. When asked if there were any topics she would avoid, she replied:

> *"No. We did lots of discussion on school shooting stuff… I did, honestly, avoid some of the Trump stuff. I just didn't want to open … some of those cans of worms. And partially because they're just, weren't appropriate for 10 year olds, unfortunately. …Normally we do lots of stuff with the elections and, you know, check out the debates and things like that. And so, that was – has been harder to do."*

Teacher S1-G took a different approach, explaining that there are some texts he selects very purposefully to engage students in what may be politically or emotionally charged discussions. For instance, he expressed great excitement to teach *The Yellow Birds*, a memoir by an Iraq War veteran, alongside *Atta*, a novel written from the perspective of one of the 9/11 hijackers.

3.3 Summary of Pilot Findings

Finding and using new texts for classroom instruction is challenging. Teachers need to locate the texts and assess them for relevance and appropriateness, with limited time and resources. Due to these limitations and the costs of updating professionally-developed instructional text sets, teachers often either reuse outdated materials or opt not use authentic readings. Interpreted in light of Kuhlthau's uncertainty model (1993), there is evidence of optimism in some teachers — they see value in resources, and look for them — but significant difficulty moving from the exploration to collection tasks, and a lack of satisfactory resolution to the information-seeking process.

This stage reveals that more experienced teachers have found solutions to some of these challenges. Veteran teachers saw the value of integrating authentic readings into their instruction to foster student engagement, and had developed strategies for finding suitable materials. Unfortunately, there are high levels of teacher turnover (Carver-Thomas and Darling-Hammond, 2017), and high workloads continue to drive teachers out of the profession (Torres, 2016), so it is not feasible to wait for teachers to gain the decade of experience necessary to begin using authentic texts in the classroom.

There seems to be an opportunity for new search tools tailored to the specific requirements of educational environments to help teachers of different experience levels quickly locate and evaluate texts, improving their ability to engage all students in reading. Findings from pilot interviews suggest three desiderata for such a tool:

1. search a wide array of texts and tailor their selection to match students' interests
2. filter for text readability to identify texts their students will comprehend
3. support efficiently identifying free resources that match curriculum needs

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4 Stage 2 – User Study

In Stage 2, teachers used a prototype educational search tool to carry out two search tasks (T1 and T2) under a think-aloud protocol while facilitators observed and recorded their interactions.

The experimental methods are based on the design of Card et al. (2001), where users carry out tasks while the experimental environment collects types of data, enabling a multifaceted analysis of teacher behavior; this forms a type of computer-focused observational study (Case and Given, 2016, p. 264). The use of a software prototype draws from 'inventive HCI' (Hudson and Mankoff, 2014), in which new technologies are developed to bridge gaps between current technical capabilities and human needs, but in the context of this work the prototype serves as a probe for studying teacher behavior rather than a tool to be formally validated.

4.1 Design and Methods

24 teachers were recruited with a snowball method starting with the teachers from Stage 1. Participants were told they would spend approximately 45 minutes evaluating a new search engine. Table 1 shows participants' self-described teaching experience, from 1 to 26 years (mean 11.75). All participants teach at public schools, except Teacher S2-A at a public charter school.

Participants used LITERATE, a prototype search tool designed by the research team to help teachers locate online resources for classroom. Having teachers in Stage 2 use LITERATE, enables direct observation of how they look for information and the challenges they face. The current version of LITERATE searches *news articles* and provides *educationally-relevant filters* and *result metadata*.

LITERATE provides a search interface (Figure 1a) with reading level and word count filters to refine results. Results that do not match the filters are dimmed and collapsed; a check box removes such results entirely. The result display contains the article title, a brief description, its source, publication date, and an indication of its media type (i.e., "Text" or "Video").

Clicking "More info" expands the result to provide additional details (Figure 1b). Clicking an article title opens the article in a new browser tab.

The interface displays information scent cues (Card et al., 2001) with two goals: to help teachers in their first-pass assessment of article relevance, and to make the results more familiar by including cues that are common in general-purpose news search tools (Sundar et al., 2007), such as title and page snippet.

The prototype backend sends teacher queries to NewsAPI[4] and annotates the results for education-specific post-processing.

The annotation process retrieves each URL returned by NewsAPI and extracts the main article text with the Readability library[5], the core of Firefox's Reading Mode; it uses heuristics to strip away advertising, navigational content, and other elements, returning clean HTML encoding the article's text and image content. This HTML is used to compute the following for annotation:

- *Length* (in words)
- *Readability*: Flesch-Kinkaid reading ease score (Kincaid 1975)
- *Type*: Number of images and videos (from HTML tags)

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- *Representative keywords:* by selecting document terms for which their computed TF-IDF (Croft, 2010) is the highest. IDF values are computed using Wikipedia as the document collection, as it is broad in topic coverage, this to identify terms that are more unique to a text in terms of capturing document content.

Facilitators gave each teacher an overview of the study, including its context and the fact that LITERATE only searches news articles, and printed task instructions. In T1, teachers used the prototype to find 1-2 articles to use in a 6th grade class studying the solar system. In T2, teachers thought of a topic they planned to teach in the next month, then looked for 2-3 articles to use as part of their instruction.

All teachers were asked to think-aloud, and particularly to describe how they might use articles they found in the classroom. As thinking-aloud is a common instructional strategy (Oster, 2001), teachers were familiar with the process. The observing researcher took notes and recorded on-screen activity and teachers' narration with Camtasia. LITERATE recorded queries and other interactions with the interface.

Query logs — records that generally include users' queries and their interactions with a given search system (Croft, 2010) — are the main data source, supplemented with observations from transcripts of teachers' think-aloud narration. Query logs enable us to store each of the teacher's interactions with LITERATE, from queries they formulated to filtering options they selected, or results they clicked on (i.e., interacted with), for analysis purposes.

To begin analysis, the 3 authors were assigned four participants and open-coded both query logs and think-aloud transcripts. This was followed by a code consensus meeting to collapse duplicates and agree upon wording, after which authors recoded the same query logs and related transcripts. They then compared results and discussed until consensus was reached. Following the consensus conversation, the team coded the remaining logs and think-aloud transcriptions independently.

One observation emerging from the coding process was that teachers often used search terms directly related to the curriculum standards. For instance, in T1 many teachers searched for "solar system" rather than using terms like "NASA". The education author therefore coded queries as "abstract phrasing" (the term was directly related to curriculum objectives) or "specific application" (phrasing that connects the curriculum objective to real-life application). Search terms appearing directly in the state curriculum standards were coded as "abstract". Some terms were not directly related to curriculum standards, but did not reference real-life applications, e.g., one teacher searched for "math in the real world" to find examples of linear equations. These queries were coded as "other".

4.2 Observations and Results

This section presents the core results emerging from query logs (teachers' interactions with LITERATE) and questionnaires.

4.2.1 Query Log Results

Users generated 136 queries in T1 and 410 in T2. Figure 2 shows average number of queries created per user to complete a given task (distributions in the margins). Because the tasks forced success — teachers were not finished until they had found resource(s) — success rates are not

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meaningful to report; query count is a better indicator of interactions needed to find potentially useful material. Only one teacher failed to find any resources.

Since T1 was a training task with a fixed goal (i.e., it was designed to enable users to get familiar with LITERATE), most users exhibited similar search patterns. Analysis for remaining results therefore focuses on T2.

Following up on the differences between novice and veteran teachers in Stage 1, Figure 3a shows query counts by years of experience; there is no meaningful relationship (Pearson's $r = -0.064$). Figure 3b shows teachers' average fraction of queries in each category of abstraction, broken down by experience level ('Veteran' is the 12 most experienced teachers, each having at least 12 years of experience). There is no meaningful difference in their propensity to use specific application queries.

11 teachers tried to pedagogically limit results through query text, usually by explicitly searching for educational materials, e.g. "Solar System Lesson for 6th Grade"; this was more common in T1 than T2.

4.2.2 Teacher Evaluation of Articles

Teachers' narration of their process yielded rich insight into their considerations when seeking and evaluating articles for classroom use. Discoveries emerging from teachers' narration are grouped based on their connection to current events, curriculum standards, and student-related concerns (i.e., background knowledge, readability levels, distractions levels, and the use of multimedia in the classroom)

4.2.2.1 Real-World Application

Teachers mentioned connections to the real world in evaluating resources (11 teachers in T2), commenting on the need to prioritize resources that help students relate content to their daily experiences. Teacher S2-I considered using an article about wind and solar power to help students connect classroom learning to energy economics:

> *This might be a good like place to like understand how much a watt is and like much energy usage is happening... good point to like build interest in – this is a current event and we could personalize or like get some intuitions about like how much energy is being used and the costs of it.*

Teacher S2-G, teaching probability, said students "always ask, 'When are we ever going to use this in real life?' Here's something that kind of explains where probability and odds is used." In her case, that was a deciding factor in selecting the article. Teacher S2-D saw value in highlighting real-world applicability of content to promote future study: "*I would give this to my students just to kind of show the real world applications of studying chemistry...*"

4.2.2.2 Curriculum Standards

Several teachers (7 in T2) explicitly referenced curriculum standards when evaluating readings. Teacher S2-O, teaching about the complexity of materials, said:

> *"... my standard is about understanding how materials are engineered and how their bonds allow them to do things. So that's definitely a possibility of a paper that would be interesting and actually fit my standard."*

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The Common Core State Standards for English/Language Arts and/or Mathematics have been adopted by 41 states (Achieve, 2013). 42 states adopted either the Next-Generation Science Standards or their predecessor (National Science Teachers Association, n.d.), so the content of these standards is available for future research.

4.2.2.3 Student Background Knowledge

Students' background knowledge was another common theme (6 teachers in T2). For example, Teacher S2-P connected an article to both immediate and earlier topics in the term:

> *"... this would be good with what we're going because before we talk about asexual and sexual reproduction, we're going to talk about DNA and chromosomes. ... students would be interested in this article and it would be a good jumping off point for when we go into asexual and sexual reproduction."*

Teacher S2-L referenced students' interests and knowledge beyond the classroom; looking for resources to discuss "fake news", she thought the article "No, A.I. Won't Solve the Fake News Problem" would be suitable for her "*more tech savvy students they talk about that sort of thing* ..."

4.2.2.4 Readability

Teachers treated the readability annotations as more definitive than the Flesch-Kinkaid index truly is. Flesch-Kinkaid is calculated from the average number of syllables in words and words in sentences (Kincaid, 1975), assuming that longer words and sentences are more challenging for readers. Although this provides an approximate grade-level equivalency score for each text, it does not consider actual text content, which some teachers seemed to overlook. For example, Teacher S2-Q used LITERATE's readability filter to 6th grade, but when reading an article she said "*... introductory text to the article seems a little higher level than I would think a sixth grader would be able to process*". Teacher S2-K also used grade filtering, hoping that relaxing constraints to the 7th grade would provide less filtered resources: "*I'm going to pop that up to maybe seventh grade and hope that our maybe lower readers have some help*".

Teacher S2-R mentioned challenges in locating resources suitable for all students, as well as the possibility to differentiate between student reading abilities: *"...So I'm going to filter one grade up and one grade down… sixth grade is where we would love them to be but the reality is many are at a first or second grade and there's a few that are higher*"

4.2.2.5 Multimedia Content

Various teachers mentioned use of multimedia (images, charts, videos). Teacher S2-E thought images could help students process *Esperanza Rising*, a historical fiction novel about immigration from Mexico:

> *"I like the images with it, too, because images are powerful. And then I am thinking I can always, teaching about Mexico and* Esperanza Rising*... I'm thinking I can even pull these images ahead of time and kids observe them and then when they come to the reading it will make a little more sense."*

Some discussed how images ease article comprehension. Teacher S2-Q said *"[...] there is this picture here within the article that visually simplifies the above text and I think it's a more approachable graphic to possibly share with a 6th grade class.*"; Teacher S2-J said that even if an article might not work for her students, its images could still be of use:

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> *"I'm not sure I would like print an article for students to use… but I would definitely get some background information for me here and maybe like a picture to show."*

Teacher S2-A mentioned classroom use of videos:

> *"it has videos which I really like, too, because I use a lot of videos in my class to tie into where it's happening in the real world."*

4.2.2.6 Detracting Factors

Several teachers mentioned specific impediments to their use of resources. Some wanted to avoid articles they perceived as political or controversial: "*Female civil rights, that's not exactly what I'm looking for. And I'm staying away from the whole voting aspect but maybe this isn't so much about that. No – politics.*" (Teacher S2-X); "*That's about – let's see that's a meme trolling – I don't think I want to get into political memes with seventh graders.*" (Teacher S2-L).

Others mentioned content – often sexual – that could "derail" the class discussion in unhelpful ways, such as "*'Sperm inspired robots could be the next big thing in drug money,' that's interesting but my kids would just giggle*" (Teacher S2-R); "*'Hoaxers Slip Breastronauts and Dog Park Sex into Journals,' which, it makes me curious as to whether there's any sort of content filter … I know that it's not offensive but I know that if I had a class looking up articles on this and they found that article, that it would derail the class pretty badly.*" (Teacher S2-L); "*I think for any sort of high school kid the idea of a self-lubricating condom is a little taboo and they would click on it for the simple fact that it would be click bait*" (Teacher S2-D).

Advertising was also a concern, sometimes connected to other content suitability concerns (e.g. "*advertisements with the article or with the video are always a little tricky because I don't know what's going to pop up*." from Teacher S2-P).

4.3 Summary of User Study Findings

Stage 2 provides insights that are useful for informing future development in this problem space.

4.3.1 Information Seeking Behavior and Query Formulation

While Stage 1 found differences between novice and veteran teachers in self-reported information seeking behaviors, Stage 2 does not find evidence this translates into observable differences in information seeking behavior or efficacy specifically on search tools offering functionality similar to that of mainstream search engines, but limiting resources retrieved to news articles: veteran teachers were no more efficient than their novice peers at locating articles. All teachers rephrased and refined their search terms before they were able to locate texts for classroom use. Veteran teachers were not more likely to form queries using terms connecting content with real-life applications instead of abstract, curriculum-based terms.

It is unclear why teachers use abstract queries. One hypothesis is that many web-based instructional resources can be located when searching the Web at large (rather than just news sites), so teachers are habituated to making such queries. "Solar System Lesson for 6th Grade" did not return any articles in LITERATE. In Google it provides numerous results; however, Google's results are largely lesson and project ideas, not authentic texts for engaging readers. Small et al. (1998) documented a similar pattern 20 years ago, finding a majority of queries are directly for lesson materials. While search technology has improved dramatically since that study,

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and teachers generally have more experience using search tools and online resources, it does not appear teachers' information seeking behaviors have changed. This aligns with related literaturein information retrieval, from which there is a clear consensus on users' struggle with formulating queries that search tools can effectively process, especially when their information needs are complex (Aula 2010, Vijayasarathy 2016, Smith 2017).

Facilitators also informed participants that the tool only searched news articles and they should try to find authentic texts for classroom use, but this was insufficient to guide them towards making queries the system would be able to support. This suggests a *gulf of execution* (Norman, 2002, p. 51) in the current information landscape and access technology, such that teachers are not able to determine what actions or search queries will lead them to the desired results; this seems to be difficulty moving from the confusion of exploration to the clarity of formulation in Kuhlthau's framework (1993).

There is room for development in technical support for helping teachers bridge the gap between curricular and pedagogical needs and the kinds of authentic texts available on the Web to promote student engagement and learning.

4.3.2 Supporting the Evaluation Process

Teachers' considerations while evaluating articles provide a number of opportunities for future development, supporting *collection* (Kuhlthau 1993). Some are solvable with current technology; e.g., the risks and printing costs of advertising can be addressed through ad-blocking software or a reading-mode library.

Others require new development. The authors expect incorporating curriculum standards into the algorithms and interface driving the search process would be feasible and helpful, but precise mechanisms require further research.

Some challenges, such as controversial article content, are unlikely to admit technical solutions. Using teachers as expert mediators of students' information experiences will enable meaningful instructional enhancements without needing computationally resolve controversy. Teachers also have the best direct knowledge of their curriculum and students, and are well-positioned to evaluate the suitability of readings for their classroom.

5 Conclusion

There is great potential in helping students better learn and connect their learning to life by providing them with access to current, authentic texts to supplement the textbooks and other instructional materials. The Web is a ready source of such readings, however, existing search technologies do not enable teachers to make effective or efficient use of the Web. While much is known about teachers' activities in the classroom, and about the use of texts to promote student learning, teachers' *information-seeking behaviors* on the Web are less well-studied, particularly when looking for resources for their students. The study presented here provides (i) new information on how teachers look for current and authentic resources for their classroom, (ii) insights into future design, research, and development opportunities, and (iii) implications for research and product development:

- Teachers' natural query formulation strategies, while useful for finding pre-written lesson material, are not effective for locating informational texts. More research is needed to

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understand the drivers of teacher query formulation; there may be opportunity for technical developments to either better interpret queries or help formulate more effective ones.

- Research and development to support teachers in locating new types of texts will need to account for teachers' query formulation strategies.
- There is need for additional methodological research on studying multi-stakeholder and educational information needs; e.g., representative, repeatable teaching-related information tasks would be an invaluable guide for future work.
- There is opportunity for technical developments to support the particular ways in which teachers evaluate resources for classroom use. These include connections to curricular relevance, readability, and background knowledge required.
- Current theories of information seeking have little to say about the particular dynamics of looking for information for others; even Kuhlthau, on whom the present analysis relies most heavily, focuses on the user's affective state with respect to their *own* state of knowledge. In the classroom setting, however, the teacher often has strong knowledge of the subject matter, but is uncertain about the availability or usefulness of resources to help their students; the dynamics of this type of information-seeking behavior, and how it may differ from the behaviors more commonly addressed in the literature, needs study.

Technological supports that leverage and enhance teachers' expertise and familiarity with their specific contexts, rather than seeking to replace them as mediators of their students' information experiences, seem like a particularly promising future direction. It also empowers teachers to help their students learn and develop their own information literacy skills through careful selection and presentation of texts, rather than leaving students to fend for themselves or aggressively restricting the available texts.

Much work remains to make LITERATE a broadly-useful tool, including expanding the scope of informational texts searched; explicitly modeling the multi-stakeholder (van Doorn et al., 2016) and group-driven aspect of the informational need; and providing richer result explanations and hints that connect texts to classrooms, students, and curriculum. A deployed system used by teachers in practice will also enable collaborative capabilities, both explicit sharing of resources and through the potential of developing and surfacing signals from other teachers' behavior (subject to privacy considerations). If the process of searching with a system like LITERATE can help teachers learn to become more effective locators and translators of information (Collins-Thompson et al., 2016), that is also a valuable outcome.

The work presented in this paper lays groundwork to motivate and guide future developments to help teachers locate current and authentic resources for their classrooms, a promising new frontier in information retrieval, human-computer interaction, and educational research.

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Table 1: Participants in research studies.

Participant ID	Teaching Experience	Current Grade Level(s)	Current Subject Area(s)
		Stage 1	
S1- A	3	4th	All subjects
S1-C	3	5th	All subjects
S1-D	21	5th	All subjects
S1-E	5	5th	All subjects
S1- B	18	8th	Science
S1-F	6	6th-8th	Math
S1-G	17	9th-12th	English
S1-H	10	9th-12th	Science
		Stage 2	
S2- A	1	7th, 9th, 10th, & 11th	Math
S2-B	3	10th-12th	Math & Computer Science
S2-C	3	10th-12th	Math
S2-D	5	9th-12th	Chemistry
S2-E	5	6th	All Subjects
S2-F	7	9th	Math
S2-G	8	10th-11th	Math
S2-H	9	10th-12th	Math
S2-I	9	9th-12th	Physics
S2-J	10	5th	All subjects
S2-K	10	10th	Biology
S2-L	11	7th-9th	Library sciences
S2-M	13	10th-12th	Science
S2-N	13	9th & 12th	Engineering & Math
S2-O	13	10th-12th	Chemistry & Academic Support
S2-P	14	7th-8th	Science

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S2-Q	14	8th	Earth Science
S2-R	15	7th-9th	Technology
S2-S	16	9th, 10th, & 12th	Math
S2-T	17	7th	Science
S2-U	17	5th	All subjects
S2-V	19	12th	English
S2-W	24	6th	All Subjects
S2-X	26	5th	All Subjects

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LITERATE

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6th g 8th grade 0 10000

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The planet, currently known as (225088) 2007 OR10, was discovered 12 years ago.

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Word Count	858
Number of Images	8
Keywords	submillimeter, hole, telescope

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Figure 2: Number of queries per task, with query count distributions in the margins. Each dot is one participant.

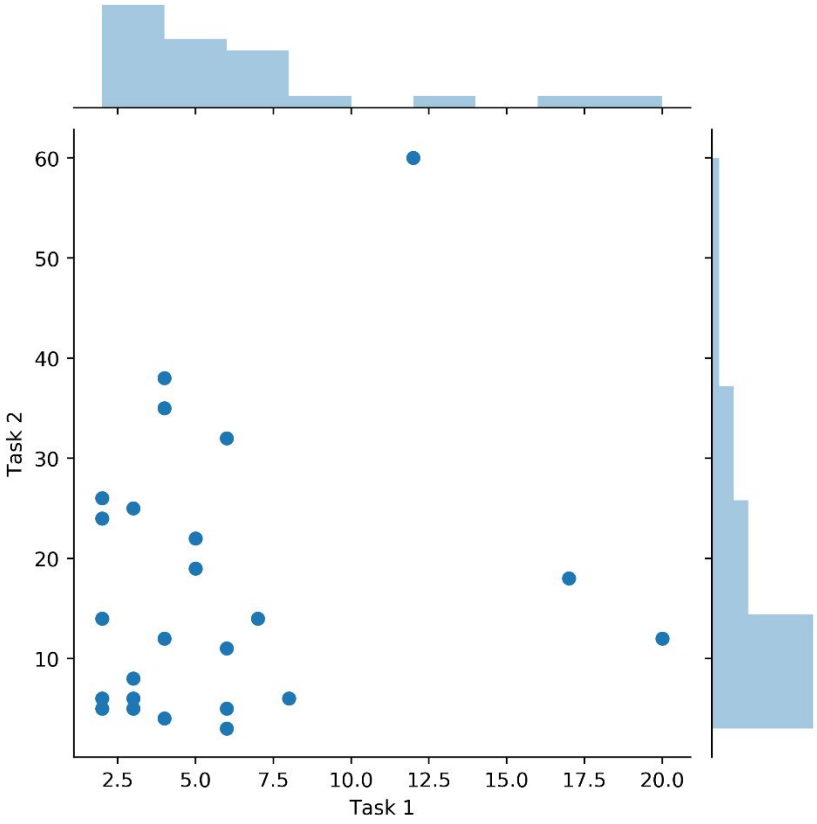

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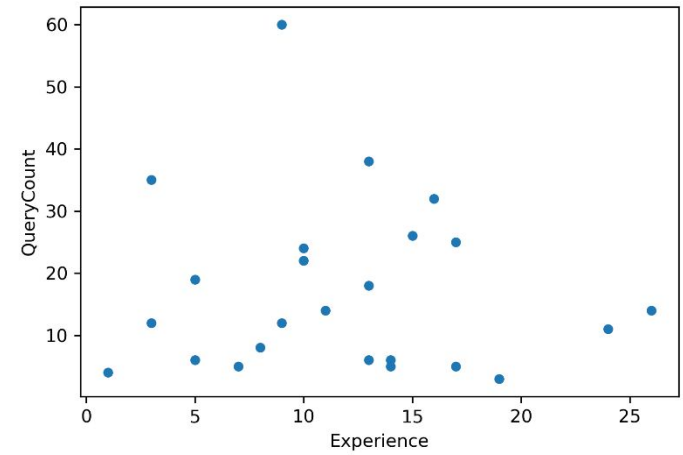
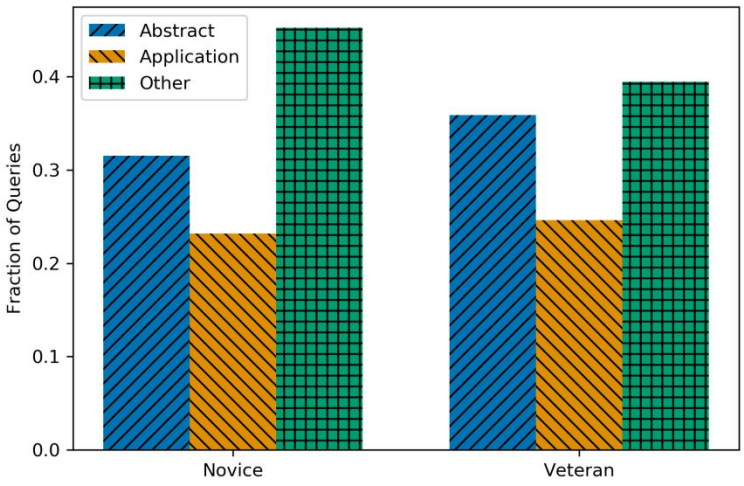
Figure 3: Query behavior by experience.





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Appendix A

Interview Guide

1. Please describe the texts you currently have available to your students in your classroom. Can you estimate what percentage are informational (versus narrative)? Were these provided by your school/district, or did you acquire them on your own?

2. How much freedom to you have in selecting texts to use in your classroom?

3. Think about a recent time you went looking for a text to use as part of your instruction. What was your instructional objective/goal? What qualities were you looking for in a text? How did you go about finding the text? Were you satisfied with what you found?

4. In a perfect world, describe the texts you would have readily available to your students?

5. What makes a text suitable for your students?

6. How often do you use internet resources as part of your lesson planning? Can you describe what you do when you start planning a lesson using an internet resource?

    1. POSSIBLE FOLLOW UPS -- What barriers do you face when using internet resources for lesson planning? What might make you use internet resources for lesson planning more often? You mentioned XYZ site/resource -- what about that site makes it useful? What could be done to improve that site?

7. How often do you use internet resources to find texts to use in the classroom? Can you describe what you do when you search for a text on the internet?

    1. POSSIBLE FOLLOW UPS -- What barriers do you face when using the internet to find texts? What might make you use the internet to find texts more often? You mentioned XYZ site/resource -- what about that site makes it useful? What could be done to improve that site?

8. Describe your students' awareness of current events. Do they talk about new/current events frequently? What kinds of topics do they discuss?

Do you ever use current events as part of your regular instruction? Why or why not?

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