



Online Scaffolds That Support Adolescents' Comprehension

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Introduction

Vignette 1: Ya-Wen had heard teachers say that writing a summary helps people remember what they've read, but she had never been able to do that. Now she is taking an online earth science course that periodically reminds her to write short notes after reading the main points of the text. She understands the information better, and she also remembers what she reads. Ya-Wen is taking notes in her regular courses, and for the first time in her life, she thinks that she's a good reader. Finally, she understands how she can become a better reader by doing things like summarizing.

Vignette 2: Julian loves adjusting and fixing the BMX and dirt bikes that he and his friends ride. He reads information online to understand how he can fix his bikes and make them more competitive. When it comes to school, however, Julian doesn't like to read. By the time his classmates finish reading an assignment, he is only halfway through. The only subject that Julian likes is his online science course. He can click on a word and get its meaning or hear it read aloud. He also likes it that none of the other students knows how far he has progressed with an assignment. Julian has discovered that some of the ideas in the science course are the same ones he uses when he works on bikes.

Vignette 3: "Boring" is the way Kareema would describe the social studies textbooks in school. In the online course that she's taking, though, she's read a diary of a soldier in Vietnam and letters that he wrote to his girlfriend. She has even read about some soldiers in Iraq, where her cousin is stationed. She looks forward to her online course. She never realized that things that happened in the past were like things that are happening today.

A frequently asked question is whether students comprehend online text as well as printed text. The answer to this question is critical, not just to determine if resources are being used wisely, but also to establish whether students are proficient at comprehending text online—a skill that is increasingly recognized as essential for full participation in the communities and marketplace of the 21st century (Patrick, 2007).

Answers to a second question related to comprehension in online contexts, however, may be even more critical because of the crisis in American schools, especially high schools: How can the enormous potential of online technologies be used to increase the literacy participation of adolescents? Many American adolescents are disengaged and disaffected with school, as reflected in lackadaisical involvement in day-to-day reading events and in international comparisons that show lackluster performances on comprehension assessments (Kirsch, DeJong, LaFontaine, McQueen, Mendelovits, & Monseur, 2002). This behavior in school contrasts sharply with the engagement that adolescents show in learning

in online contexts outside of school. For many adolescents, their learning in school is becoming increasingly disconnected from the experiences they have online after school (Ito, Horst, Bittani, Boyd, Herr-Stephenson, Lange, Pascoe, & Robinson, 2008).

One clear reason to use online contexts is to build on the interest and skills that adolescents show in their online lives outside of school (Greenhow & Schultz, 2007). A second reason, equally compelling, lies in the features of online contexts that have often been underused in school settings. A growing body of scholarship points to three features of online contexts that can involve adolescents in literacy and increase their competencies as readers. The first vignette that introduces this paper illustrates the feature of engagement. Through design and content, online contexts can support adolescents' ownership and control over their reading. Access is illustrated in the second vignette. Online contexts can be designed so that disengaged or struggling readers get the support they need to read and interact with texts and content that may be difficult for them to read independently. The final vignette illustrates connectedness. The connections within and between texts as well as to various forms of information (e.g., video clips) can be represented in online contexts in unique and interactive ways that can help develop deep understanding of content.

This review, then, addresses two questions:

1. How does adolescents' comprehension in online and print contexts compare?
2. What features of online contexts can be used to increase adolescents' involvement in literacy and comprehension?

Before addressing these questions, we define key terms used in this paper.

Scholarship

The scholarship we examined for this review came from numerous disciplines, including computer sciences, cognitive psychology, information theory, reading education, learning theory, and technology education. Terms are many and often differ from one discipline to another; they include computer-mediated, computer-assisted, network-accessible, hypermedia, virtual learning, technology, Web-based, multimedia, electronic learning, e-learning, and online learning. We have chosen to use the term *online* because, building on the definition of Keeler, Richter, Anderson-Inman, Horney, and Ditson (2007), we believe that it best describes the learning context of interest. Keeler et al. define online courses as "electronic learning environments comprising materials to read, videos to watch, activities to do, assignments to complete, discussions to join, tests to take, and so forth" (p. 129).

Scaffold

Scaffold is used as a metaphor for the kind of support that is provided to learners as they acquire a skill or strategy (Wood, Bruner, & Ross, 1976). As learners move toward independence, scaffolds are provided to ensure that students understand the processes or content of a domain. As students master the task, the scaffold is gradually removed. Within online contexts, scaffolds can take a number of forms. Some scaffolds may provide students with reminders and models of strategies to use at particular times when reading or responding to a text or task. Other scaffolds might be the pronunciations and definitions of challenging vocabulary. Still other scaffolds might be to uncover for students the organization of a particular discipline and the manner in which experts in that discipline typically organize their presentations.

Comprehension

By *comprehension*, we are referring to students' capacity to understand and retain their understanding of the information in texts. Much has been written about the multiple literacies that can occur in online contexts as students process information and share their interpretations and constructions in various ways (Leu, 2006). Processing, interpreting, and remembering text is a proficiency that is even more critical in the 21st century than in the past, if individuals are to fully participate in the marketplace and community.

Adolescents

The final term in the title is *adolescents*. While many of the conclusions that will be made in this paper are applicable to adolescents as a developmental group, we are most concerned with two groups of adolescents. The first is composed of the adolescents who are disengaged as readers and learners. These are students who can read adequately but rarely choose to do so (National Endowment for the Arts, 2007). Struggling readers make up the second group. These students are caught in a vicious cycle of not reading because they do not read well (and consequently reading even less and falling even further behind). For disengaged and struggling adolescent readers, we believe that online contexts offer a chance to become reengaged, to gain access to texts that may otherwise be out of reach, and to increase knowledge of critical content.

How Does Adolescents' Comprehension in Online and Print Contexts Compare?

We attend first to the question of whether students' comprehension of online contexts is equal to their comprehension of printed text. Three recent meta-analysis studies have investigated the effectiveness of different types of online experiences on the reading achievement of middle- and high-school students (Moran, Ferdig, Pearson, Wardop, & Blomeyer, 2008; Murphy, Penuel, Means, Krobark, Whaley, & Allen, 2002; Slavin, Cheung, Groff, & Lake, 2008). In the majority of studies that address this question, the predominant variable of interest has been comprehension, typically measured by performances on silent reading tests (Moran et al., 2008).

The Moran Study

Moran et al.'s (2008) meta-analysis examined 20 experimental and quasi-experimental studies, published between 1988 and 2005, on the effects of technology on the reading performance of middle-school students. The learning contexts ranged from reading a text online or taking an online test on a book that had been read offline to performing problem-based, interactive activities with virtual tutors. Overall, the mean weighted effect size of 89 different effects was 0.49. Of the 89 effect sizes calculated, 26% were large, 32% were moderate, and 42% were small. Moran et al. do note that the effect sizes were greater for interventions aimed at general populations rather than populations with specific needs, such as struggling readers.

The Murphy Study

Murphy et al.'s (2002) meta-analysis consisted of 25 experimental and quasi-experimental studies published between 1993 and 2000 investigating the effect of K-12 digital content on reading; eight of these focused specifically on middle-school students, and one focused on high-school students. Overall, 31 weighted effect sizes were reported for these studies, with a mean weighted effect size of 0.42. Nearly 13% of the reported effects were large

(>0.8), 19% were moderate (0.5–0.8), and the remaining 59% were small (0.01–0.5), out of which slightly over half (57%) could be considered small but educationally meaningful (0.25–0.50). Similar to the work of Moran et al., this meta-analysis included a wide range of educational technology designed to improve reading comprehension; there was no overlap in terms of the studies analyzed. It is interesting to note that, overall, the findings of both of these meta-analyses are quite similar and provide evidence suggesting that technology can contribute to improved reading comprehension for secondary students.

The Slavin Study

Slavin et al. (2008), using a best-evidence approach, reviewed research on reading programs for secondary students. Eight studies of online instruction were analyzed, involving almost 13,000 secondary students. The overall mean effect was +0.10, with effects ranging from 0.03 to 0.56. Although the effect sizes reported by Slavin et al. (2008) are smaller than those of the two meta-analyses described previously, Slavin and his colleagues took into account sample size and methodological quality, in addition to effect size, in rating the strength of the evidence regarding the effectiveness of the different secondary reading programs reviewed. Both of the commercial online programs met the criteria for moderate evidence of effectiveness.

Conclusion

All three meta-analyses suggest that online contexts can support the reading comprehension of middle- and high-school students. As is typical in a meta-analysis, however, conclusions are made about the results of projects that can have very different features. While confirming a positive effect for online contexts, meta-analyses fail to provide insight into the particular features of online contexts and the mechanisms whereby these features support student learning. To identify such features and the reasons for their efficacy requires more in-depth reviews of scholarship.

What Features of Online Contexts Can Be Used to Increase the Involvement in Literacy and Comprehension of Adolescents?

When a new field emerges, numerous attempts are made to identify salient patterns or categories. That is definitely the case with adolescent learning in online contexts. The literature on learning in online contexts is vast and spans diverse fields and research traditions. To provide the clearest answer to the question of what online scaffolds can enhance comprehension, we have identified three primary factors: (a) engagement, (b) access, and (c) connectedness of texts and information. We make no claims that these categories are inclusive of all potential online scaffolds. With added attention, other elements are likely to be identified. These three categories, however, are sufficiently comprehensive to demonstrate the ways in which adolescents' comprehension can be enhanced in online contexts.

Engagement

Proficiency in reading is necessary to successfully make meaning from text. In addition, as Guthrie (2008) has underscored, individuals who read frequently have an interest in reading and are deeply involved when they read. All of these elements—proficiency, interest, and involvement—make up what Guthrie has described as engagement. Measures of engagement have been shown to predict students' reading achievement better than

measures such as socioeconomic background or a parent's educational level (Guthrie, Schafer, & Huang, 2001). Engagement in readers, according to Guthrie (2008), can be supported by five characteristics of learning contexts: mastery, interest, autonomy, self-efficacy, and social interaction. For clarity of presentation, we have organized these elements into three clusters: developing expertise (mastery, interest), a sense of agency (self-efficacy, autonomy), and social interaction.

Developing Expertise

While human beings are driven by the desire to be competent from infancy on (White, 1959), being competent and being judged to be competent matters particularly to adolescents. Students engage more readily and more deeply with texts and tasks that they see as relevant and interesting as opposed to irrelevant and uninteresting (Vansteenkiste, Lens, & Deci, 2006). Further, they prefer learning experiences in which they can understand a topic deeply and thoroughly to a regimen of unrelated or disjointed topics and facts (Seifert & O'Keefe, 2001).

Online contexts have a number of features that make it possible to create experiences that help students develop expertise. Unlike classroom contexts where assessment is usually public and clumsy, evidence regarding students' background knowledge and interests can be gathered efficiently and discreetly in online contexts. Public intervention is not necessary for adolescents to get material that recognizes their background knowledge and strategies. A second feature of online contexts is the ease with which instructional sequences can highlight the relevance of content. For example, through video clips, students can hear individuals who do not have the rights guaranteed by the U.S. Constitution.

The production of online courses has outpaced research that considers how particular features affect the development of adolescents' expertise. Consequently, it is not evident how adolescents' engagement is influenced by opportunities to master content or to connect to students' background knowledge and interests. However, several research projects have examined how tasks that encourage competence and mastery affect learning in comparison to tasks that emphasize competition.

Elliot and Harackiewicz (1996) found that emphasizing learning to avoid failure undermined learning, while students who were learning for the sake of learning understood content better, regardless of whether their performances were compared with others. These patterns have also been reported by Moos and Azevedo (2006). In Rezabak's (1995) project in which the presentation of information was varied in ways thought to influence motivation (e.g., game-like format versus a sequential listing of information), the presentation was less important than a balance between the challenge and learners' skills. Students with higher prior knowledge were more competent and were reported to be more intrinsically motivated to complete the tasks than their peers with less prior knowledge.

Further, when motivational techniques are matched with students' prior knowledge, goals, and ways of learning in an online context, students have higher performances and more extended attention (Song & Keller, 2001). Even with initially disengaged students, providing motivational techniques that adapt to students' ways of learning results in increased cognitive engagement, concentration, enthusiasm, and attention (Wang & Reeves, 2006). Chan and Ahern (1999) concluded, based on their investigations, that adaptations to motivational techniques and goal structures, as well as to preferences and

background knowledge of individuals, need to be made at different points in a course or a lesson. As learners gain skill with the content or the context, the complexity of content (and tasks) can be gradually increased.

Sense of Agency and Self-efficacy

A sense of agency or ownership involves autonomy and self-efficacy. When students are given choices of what to read or how long to spend on specific tasks, their sense of autonomy and time spent on reading increase (Reynolds & Symons, 2001). If students are constantly interrupted in lessons, they fail to take ownership or personal responsibility for the reading assignment (Assor, Kaplan, Kanat-Maymon, & Roth, 2005). Too many choices, however, can overwhelm some students, especially struggling readers. For these students, the goal is to move them gradually to the point where they are making multiple choices within a lesson, such as topic and text selection, partner or group selection, and decisions about the end product.

Self-efficacy refers to students' perceptions of their abilities and the reasons they give for their successes or failures. Self-efficacious learners attribute success to effort, while less self-efficacious students attribute their lack of success to luck or their lack of ability. Students who make attributions of the former type have been found to persist longer and learn better in online contexts (Martinez, 2003).

One of the benefits of online contexts is that courses can be designed to support students in changing from passive attributions to attributions in which they take greater responsibility for their learning. Middle-school students in an online context were given opportunities to review their progress and to attribute this progress to their effort and hard work on the task. Students in the attributional treatment were more motivated and acquired more knowledge than students in the control condition (Dresel & Haugwitz, 2006).

Further evidence that online contexts can prompt changes in readers' sense of agency comes from O'Brien (2003), who worked with adolescents who were considered to be at risk of dropping out of high school and had long histories of performing poorly in print literacy tasks. These students viewed their lack of ability as readers to be beyond their control in typical classroom settings. By contrast, in the online context, where the tasks had more flexibility and scaffolding to support students' understanding, students developed the sense that ability was less stable and more dependent on specific strategies they used. As a result, they focused more on learning and using helpful strategies to aid learning, rather than citing lack of ability as a reason for failure to learn. This group of adolescents consequently developed a greater sense of agency in the online context, in addition to higher levels of engagement as readers.

Similarly, Alvermann (2006) reported that adolescents who had scored in the lowest quartile on a standardized reading achievement test engaged in literacy practices as they searched the Internet for song lyrics, read Japanese anime online, and produced their own articles on fashion and favorite rap groups. Both O'Brien's and Alvermann's research projects were conducted in out-of-school settings where adolescents had considerable flexibility in determining task structure, content, pacing, products, and more. These studies of out-of-school online learning suggest there is important potential for similar patterns with academic content in online contexts.

Social Interaction

Online contexts have been a primary testing ground for the premise of constructivist theories that suggest social interaction supports high-level comprehension and thinking (Engeström, 1999). Social interaction permits the generation of new perspectives and the verification and extension of knowledge within the community, results that cannot be achieved when individuals work alone.

Typically, such social interaction in online courses occurs through students' sharing their work products and commenting on the products of their peers. For example, in CoVis (learning through collaborative visualization) (Edelson, Pea, & Gomez, 1995), students record their observations and activities in an online notebook to which all have access, allowing everyone in the group the opportunity to view and comment on each other's work. When such experiences are part of online contexts, students have shown superior abilities in tasks such as question-asking, and higher comprehension and vocabulary performances (Lamon, Secules, Petrosino, Hackett, Bransford, & Goldman, 1996). One project reported an increase in the time-on-task and conceptual knowledge of low-performing students specifically (Scardamalia, Bereiter, & Lamon, 1994).

Since the quality of social interactions matters more than the quantity, researchers have provided collaborative teams with structured communication interfaces, such as sentence-opener interfaces (e.g., "I disagree because . . ." or "Why do you think this might work?"). Collaborative teams working with structured interfaces have been found to be more task-focused than those with free chat interfaces (Baker & Lund, 1996).

Conclusion

The evidence is strong that the presence of particular features in learning environments, including online ones, can increase readers' engagement and, as a result, their comprehension proficiencies. At the same time, learner engagement cannot be taken for granted in online contexts. Many struggling readers have difficulty monitoring and managing their learning—a situation that can be exacerbated in online contexts where time management and choices often need to be regulated. While mandated scaffolds may help struggling readers to focus and manage tasks, such features can potentially counteract the engagement that is associated with higher-order learning. This conundrum makes it essential that online contexts be designed carefully, giving students options while at the same time ensuring that tasks are sufficiently scaffolded so that students become independent in applying strategies.

Access

Access refers to making the content and texts amenable to learners' levels and proficiencies through scaffolds such as text-to-speech support, vocabulary definitions, note-taking functions, or links to background material. In this context, we distinguish between adaptive scaffolds that are aimed at supporting comprehension of a particular text and strategic scaffolds that are aimed at increasing the comprehension capacity of learners with texts in general. Since question-asking is a strategy used by good readers (NICHD, 2000), an adaptive scaffold would, for example, provide students with questions at critical points while they are reading a specific online text. An example of a strategic scaffold would be to prompt students to ask their own questions at critical points as they are reading texts

online. While the questions in this second condition might be modeled initially, this prompt would gradually be faded out.

Adaptive Scaffolds

Several adaptive scaffolds have become quite common in online courses because of their efficacy in supporting struggling readers. One such scaffold is text-to-speech support. When students get to target words for speech feedback, they typically score significantly higher on measures of both text comprehension and word recognition (Elkind, Cohen, & Murray, 1993; Olson, Foltz, & Wise, 1986). In one such project with a sample of adolescents that included average and struggling readers, the group that read the text silently as it was being read aloud had higher levels of comprehension than either the group that read the text silently online but without audio or the group that heard the audio only (Montali & Lewandowski, 1996). The struggling readers in the silent reading with audio group achieved comprehension rates that were comparable to the rates for above-average readers reading on their own. Other studies have confirmed the value of text-to-speech aids to struggling adolescent readers (Lange, McPhillips, Mulhern, & Wylie, 2006).

Another adaptive scaffold within online contexts involves the availability of information about unknown words, including definitions, pronunciations, illustrations, or usage in sentences. Middle-grade students who read a text under a vocabulary assistance that was mandatory (i.e., critical words were defined for these students) scored higher on measures of vocabulary and text comprehension than did peers in either a dictionary or an options condition (where students could choose whether and when to use the vocabulary assistance) (Reinking & Rickman, 1990).

While examples of successful products from a task (e.g., a summary of what has been read) can be provided to students in typical classroom settings, such examples can be highlighted and brought to readers' attention in unique ways in online contexts. For example, an online text might provide a sample summary that highlights paraphrases of important ideas. Providing students with examples of successful products has been shown to aid comprehension and understanding in online contexts (Renkl, 2005).

Strategic Scaffolds

A substantial research literature indicates that successful readers employ a set of four strategies—especially when they are reading challenging texts—that their less successful peers do not employ: making predictions, asking questions, clarifying confusing parts, and summarizing (NICHD, 2000; Rosenshine & Meister, 1994). Successful readers also apply these strategies when reading texts online. They also use several additional strategies that are specific to reading texts online (Davidson-Shivers, Rasmussen, & Bratton-Jeffery, 1997).

Online contexts can provide virtual coaches or tutors that guide less proficient readers in becoming aware of these strategies and beginning to apply them appropriately. Algorithms can be applied in online contexts that allow for gradual release of support, ensuring that students take ownership of the strategies.

One means whereby such guidance can be provided is through some form of virtual instructor or tutor represented by a voice and, typically, an icon. This instructor or tutor consistently reminds students to apply a strategy such as previewing a text or summarizing

after reading. The presence of consistent instructional scaffolding or guidance on particular strategies has been validated to have a positive effect on comprehension.

In one such project, the virtual instructor gave students reminders to reflect on what they were reading at critical junctures in texts (Saloman, Globerson, & Guterman, 1989). Students who have received such scaffolding have been shown to have significantly higher reading comprehension performances than students in a comparison group. Further, students who received the consistent guidance through a virtual presence also produced essays that were rated higher than comparison students.

In another project, the tutor coached students in constructing a good explanation in response to a question, corrected misconceptions, and answered students' questions (Graesser, McNamara, & VanLehn, 2005). In another, animated tutors guided readers in evaluating their comprehension, paraphrasing, inference-making, prediction, and elaboration (McNamara, Levenstein, & Boonthum, 2004). Students who receive such animated tutoring have been found to use strategies more and have higher comprehension than students who are also online but are taught to self-explain without modeling or feedback from tutors (McNamara et al., 2004).

Summarizing is another strategy that has consistently been found in the repertoire of successful readers. Support in summarizing can be offered in a variety of ways in online contexts, the most fundamental of which is to make it prominent in lessons and programs. Such inclusion may support students in summarizing, but it is through the provision of models and guidelines for summarizing that the quality of students' summaries is affected.

Getting feedback on summaries can also aid the quality of summarizing. The development of latent semantic analysis (LSA) has made it possible for students to receive feedback on their summaries and other written products with rapidity and consistency that is not possible in conventional learning contexts. In LSA, a document or set of documents is analyzed for concepts and the relationships between concepts. This technique can be used to compare documents for similar terms, including synonyms. This technique makes it possible to analyze the quality of students' writing, such as summaries and essays.

LSA has been used to give students feedback on the adequacy of their summaries (Franzke, Kintsch, Caccamise, Johnson, & Dooley, 2005). Students can revise and resubmit their summaries until each summary adequately represents the main points of the text. Young adolescents have been found to spend twice as much time on these summaries as do peers who are writing their summaries on word processors. Raters have scored the summaries of the former group as superior to those of students in the word-processor group. Further, the comprehension of students who have received strategic scaffolding in summarizing online has been found to be significantly higher. What is particularly notable is that low- and average-performing students have made the greatest gains (Franzke et al., 2005).

Conclusion

A fairly robust literature has been amassed on the effects of adaptive scaffolds in online contexts, especially for struggling readers. When provided with adaptive scaffolds such as text-to-speech support and support with vocabulary, struggling readers perform at higher levels, even levels similar to those of grade-level readers. However, as it is widely known that adolescents who are struggling readers often fail to use adaptive scaffolds (Farmer, Klein, & Bryson, 1992), it is important that implementation encourage or mandate their use.

Research is also fairly clear that struggling adolescent readers do not use productive strategies such as predicting, questioning, clarifying, and summarizing to facilitate their comprehension. Strategic scaffolds in online contexts can guide struggling adolescent readers in using such strategies more consistently—particularly questioning and summarizing—with benefits to their comprehension.

Connectedness of Texts and Information

No book or learning environment in human history has had the capacity of an online context to make such a volume of information available to users, to present so many forms of information, or to make connections within and across information (Cavanaugh & Bolometer, 2007). In just a handful of minutes, students can be introduced to a complex concept, such as representational government, through graphic media; watch the transition of elected officials on a video clip of a swearing-in ceremony; view an image of the original U.S. Constitution; and listen or watch an interview with a political scientist explaining the text structures that are typical in articles about government.

Two aspects of the design of online contexts can be used to increase the breadth and depth of learning experiences for adolescents: (a) connections within and across texts and information and (b) varied modes of information.

Connections

Similar to texts in online contexts, printed texts can be read in parts and can include ancillary information, such as advance organizers that describe the purposes or the organization of the text, or highlighted or boldfaced words that indicate vocabulary that is central to the topic. These connections in printed texts, such as cross-references to prior examples or a glossary, can be unwieldy and cumbersome, leading many adolescents to choose not to use them. In online contexts, however, students can be guided in making these connections. Further, experiences within online contexts, more so than within print-only contexts, can be organized in a manner that gives readers many more opportunities to see how ideas connect and information is organized.

The linking between texts and multimedia resources that characterizes online contexts is typically described as hypertext. Hypertext makes it possible to design lessons and courses so that learners have access to related information about content, including additional texts, definitions or pronunciations of words within texts, or resources such as video clips through links (also called hyperlinks or hot links). While the links within a CD-ROM are internal to the lesson or the course, the locations that learners may be accessing by clicking a link can be external to the course or lesson in an online context.

The possibilities that hypertexts offer for extending learners' experiences with content are immense. One of the critical tasks that confronts the developer of educational content is the manner in which a hypertext should be organized and the number of links that should be made available to learners. Researchers have considered the effects of the most common ways of making links within hypertexts. The most basic ways of connecting are either a listing of all units (i.e., texts or chunks of information) that the reader can access, similar to a table of contents listing the chapters in a book, or a simple linear listing with each unit linked to the one before and after it, allowing readers to move forward or backward as they would in turning the pages of a printed text. Hierarchical linking systems allow for information to be presented in more sophisticated ways, with a unit that

represents an overall idea linked to other units that are subordinate points or elaborations. Within a networked form of links, relationships are associatively linked, as when news stories on natural disasters around the globe are linked. Program designers can also choose how to convey the relationships among links to users. For example, the navigation system can indicate which links are available to users within a particular unit. While these hyperlinks enforce navigational patterns, they do not explicitly display the structure of how units are connected. In contrast, interactive overviews allow users to view the overall structure of the hypertext or a portion of it, and they provide the navigation system.

Several studies have found no significant differences between print and equivalent online versions (where the entire text is contained within one scrollable text unit) on students' reading comprehension (e.g., Naumann, Richter, Flender, & Christmann, 2007; Reinking & Schreiner, 1985). However, when the structures are more complex, the organization of the online content and its associated navigation system influence comprehension.

One aspect of the structure that makes a difference to comprehension is the number of links and the size of text units within an online text. When Dee-Lucas and Larkin (1999) varied the number of links and the size of text units in online texts, college students in the "fewer but longer text units" condition had a broader understanding of the text, while those in the "more but shorter text units" condition had a narrower but more detail-oriented understanding of the content. Whereas the size of each text unit was not significant, Zhu (1999) found that texts with fewer links (3 to 7 links per main topic) were better comprehended than texts containing more links (8 to 14 per main topic).

Extending this work, Shapiro (1999) created four online texts with the same content but with different numbers and types of links: a linear hypertext that contained only links to the previous and next text units, an unstructured but linked hypertext in which all text units contained links to all text units, a clustered online text in which nonhierarchical clusters corresponded to each of the main topics, and a hierarchical hypertext. While all conditions had similar knowledge of facts (since all groups had the same content), those who read hypertexts with multiple links between text units (hierarchical, clustered, and unstructured but linked) made significantly more associations between topics than those who read the linear text. In a problem-solving task that required information from two linked text units, only the students who read the clustered hypertext had significantly superior performances. Based on these results, Shapiro suggested that grouping related items together and signifying these semantic relationships through highly visible links may be what aids comprehension, not the structure of the online text per se.

Paolucci (1998) presented the same content in three versions that differed in structure—hierarchical, networked, and combined hierarchical and networked—and in number of links—from 37 in the hierarchical version to 173 in the networked version. Students who read the text in the hierarchical and mixed formats scored significantly higher on questions pertaining to higher-order concepts (although not on factual content) than those who read the networked version. Similarly, studies with adults indicate that hierarchical or simple networked structures, but not complex networked structures, positively affect comprehension, particularly for those with low prior knowledge about the topic (Calisir, Eryazici, & Lehto, 2008).

Concept maps, graphic organizers, and other forms of overviews that make explicit the structure of a text or a content area have been known to support comprehension. In online contexts, such overviews can be presented in ways that are not possible in conventional learning environments. For example, as students progress through a unit, animation can be used to show how a concept map for a topic is expanding. Overviews can be interactive, allowing students to choose among potential content that might be part of a unit.

Research confirms the efficacy of content overviews as scaffolds in online contexts. Middle-school students who used a structured overview had better comprehension at a conceptual level than students using an unstructured overview that listed topics, although recall at a factual level was the same (Puntambekar & Goldstein, 2007). Adults have also shown improved comprehension at a deeper level when using interactive overviews that display the relationships between text units as hierarchies or simple networks, particularly when the adults possess little background knowledge (de Jong & van der Hulst, 2002; DeStefano & LeFevre, 2007; Naumann et al., 2007).

Varied Modes of Information

While information can be presented through visuals or words in both printed and online contexts, online contexts allow for the dynamic presentation of information. Unlike printed texts, where visuals are always static, the visuals of online contexts can be video clips, animations, or simulations. When static images are presented in online contexts, they can be made more dynamic by being placed in a series that moves through rapid succession. Information can be presented dynamically through audio recordings, such as poets reading their work or a Shakespearean actor reading a soliloquy.

As has already been explored, these multiple forms of information can be a source for increasing the engagement of struggling and disengaged adolescent readers. The varied media can also ensure access for students who have difficulties in processing particular forms of information. At the same time, however, when information is presented in multiple, simultaneous ways online, the processing demands for learners, especially for those who are learning-disabled, increase.

The factors that influence learners' processing of single or multiple sources of information can be many. Numerous research literatures address the influence of particular factors on learning as well as how the efficacy of particular factors is influenced by individual differences. We cannot review all of these literatures. But we will focus on two areas where a substantial body of research is available in online contexts: (a) visuals, particularly animation, and (b) the amount and cohesion of information.

Research on the manner in which visuals—static ones such as photographs as well as dynamic ones such as video clips—influence comprehension has a long history (Anglin, Towers, & Levie, 1996; Levie & Lentz, 1982). The general conclusion is that visuals can facilitate the acquisition of knowledge in texts. However, their facilitative effects are influenced by the task, the closeness of the information to the text, the degree of realism in the illustrations, their simplicity, and cultural compatibility (Anglin et al., 1996). The general rules of thumb from this research are that simplicity is better than complexity and that the content of the visual needs to be closely aligned to the content of the text.

Animations, in particular, have been of interest to researchers because of the cost in time and money required for this feature of online instruction. The conclusion from a fairly robust body of studies is that, especially for learners who are novices within a domain, animations can produce superior learning outcomes when concepts or phenomena depict changes, steps, or processes that readers may not be able to infer from static representations (Betrancourt, 2005; Rieber, 1996). When these conditions are not met, however, static presentations may support learning outcomes as well as animations (Zhu & Grabowski, 2006).

Second, the degree to which information within a text has a unifying theme and structure—that is, how coherent and cohesive a text is—can be a powerful determinant of comprehension. While analyses that compare the lengths of texts in online and conventional courses have not been conducted, the addition of a page or two of text in an online course is not necessarily as costly in terms of delivery as it is in a printed text. There could arise the temptation to err in the direction of including interesting or related information in online courses, as ancillary or supplementary material in links if not in the primary online text. The association of online contexts with entertainment could also prompt a second temptation in creating or selecting texts for online contexts—the inclusion of interesting or provocative ideas that are viewed as motivational in nature. For example, a text on weather patterns might begin with a provocative anecdote about an individual chasing a tornado. The use of extraneous information, or what Garner, Gillingham, and White (1989) termed “seductive details,” does not necessarily support comprehension in print or in online contexts (Mayer, 2005). It should be noted, however, that researchers have not considered whether the seductive details served their purpose—getting disengaged or struggling readers to read the text (which they might not have done without the anecdote).

McNamara and Shapiro (2005) also caution that cohesive, concise texts appear to benefit low-knowledge readers more than high-knowledge readers. They describe a potential reverse cohesion effect where the active processing of information by high-knowledge readers can even be impeded by a highly cohesive text. Overviews and structures of texts may need to be adapted for students of different levels, McNamara and Shapiro suggest. More experienced learners in a domain can manage texts that are less organized and structured.

Conclusion

The evidence to date indicates that the structure of information and texts in online contexts matters. Especially for struggling readers, hierarchical or simple networked texts appear to positively affect reading comprehension. Furthermore, interactive overviews are useful in making the structure of a text and information visible. Showing the location of the current text unit within the online text and which links have been visited also appears to be useful. Aids such as concept maps that give information about the relationship between text units are useful, as are previews that provide information about main points contained in the linked text unit. The number of links also requires consideration: when learners are new to a domain, too many links can detract from understanding.

It's challenging to make generalizations about how the types and structure of information influence struggling and disengaged readers' comprehension of online texts. The components of online contexts are many, and the interaction between factors and individual

differences are many. Readers bring diverse learning styles and preferences to each interaction with digital content. Animations can make a more profound difference with certain content and learners but have less impact on other content and other learners. Audio that accompanies text can be useful but can lose its efficiency when the information is redundant. The amount of information and the means of presenting this information in online contexts can, if not monitored, far exceed the capacities of learners, especially struggling adolescent readers. Content developers need to continually return to the question: What about this added feature or additional information can be expected to support higher levels of engagement and comprehension among struggling and disengaged adolescent readers?

Conclusions

In discussions about the efficacy of online contexts in schools, the first question that often arises is whether students do as well in the online context as they do in conventional school learning contexts. The existing research indicates that the answer is yes. Middle- and high-school students comprehend texts in online contexts significantly better than they do in printed texts. The effect is not as large for struggling readers as it is for their more proficient peers. However, the technique of meta-analysis that is used to draw this conclusion does not evaluate the presence or quality of particular features of projects included in these reviews (Moran et al., 2008; Murphy et al., 2002; Slavin et al., 2008).

Answers to the second focus of this review—regarding which features of online contexts can be used to increase adolescents' involvement in and comprehension of literacy—indicate that particular components of online contexts cannot be ignored in either design or research if the enormous potential of these contexts is to be realized for struggling and disengaged readers. Many aspects of online contexts have yet to be thoroughly investigated, particularly with respect to these readers. Nonetheless, our immersion in the scholarship leaves us with no qualms in stating that there is a sufficient foundation to offer a number of conclusions as to how the comprehension of struggling and disengaged adolescent readers can be facilitated in online contexts. All online contexts are by no means equivalent. To capture the potential that online contexts offer for facilitating the engagement and proficiencies of struggling and disengaged adolescent readers, particular constructs require thoughtful design and execution.

Engagement through Online Contexts

Engagement is the first of these constructs. Adolescents are frequently described as lacking motivation for school learning. The construct of engagement, as outlined by Guthrie (2008), moves motivation away from being an entity that is either present or absent in adolescents to being a feature of learning contexts and the characteristics of those learning tasks. Engagement directs the attention of those responsible for designing and delivering educational experiences to the design of tasks and how their features fit with what interests and energizes adolescents.

Developing expertise is one motivation that drives adolescents. Online contexts have the benefit of representing something in which adolescents are interested and with which they want to develop expertise (Ito et al., 2007). The disconnect between adolescents' online lives outside of school and in school has been described as a digital divide (Lenhart,

Madden, & Hitlin, 2007). What are the characteristics of online contexts that might narrow this digital divide and build on the interest that adolescents have in online contexts?

Online contexts should provide tasks that allow for students to be successful and that relate to a purpose or topic that they see as relevant and interesting. Tasks should be integrated in design, and the connections between different components of tasks should be evident to the learner. Many small, unrelated tasks lessen a sense of mastery and agency. The use of online assessments can ensure that students have texts and tasks at the appropriate level. Having sections of text reread, or getting to change the pace at which text is presented, can support students' learning and contribute to expertise and interest.

Adolescents are also motivated by feeling that they have some say in the tasks they do. Adolescents who believe that successful reading is something that comes from their effort and work, not from an innate ability or the vagaries of the task, are also motivated to sustain involvement in a task, even when it gets difficult.

Online contexts can be designed to allow adolescents the choice of particular tasks or texts to pursue. Self-efficacy can be directly scaffolded through explanations by virtual tutors as well as through self-assessments. Opportunities to view progress, accompanied by reflections on the learning process, can also help struggling readers understand how effort contributes to proficiency.

Another motivator for adolescents is to interact with peers and to feel they are not working in isolation. Seeing, hearing, and responding to others who are talking about their interpretations of the same text or task can lead to deeper understanding.

Online contexts can give students occasions to interact with one another through such features as chat rooms, discussion boards, and reflections on sample work. At least initially, struggling readers need models on how to comment on another student's work. These models can be provided through sample questions or reflection sheets.

Access through Online Contexts

Access is a second construct that can potentially be exploited in online contexts to the benefit of struggling and disengaged adolescent readers. Access means making the content and texts amenable to learners' levels and proficiencies. These features can take the form of an adaptation that gives struggling readers additional information about unfamiliar words, or they can be instructional sequences in which critical strategies are made explicit. The aim of the former is to ensure comprehension of a particular text; the aim of the latter is to ensure that students have strategies that will work for texts in general.

Some of the features that contribute to access have already been described as part of the conclusions related to engagement. When students have access to content and texts, their engagement will be positively influenced. Despite the overlap, we believe that the features of online contexts that ensure struggling readers can participate with grade-level content are sufficiently unique to merit repetition.

When struggling readers use adaptive features such as text-to-speech support and vocabulary definitions or descriptions, they can participate with content that is considerably above their independent reading level. Because struggling readers are often not strategic, they may not use these resources unless required to do so. Providing examples of

successful outcomes or processes is one adaptive feature that is especially easy to provide and that supports higher levels of performance.

The technologies that are currently available, such as virtual tutors, make it possible to move struggling readers from mandatory use of scaffolds such as text-to-speech support to independent use of these scaffolds—in offline and online contexts. Success with virtual tutors has also been established with sophisticated comprehension processes such as summarizing, questioning, and predicting.

Connectedness of Online Contexts

Connectedness of texts and information is the third feature of online contexts that offers promise for enhancing adolescents' engagement and comprehension. The organization of and connections between content can be made explicit to readers in ways that are difficult and unwieldy in printed texts. The forms of information can be varied, and readers can be presented with these forms (i.e., visual, auditory, textual) simultaneously or in quick succession. The factors that can be manipulated in online contexts are many, and particular factors can have differential effects on readers, depending on the individual. However, several generalizations are possible about the effects of connections across texts and of varied forms of information.

Hierarchical or simple networked texts appear to be most effective in supporting the comprehension of struggling readers. Interactive overviews and aids such as concept maps that make the structure of and connections between information visible are also useful. When students are new to a domain, the number of links and units of information can influence their learning. A general guideline is that more is not necessarily better.

Animations appear to be most effective when they accomplish something that cannot be done with static images, such as illustrating processes or strategies that are new or difficult for readers to visualize. Audio that accompanies text can be useful but can lose its efficiency when the information is redundant. Struggling readers benefit from information that is coherently and clearly presented.

We underscore the conclusion that many factors influence learning from texts and that the interaction between factors and learners' capabilities can create a multitude of effects. One critical point to be considered—and which research has not sufficiently considered—is the nature of adjustments necessary to accommodate learners' increasing experience and expertise. When online contexts are successful in increasing the capacity of struggling and disengaged adolescents, courses need to acknowledge and accommodate these changes at different points in the learning cycle.

While there is evidence backing each of the identified scaffolds, not all the evidence is equally strong or well researched. Educators are probably asking what forthcoming evidence will show regarding the efficacy of online scaffolds on adolescent readers' comprehension. We believe that data from the randomized trials that have been claimed as the gold standard in educational research over the past decade (Shavelson & Towne, 2002) are unreasonable in this field. The speed with which new technologies are entering the marketplace, the amount and variety of forms of knowledge that can be accessed digitally, and the myriad of features that are part of online contexts all make quixotic the idea that numerous randomized experiments can be amassed. At the same time, we agree with the necessity for more documentation of the effectiveness of online contexts, including the

three constructs of focus in this review. This documentation begins with scholarship that is embedded in the design, implementation, and evaluation of online educational products. Evaluations that follow the theoretically grounded models in reading education (e.g., Dole & Osborn, 2003) can be used to establish how the constructs of engagement, access, and knowledge organization are represented in current online products. Collaborations are needed among the various stakeholders in the educational system—developers and publishers, state and district assessment and curriculum specialists, and researchers—to evaluate implementations of online programs currently in place.

The disengagement of many American adolescents in school learning is a source of national concern. Online contexts offer an antidote to this learning crisis. Through the capacity to engage students, increase access, and organize content, online contexts offer a means for supporting adolescents in acquiring the literacy proficiencies they need to participate fully in the global community.

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