

Writing, Citing, and Participatory Media: Wikis as Learning Environments in the High School Classroom

IJLM

Andrea Forte
Drexel University
aforte@drexel.edu

Amy Bruckman
Georgia Institute of Technology
asb@cc.gatech.edu

Keywords

wikis
secondary education
collaboration
information literacy
science education

 Visit IJLM.net

doi:10.1162/ijlm_a_00033

© 2010 Massachusetts Institute of Technology
Published under [Creative Commons Attribution-Noncommercial-No
Derivative Works 3.0 Unported license](#)

Volume 1, Number 4

Abstract

In this article we use the rhetorical notion of *genre* as an analytic lens for studying the use and impact of new media in schools. Genre pervades the scholastic life of students as they become adept practitioners of written performances. Our empirical studies investigate how creation and consumption of media are linked as high school students produce a public information resource in their science classes using a specially designed wiki. We found that, although institutional assessment regimes for both students and teachers inhibited collaboration and although the wiki tools were appropriated as single-author environments, the wiki, because it is an open, transparent medium, supported students in building a shared understanding of genre as they struggled with an unfamiliar rhetorical situation. As we describe the process by which students made sense of an assignment that served purposes beyond test preparation and classroom assessment, we also demonstrate how writing on a public wiki was a particularly useful writing experience that brought about opportunities for reflection and learning. These opportunities include transforming the value of citation, creating a need to engage deeply with content, and providing both a need and a foundation for assessing information resources.

Introduction

The idea of collaboration inspires people; it is, after all, a poetic concept: together, many prosper jointly where the individual may falter alone. Computer-supported forms of collaboration have long inspired researchers and educators, but in the past several years popular interest in online collaboration has bloomed with the proliferation of social software. In particular, wiki software has become a well-known and increasingly well-used tool for collaboration.

“Edit this page” is the ubiquitous invitation to collaborate that defines wiki software. Wikis were conceived in the mid-1990s as a tool for fast collaborative authoring (Leuf and Cunningham 2001) and have given rise to countless collaborations since then, including *Wikipedia*, which, for many, has come to represent an ideal example of collaboration online. Still, no one has to collaborate on a wiki. Researchers have observed that when norms within an organization are not aligned with collaboration, new collaborative media may be adopted in ways that mimic the old ways of doing things or simply may not be adopted at all (Orlikowski 1992; Grudin 1994; Guzdial et al. 2002).

In a study of wiki adoption in an American high school, we likewise found that even when wiki was enthusiastically adopted, collaborative uses of the tool quickly died (Forte and Bruckman 2007). Others have also observed similar phenomena in secondary education (Grant 2009). In this article, we describe findings that suggest wikis’ unique affordances (i.e., those properties that users can easily discover) can nonetheless play an important role in supporting groups of authors. Although students did not collaborate like Wikipedians, they found ways to use the affordances of the wiki as an open, transparent publishing medium to build shared understandings of genre as they struggled with an unfamiliar rhetorical situation. Wiki supports groups of authors not only by allowing for the collaborative production of text but also by allowing individual authors to “see into” the processes of their peers and develop shared practices. We also found that the transformed genre made for a particularly useful writing experience that brought about opportunities for reflection and learning.

Over the course of three years, we conducted studies in classrooms to develop new wiki tools that support student writing in high school science classes. We started out with existing technology and—guided

by a pilot study, teacher interviews, and usability testing—created new wiki tools to support academic writing practices and teachers’ needs. We launched the site *Science Online* in fall 2006 and conducted an initial study during the 2006–2007 school year and a follow-up in 2007–2008.¹ In this article, we briefly describe the design process and wiki modifications, then present findings from our studies that explore how students’ experiences with wiki tools in the classroom led them to reexamine their ideas about school writing and to engage with science content in new ways. In these studies we addressed the questions:

- How do students write and reason about information when constructing an information resource for others?
- What role does the wiki medium play in shaping their writing and information-related practices?

Genre and Schooling

Education is frequently described as enculturation—becoming able to act skillfully within a community of practice and contribute to its goals. Many ideas about how people learn focus on sustaining and reproducing the valued (and valuable) practices of communities in the next generation of their membership. From midwives, tailors, and quartermasters (Lave and Wenger 1991), to would-be scientists, engineers, and mathematicians (Scardamalia and Bereiter 1996b; Kolodner, Gray, and Fasse 2003; Renninger et al. 2004), to historians and journalists (Hatfield and Shaffer 2006; Wiley and Voss 1996), the literature on human learning is full of examples of encouraging learners to “think like a,” “act like a,” or “see themselves as a.”

This ground is theoretically well trodden. Legitimate peripheral participation provides a way of thinking about the kinds of activities that learners might engage in to become central members of a community of practice (Lave and Wenger 1991). Cognitive apprenticeship appropriates the apprenticeship model of learning for cognitive activities and examines the ways that teachers can model and coach students as they adopt expert ways of thinking as well as doing (Collins et al. 1989). Schaffer and Resnick’s (1999) thick authenticity includes disciplinary authenticity as a desirable feature of learning activities, meaning that learning activities ideally involve tools, strategies, and outcomes that are characteristic of the

discipline being learned. Theorizing about processes of enculturation and how to use these processes to bring about desirable learning outcomes in formal education has come a long way and has yielded useful yardsticks for the design of new educational environments. This article breaks from the tradition of examining processes of enculturation and instead focuses on how the introduction of a new technology caused a disruption in practice that created opportunities for learning.

Genre is one way that community practices become reified and recognized and are sustained as membership changes over time. The study of genre has a long and nuanced history. In this analysis, we adopt the post-structuralist view that genre cannot be understood apart from the situations in which texts are produced. Genre describes both form and communicative purpose; it describes not only the form of the written artifact itself—"novel," "syllabus," "business memo"—but also the demands of a particular rhetorical situation. Genres are kinds of texts, but, furthermore, they are kinds of social actions within a particular community (Miller 1984; Flower 1994).

As it becomes a stable and identifiable feature of a discourse community, a genre becomes a tool that members use to shape their participation. In his examination of the experimental report in science, Bazerman observes that "writers find in existing models the solution to the recurring rhetorical problems of writing science. As these solutions become familiar, accepted, and molded through repeated use, they gain institutional force. Thus though genre emerges out of contexts, it becomes part of the context for future works" (Bazerman 1988, p. 8). Bazerman argues that the adoption of a genre by an individual scientist is a critical appropriation, that genre is always interpreted and used in a particular situation by a particular individual. Still, as social constructs, genres imply consistency, mutual intelligibility, and evaluative standards. By structuring discourse, the genre of the experimental report, for example, both frees scientists from some of the rhetorical burden implied in the communication of experimental findings and also becomes a powerful constraint by establishing rhetorical expectations that can be satisfied only by engaging in certain practices. In other words, although scientific reports are literature that distill, simplify, and at times even misrepresent the activity of the laboratory (Knorr-Cetina 1981), certain practices of the scientific trade are embedded within the genre. Thus the genre becomes a powerful instrument of stability within the scientific community.

From this perspective, it would make sense that students should become adept at producing specific genres in order to practice participating in the disciplinary discourse communities they will someday join. Although school genres are never quite like the genres of the professional world, in the best case they serve as a jumping-off point—a place to practice (Barab, Duffy, and Land 2000). Russell describes the role of school genres as a kind of mediator between the activity system of school and the activity systems of the professional world. He observes that the classroom genre exists at the boundary of these systems and repurposes professional genres to serve pedagogical ends (Russell 1997). By participating in the production of professional-like genres in a school environment, learners can begin to orient themselves toward (or, as Russell points out, away from) the practices of a professional community.

Several innovative projects have reproduced the rhetorical situations of a particular profession to create a bridge between educational writing contexts and disciplinary modes of thinking and communicating. These projects often include the design of innovative new media. Hatfield and Shaffer's *Science.net*, for example, builds on the idea of "epistemic frames," or ways of knowing and thinking (Shaffer 2006), to create an environment where students learn to think and write like a science journalist (Hatfield and Shaffer 2006).² *Science.net* uses special software designed to introduce learners to journalistic writing by including structural cues in the form of markup tags like `lead{}`, `body{}`, and `jump_line{}`. The software used on the *Science.net* site encourages students to engage with science content by structuring their writing experiences around two important elements of journalistic writing: *writing to formula* and *writing as a watchdog*. Explain Hatfield and Shaffer, students in the class that used the site "engaged in the practice of writing to formula, which involves developing journalistic skills and knowledge such as writing story leads and using inverted pyramid story models. These profession-specific writing structures are part of the highly formulaic writing that differentiates journalistic writing from other genres" (Hatfield and Shaffer 2006, p. 237). In this case, the writing technology was intended to help learners think like a journalist.

Scardamalia and Bereiter's Knowledge Forum (and its predecessor, the Computer Supported Intentional Learning Environment, or CSILE) is similarly designed

to support modes of discourse among learners that resemble those of scientists. The “knowledge building” discourse of science provides the model for an innovative way of thinking about formal education and the design of classroom activities and software. Scardamalia and Bereiter’s goal was to encourage learners to take responsibility for examining and furthering the knowledge of their class, much like scientists do (Scardamalia and Bereiter 1996a). Knowledge Forum is a discussion forum that structures students’ discourse in part by asking them to reflect upon and label their contributions with labels such as “my theory,” “I need to understand,” and “a better theory.” When a student creates a note that she believes makes a particularly sound contribution to the knowledge of the class, she can submit it for review, and, if published, it becomes marked as such in the software. By creating learning contexts in which students work toward publishable notes, knowledge-building activities on Knowledge Forum approximate the rhetorical contexts in which scientists create and communicate about new knowledge. Knowledge Forum notes do not look much like scientific publications in form, but they satisfy a similar social purpose and allow students to perform similar social actions through writing. Scardamalia and Bereiter recognize that simply reproducing scientific genres like lab reports is not sufficient to bring about scientific thinking: “[I]t is not likely that imitation of surface forms can produce the radical restructuring necessary to turn schools into real knowledge-building communities” (Scardamalia and Bereiter 1996a). Instead, they try to create a set of rhetorical demands and social supports to get students thinking like scientists.

Although genres and the situations in which they are produced are sometimes simplified or replicated for pedagogical purposes, genres are not straightforward recipes for successful communication. Genres change. People are agents who bring with them motives and interpretations that affect their appropriation of genre as a tool for structuring interactions. Miller explores how genre facilitates social action and connects individual agency with cultural convention (Miller 1984). She explains that although they represent recurrent rhetorical situations and patterns of language use, genres are not permanent immutable features of discourse but evolve and are adapted to new circumstances. A constant dialogic interplay exists between the microlevel at which individuals and groups produce texts and the macrolevel at which genres represent

the structure of social discourse. For Russell (1997), this is a reason to educate young people not only to reproduce genre forms but to enact genre reflectively and critically. With education, genre can become a tool through which students can assert themselves. Bazerman, too, notes that schools should not think in terms of “simple genres that must be slavishly followed, that we must give students an appropriate set of cookie cutters for their anticipated careers, but rather that the student must understand and rethink the rhetorical choices embedded in each generic habit to master the genre” (Bazerman 1988, p. 8).

Genres change over time because people experience new kinds of rhetorical needs. When and how genres change is a question with implications for studying genre in education. Bolter and Grusin (2000) examine how meaning is communicated differently when messages from one media are repurposed and represented in another. They articulate this process as *remediation*. Orlikowski and Yates (1994) have used the notion of *genre repertoire* to examine how communicative practices change over time in organizations and how individuals repurpose genres as new situations create new rhetorical demands. We position new media as a transformative element in schools. The affordances of the wiki and the tools we designed played an important role in supporting students as they adapted the research paper genre, so we explored the design of the wiki environment as an integral part of their writing experience. If breaking from communicative conventions is difficult, then what kind of work is it? What kind of opportunities for learning does it afford? What role does the medium of communication play? Our research project examined the use of wiki in formal educational contexts, and our findings demonstrate how creating a public venue for student writing created important learning opportunities and how the wiki medium supported learning by making visible not only students’ work but also features of their writing process.

Science Online

In recent years, literature has emerged that depicts youth as prolific creators of online content (Jenkins 2006; Lenhart et al. 2007). The impact of social media on young people’s public lives has drawn a lot of attention. Yet, excitement about opportunity and anxiety about dangers have outpaced rigorous examination of how young people contribute to and learn

from their experiences with participatory media such as wikis, blogs, and social network sites. In 2005, we began a project to address this need for research by investigating how wiki publishing experiences could support science learning in American high schools. The focus on wikis was inspired by our earlier studies of *Wikipedia* in which *Wikipedia* editors reported having powerful learning experiences and a high motivation to write.

Our design goals were to build a wiki that supports academic writing practices like citation and that also fits into a classroom setting by integrating with teachers' practices. We began by conducting a pilot study with an existing wiki in an undergraduate American government class and reviewing the literature on wikis in education. The study yielded several design guidelines for wiki tools in the classroom, including features that allow students to easily save and format references and automatically link references to the pages that cite them, as well as allow both students and teachers to easily find their work and the work of other students and to identify students in the class (Forte and Bruckman 2006).

Our first design goal was to build scaffolds for citation in a wiki environment. We chose to use the open-source MediaWiki software, the software *Wikipedia* is built on. MediaWiki saves references in the text of a page. All the relevant information (author, title, etc.) is entered using a special syntax in a reference tag in the wiki text, which is rendered as a footnote when the text is saved. References in *MediaWiki* are essentially text decorations at the end of the article. They are not shared in a bibliographic repository, nor are they linked across articles. Because we wanted to support explicit, critical reflection on information sources and because citation plays a central role in the social construction of knowledge in the sciences, we wanted to embed critical citation practices in the design of the wiki authoring environment. Our ReferenceTools extension elevates references to first-class objects in the system. The design of ReferenceTools was guided by examining features of commercial academic bibliographic tools and refined in consultation with a local high school science teacher. Usability tests were conducted to further improve user experience before in situ field observations began.

ReferenceTools allows students to enter their information sources as they edit a wiki page. An "insert reference" button calls a separate data entry window where the relevant citation data can be entered into

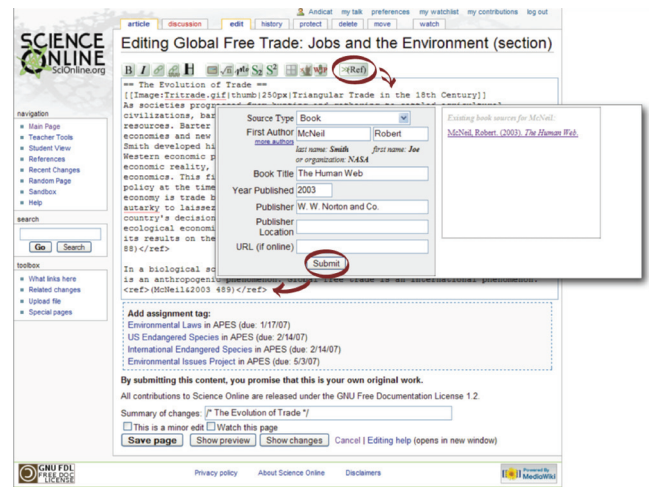


Figure 1 Using the ReferenceTools MediaWiki extension to insert a reference.

a form. (See figure 1.) When the student saves the reference (or selects an existing reference), a special reference tag is added to the wiki text. Upon saving, the tag is rendered as an in-text parenthetical reference, and a list of works cited appears at the bottom of the page. References are saved in the database. Thus, although each citation is initially associated with a specific article, the bibliography is shared across the wiki, so each information source need only be entered once and can be used to support multiple articles. If the reference tag is removed from all articles, the reference itself persists and can still be used. When a reference is entered into the database, a wiki page is automatically generated for that reference where its contents can be discussed or summarized. The reference page allows users to modify the reference information, see a history of all modifications, and revert changes if necessary. The reference page also provides a reverse citation index; that is, it lists all articles where the reference is currently cited.

In addition to ReferenceTools, we also created extensions to support classroom use: TeacherTools and StudentView. In our pilot study, we found that one of the aggravations associated with using wikis to support classroom work was information sprawl and a resulting inability of teachers and students to find one another's work and understand who had done what. The TeacherTools extension provides teachers with a central place to manage their classes, students, and assignments. StudentView provides essentially the same functionality for students—it automatically groups together pages that describe their assignments

in one place, and lists their classmates so that they can contact one another easily.

Protecting students' identities was also important. One of the goals of *Science Online* is to give students a chance to write for a real audience; however, because students were compelled to write on the site for a grade, we did not wish to coerce students into publishing under their real names—once something is online, there is no getting it back. On the *Science Online* wiki, students publish under pseudonyms. We modified MediaWiki to support group permissions organized around classes: real names are revealed only to students' teachers and other students in their classes.

The Studies

By inviting local science classes to write on *Science Online*, we set out to understand how the experience of participatory media can be used for educational ends. How do students make sense of and learn from creating public artifacts that have value beyond the classroom? What was their process for constructing wiki articles, and what kind of engagement with science content did this process afford? Furthermore, we wanted to understand not only how students constructed wiki articles, but also how they found, assessed, and used information sources to inform their compositions. Creating a public information resource is a not only a matter of writing down what one knows but of remixing information and making decisions about what information to include and how to represent relationships with other information sources.

Study Sites and Participants

We conducted studies at two high schools over the course of two school years. The first study lasted eight months, involved 19 Advanced Placement environmental science students, and was conducted during the 2006–2007 school year at Rosedale High, a highly ranked suburban public high school. The second study lasted 11 weeks, involved 14 honors biochemistry students, and was conducted during the 2007–2008 school year at Underwood Academy, a private suburban high school.³ In both studies, the students were juniors and seniors, ages 16–18. The teachers in both schools were scientists. The private school teacher held a PhD, and the public school teacher had completed all but his dissertation. The teachers,

in close cooperation with the researchers, were the primary developers of the wiki writing activities.

Methods

In both studies, we used a combination of qualitative data collection methods. Interviews and classroom observation sessions captured students' information seeking and composition processes as well as their explanations of what they were doing and why. In the first study, a researcher was present in the classroom for 47 days of the school year. In the second, shorter study, students were not given time in class to work on wiki writing assignments, so observations were conducted on only six days, when the wiki assignments were introduced or mentioned. We also periodically interviewed the teachers to understand their experiences of the wiki and the kind of one-on-one instruction they were providing for students.

Capturing students' processes for completing homework assignments is difficult. School writing happens at different times and in different places—at home, at the library, in the classroom, and in any other place where students have access to a computer. Some students wrote sections by hand and then typed them up. Researchers were seldom present to observe what students did as they completed their homework assignments. Wikis partly mitigate this problem by providing a log of all editing activity on the site; however, as we found in pilot work, comparisons between wiki editing history and students' explanations of their process for revising their work revealed that the editing history was insufficient for understanding the process (Forte and Bruckman 2006). An edit history reveals little about what the editor was thinking. Furthermore, many students extensively revised offline before making changes on the wiki. To address these challenges, we devised a strategy of using a three-phased approach to interviewing. At the beginning of interviews, students typically led the conversation by responding to broad prompts such as "Tell me about school" and "What kinds of things do you use the computer for?" This relatively unstructured approach led to a range of topics being covered. Once the researcher had a sense of the students' personality, likes, and dislikes, she turned to a semistructured approach and used a topic guide to ensure that certain data points were obtained from each student about Internet use, writing, and the class. Interviews also had a more structured segment during which students

reconstructed their writing activities. Together with the researcher, the interviewee reviewed the work he had recently done on the wiki and verbally reconstructed his process. For search activities, students reenacted their searches and explained how they found sources and how they decided what to use.

Students completed pre- and posttests designed to help us understand the kinds of strategies they used to assess information sources. These tests involved document-based questions. Students were given four documents from different kinds of sources and asked to use these to support their response to a direction such as, “Read the following documents; then explain the relationship between power lines and childhood cancers such as leukemia. Justify your explanations using the readings.” They were then asked in interviews to reconstruct their strategies for using the documents to answer pre- and posttest questions.

We used grounded theory as described by Strauss and Corbin (Glaser and Strauss 1967; Strauss and Corbin 1998) to develop explanations of students’ writing practices based primarily on interview data and supported by our classroom observations. Grounded theory is an inductive approach to understanding a phenomenon in which researchers use iterative rounds of data collection and coding in order to work from empirical data to construct theoretical explanations of the phenomenon under investigation. This is an appropriate method for building a description of process that is grounded in actual practice. We chose this approach because we set out to understand from the students’ perspective how they make sense of participatory media in formal classroom environments and where their processes for constructing media afford opportunities for learning. The theory-building process consists of two phases. The first, open coding, involves closely examining all the data, often multiple times, in order to identify salient concepts. The second phase, axial coding, involves revisiting each identified concept and examining the relationships between them to create explanations and to identify one or two core concepts that provide the foundation for theory building.

In open coding of data from the first eight-month study, we were able to identify a variety of strategies that students used for assessing information sources and for organizing their writing. Axial coding proved difficult, however. Because the data were relatively sparse, finding patterns or connections between these strategies was difficult. Many students resisted

scheduling interviews, which had to be done during their lunch hour or before or after school. In the first iteration, we conducted 21 interviews with 15 of the 19 participating students. These interviews were spaced out over the eight-month study. In order to collect denser process data in the second study, we targeted one writing project as a context for data collection. The project lasted 11 weeks. Most of the 14 participants were interviewed three times during the assignment, yielding 36 interviews.

Findings: Transforming the Research Paper Genre with Wikis

The second high school study took place during spring semester 2008. We had been in contact with the teacher, Dr. Baker, for two years and met with her on several occasions to discuss wiki writing assignments. She informed her students early in the year that they would be doing a final research project on the biochemistry of human diseases. She told them that they would be doing the projects on a website and that a researcher would be visiting the class. The students seemed to have the impression that we would study the quality of their writing rather than their process. On the days *Science Online* and their assignment were introduced, one of the authors was present. When the website was demonstrated, the class responded with excitement. One student commented, “So this is like a science *Wikipedia*?” Another student asked whether the project was like “papers for the 21st century.” One of the students asked the researcher if she was researching whether they write better online than off.

The students in general appeared enthusiastic and excited about the online writing assignment and seemed to anticipate what it meant to write on a wiki. However, in interviews, it became apparent that when they approached the task this new context for researching and writing about science created confusion. The students recognized that writing for the wiki had a different purpose than a traditional paper and weren’t sure what the results of their efforts should look like.

I was like, “Mom. I’m getting something published on the Web!” I was really excited. I didn’t know it was going to be like this though. I didn’t know it was going to be a webpage. I thought we were going to write like a research paper . . . [but] it’s not really going to be like

a paper, it's just going to be like—I don't even know how to describe it. It's like a paper but not a formal paper. 'Cause we're doing research and everything, it's just not.—*Becca*

I think it's really interesting that it's like [*Wikipedia*], it's really cool. I like it a lot and like, instead of writing a regular paper, that's what it's for and I think I like this better than just sitting down and writing a regular paper. . . . I'm a little confused because originally it was a research paper and now it's online.—*Erin*

I actually thought we were going to, like, be writing a paper. . . . I have no idea where we are going with this. I think we are just making a web site for other people to use. . . . I like that a lot better than actually having to sit down and write a research paper that has to be so-and-so amount of paragraphs, so-and-so amount of words. This is kind of, like, you can get your point across and you can do it in the way you want to do it.—*Jamie*

It's kind of almost like writing a paper.—*Jana*

When I normally do a paper, it is just like only my teacher is going to see it, and if I let my mom proofread or my dad or something like that. It's like a more intense form of a paper.—*Lisa*

Although the teacher framed the writing assignment as a traditional research paper and instructed the students as she normally would for a research paper assignment, these students felt that the familiar scholastic genre “research paper” did not satisfy the rhetorical demands of writing a publicly accessible article about a science topic on a wiki. When the “research paper” went online, it became somehow different. The form and communicative purpose had changed; it was no longer a genre that they were skillful in producing. So how did they proceed? As we coded interview data to understand the process students used to write their wiki articles, we found that they attended to two distinct communicative goals as they assembled their understanding of what kind of written artifact they ought to produce:

- Meet assessment criteria (doing school).
- Provide a public resource (publishing).

Over the course of the two-and-a-half-month assignment, the students moved between these goals as they progressed in the construction of their wiki pages. The two communicative purposes are not separate ways that students engaged with the task of writing a science article. Rather, they represent two rhetorical situations in which students needed to act simultaneously. Each of these goals alone implies the production of different genres in terms of both form and communicative purpose, and students used different rhetorical strategies to inform different phases of their writing as they moved between the two goals. Still, in the end, the students' writing efforts yielded a single written artifact, not two. They reconstructed the genre of “research paper” in a way that satisfied the new rhetorical demands that were imposed by the public nature of the assignment.

To examine in detail how students reconstructed the genre and to understand where learning opportunities are situated in this process, we broke research and writing into three sets of tasks: *finding*, *crafting*, and *sourcing content*. Students moved between these iteratively, not sequentially, and used different strategies as they switched among tasks and goals and as they gained expertise about their topics (see figure 2). The three kinds of tasks are interdependent; they inform one another. See Table 1 for high-level strategies for each goal and each set of tasks.

Meeting Assessment Criteria

Writing assignments are often an assessment vehicle; students not only learn about something but also demonstrate what they know by writing about it. The students in these studies were doing schoolwork. They were assigned the task of writing a science article about a disease and found themselves in the familiar rhetorical situation of producing a text that would be used by their teacher to assess their learning. Students not only

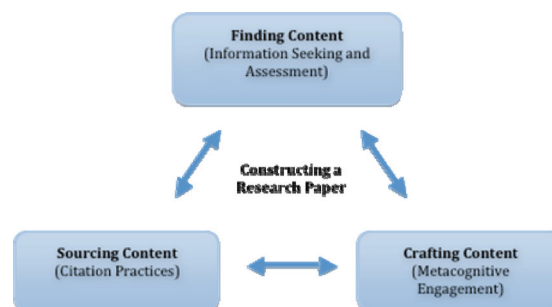


Figure 2 Constructing a research paper.

Table 1. Student Strategies for Meeting Two Distinct Communicative Goals

	Goal 1: Meet Assessment Criteria	Goal 2: Provide a Public Resource
To craft content, students	<ul style="list-style-type: none"> Followed teachers' directions. Looked at other students' work. Applied conventions from other classes. Sought feedback from teacher/authority figures. 	<ul style="list-style-type: none"> Simplified scientific language they found in journal articles. Invoked a lay audience; i.e., imagined younger or less educated readers. Used existing online sources as a model. Reflected on own experiences as a reader.
To find content, students	<ul style="list-style-type: none"> Followed teachers' directions. Applied conventions from other classes. Invoked the teacher as audience. 	<ul style="list-style-type: none"> Used "regular" search habits—i.e., Google
To source content, students	<ul style="list-style-type: none"> Looked at other students' work. Applied conventions from other classes. Sought feedback from teacher/authority figures. 	<ul style="list-style-type: none"> Used the same strategies as for Goal 1 but explained that these strategies had different purposes; namely to <ul style="list-style-type: none"> Ensure credibility of their work. Defer responsibility for wrong information.

used explicit directions from their teacher but also imported experiences of writing in scholastic genres from other classes to decide how to meet assessment criteria. To understand how to write this assignment successfully, they both followed directions and used their understanding of how writing assignments serve an assessment function in the system of schooling in which they were required to act.

Many of the students' decisions about how to proceed in their research and writing were guided by their perceptions of what the teacher wanted. Yet, when they were directly asked in interviews throughout the project, none of the students reported that they understood what grading criteria their teacher would use:

It's been difficult, not horrible, because we don't really know exactly what our requirements are. We're kind of just given, you know, a rough sense of what we need to do.—*Jana*

She hasn't done like, you need to have your introduction done, you need to have like an outline handed in. Like every other research paper I've had to write, that's what it's been like and this has not been like that at all.—*Becca*

The one thing I don't like about the way we've had this set up is that I don't feel like I have a really good grasp of what the whole thing's going to look like when it's all done. . . .

So, you know, it's hard to figure out how to do it.—*Jamie*

I don't really know. She hasn't given us a rubric or anything yet. I'm not sure.—*April*

We haven't even seen a rubric . . . so I don't know if it's based on the actual English part of it and how well we defend our topic or if it's just—I don't know. To be honest with you, I don't know.—*Jerry*

This perception of openness meant that students had to find indirect ways to define the rhetorical constraints associated with meeting assessment criteria for the assignment. The strategies that we identified in the interview data are applying conventions from other classes, invoking the teacher, calibrating with other students' work, and seeking feedback.

Although the students reported that the assignment was unstructured, Dr. Baker gave them explicit procedural and structural guidance. First, on the day that *Science Online* was introduced, she explained what a primary resource is and how science publication works. She also gave explicit instructions on how to find peer-reviewed journal articles on indexes like PubMed, a digital library run by the U.S. National Library of Medicine, and Galileo, the state virtual library. Second, while demonstrating for the students how to edit the wiki, Dr. Baker made up a sample outline for an article. Many students referred to her outline as they began the task of organizing their articles. Finally, she structured their writing process by

imposing three due dates: early on they were required to choose a disease topic and post a draft outline as well as one relevant peer-reviewed source; about half-way through they were required to post an image of a relevant protein and write a draft of the section on the biochemistry of the disease; the final due date included instructions to cite three peer-reviewed journal sources and five websites. Individual students also sought feedback from Dr. Baker as the assignment progressed and received explicit directions in one-on-one sessions.

Providing a Public Resource

Because their writing also functioned as a contribution to an online information resource, the students found themselves needing to act in another kind of rhetorical situation: informing an unknown readership. In our 2005 pilot study, students either did not understand or did not buy into the idea that their work would be viewed by the public—even though they were editing a public wiki (Forte and Bruckman 2006). In this study, students accepted that their work would be available for the public to see and use. In interviews, some expressed apprehension about the idea that their work was available for the world, whereas others were excited by the idea.

It's like "oh my gosh, I have a huge responsibility now" even if nobody actually uses this. It's still there, somebody *could* use it so everything has to be exactly right and I want to put as much information on here as possible.—*Reagan*

I don't know if I would do something like this without having an assignment for it.

INT: So explain what you mean by that.

I just mean, I wouldn't—like I don't think I see myself as a blogger or someone who puts up stuff on the Internet.

INT: Why not?

I don't know. It's just weird to put your stuff so like everyone can see it. Like everyone in the world can see it. It's just weird. I guess some people are like, yeah, I want everyone to notice me, but I'm like, ummmm.—*Diane*

I think it's so cool! . . . I think it's great! 'Cause it's just like *Wikipedia* except *you* can do it. So I think it's really good.—*Julia*

I'm not going to lie. I'm sure I'll never know this but if I find out like someone uses my information, like some little kid for their research? I'm going to be like, yeah, that was me! I did that research! But I'm sure I would like never be able to know if someone actually used it.—*Becca*

Like, I'm the person that hates to be on stage and stuff like that. I don't like any kind of attention. But for this I don't care if someone looks at my work.

INT: You don't care if someone looks at your work or you don't think they are?

Well, I'm sure someone probably has and I don't know, but I really, to me it wouldn't matter. As long as I don't make a fool of myself.—*Hans*

I kind of like writing it online, but it is kind of weird, because I have never done anything like that before. It is kind of weird just thinking that other people are going to see this, possibly. That is so weird to me.—*Lisa*

All of the students seemed aware that their work was public and described writing strategies that indicated they were reflecting on their readership and how best to inform them. The writing strategies we identified in the interview data include invoking an audience, simplifying scientific language, and using existing resources as a model.

Balancing These Goals in Practice

Because they needed to produce one text, students had to balance the two rhetorical goals that they experienced, *meeting assessment criteria* and *providing a public resource*, as they composed their wiki articles. How did this translate into concrete strategies for writing? How did the students figure out what to do when they were not sure what it meant to write a research paper to inform the public?

Finding Content (Information Seeking)

Students had more than one way of thinking about information and where to find it. We found that they changed their tactics many times even within a seemingly single context such as completing a homework assignment. They used different strategies depending on their level of knowledge about the topic, what

goals they were attending to, and where they were in the assignment, all of which changed fluidly throughout the study. This finding is consistent with literature on information seeking that underscores the iterative nature of information seeking as a process (Wallace et al. 2000; Rieh 2005).

All of the students described doing general searches on Google as they began learning about their topic. Early in the process, many students described using resources such as *Wikipedia*, Mayo Clinic, and other websites to inform themselves, get background information, and formulate better search queries. These findings confirmed data from our first study and other literature that suggest students refine their search process iteratively. Their criteria for identifying good early sources from which to learn tended to revolve around accessibility, whether the source had helpful information, and whether it “looked professional.”

First I started on just a basic Google search.

INT: Can you show me literally what you did and talk through?

I started just researching protein-based diseases and from there they gave a list of like, Alzheimer’s and stuff like that and some of those were already taken by other students. And so that’s how I found [this disease] and then I went to the evil *Wikipedia*. . . . So first I did *Wikipedia*, then I tried to kind of get away from that.—*Jana*

Oh. I went to Google first, Google’s my bread and butter. So I just did Google—I probably spelled [it] wrong the first time I did it . . . {looks at search results} *Wikipedia’s* number two so I was golden.

INT: So why do you use *Wikipedia*?

’Cause it’s so user friendly. I mean, I love this little box here. Like little outline format so I can jump right to it. . . . And then I think after I did this, got some kind of idea, realized that it wasn’t always as severe as [it’s portrayed in the movies], I went back and I think I searched for the involved enzymes.—*Hans*

I went online like next, like that night or something and found like the background information on it.

INT: So how did you do that?

I just went to Google.

INT: Can you show me what you would do?

Alright yeah . . . {searches on Google and clicks on *Wikipedia*} This is where I read about it before I actually was like, that’s what I’m going to do.

INT: Ok so how did you decide to choose that link? How did you decide to click on that?

’Cause *Wikipedia* is like something I’ve been using since freshman year, and it’s the first link. . . . People, when they hear “research paper” they immediately go to Google and *Wikipedia*.—*Becca*

Google. I always go to Google first; it’s like my best friend. And then I would just type in [the disease name]. Just to find general sites. And the first one I saw was this one, and it seems really professional.

INT: This one?

Yeah. . . . I went to this one and I went to *Wikipedia*. For secondary sources, I love *Wikipedia* also. {Clicks on *Wikipedia*} Yeah I went to this one. They just give you like a good definition. A good foundation for it.—*Kimberly*

Conflict around *Wikipedia* arose recurrently as students described their information-seeking efforts. *Wikipedia* holds a central place in these students’ general information-seeking habits, and they likened *Science Online* to a “science *Wikipedia*,” which made it a natural place to look for information. However, they had received mixed messages from teachers about the appropriateness of using *Wikipedia* in school. Some students described being told not to use *Wikipedia* at all, some described being told it was fine, and still others were advised to use it only in conjunction with other sources. Three of the 14 students in the second study avoided *Wikipedia* altogether, and most of the others indicated that they used it despite the fact that it is taboo. This confusion is consistent with findings from our first study iteration, in which students also frequently turned to *Wikipedia* but had poor understandings of how it works (Forte and Bruckman 2008). Some students suggested that they

would not or should not “use” *Wikipedia*, but when they described their actual actions it was frequently one of the first places they went to begin reading about the topic.

INT: {looking at search results} Ok, so you’re looking at your results. What do you [click on]?

Ok well, probably not *Wikipedia*. Well, sometimes *Wikipedia*’s good, but sometimes it isn’t.

INT: So can you explain why you would or wouldn’t?

’Cause *Wikipedia*, anyone can edit it, so you don’t necessarily know if it’s good or not, but it can be helpful if you’re starting off. Just to look at like—this has categories and just talks about it.

INT: So did you look at *Wikipedia*?

I did. Yeah, I looked at it at first.—*Diane*

INT: Can you show me [what you did to search]?

Yeah. {whispers to interviewer} I looked on *Wikipedia*.

INT: {laughs, whispers into the recorder} She looked on *Wikipedia*.

Apparently we are not allowed to. {looks at the *Wikipedia* article} So wow, look at this. This is what it is. Symptoms, lots to write about there. Diagnosis. Pathology. And then this stuff that I don’t really want to know about. Therapy.

INT: Ok, so you are acting like you shouldn’t have looked at *Wikipedia*.

I think we’re not allowed to. . . . I mean even my previous school teachers would be like don’t use *Wikipedia* to search science.—*Julia*

I started yesterday looking for the primary protein that’s involved in like causing, and it’s like, Gluten, G L U T I N [*sic*], I guess that is how you pronounce it. So I typed it on *Wikipedia*. . . . In English or in history or in papers like that I never use—or I never can cite *Wikipedia*—we are not allowed to do it. However, I do use *Wikipedia* for my own knowledge, like

even if I can’t use it in my work cited I am still going to read it.—*Jerry*

{looking at search results} I skipped *Wikipedia* because usually teachers tell you not to use *Wikipedia* as like a source. Typically if I’m just like interested about something, that’s where I’ll go ’cause it has like everything, but they always tell you to like steer clear of *Wikipedia* for things.

INT: So you said that most teachers don’t want you to use *Wikipedia* as a resource. Did you look at *Wikipedia* at all?

I actually didn’t, because there was so much other stuff on there about it, but you know, if I was looking for something more complicated or they didn’t have anything or if I wasn’t trying to do it for a research paper. If it was just for, you know, doing my homework and I don’t know what something is or what something means or what they’re talking about, and you’re not going to quote or cite or anything like that, you just want to know, that’s where I would go.—*Jamie*

Teachers kind of discourage us from using *Wikipedia*. So I don’t really use it unless I have to look for something really basic, if I’m like starting on a whole new topic and I just want to get like the basic overview, then I’ll use *Wikipedia* for that.—*April*

I use *Wikipedia* all the time. You know, they tell you we’re not supposed to use it technically because, like, Underwood says it’s not a very good source ’cause anyone can get on there. But for quick things, it’s really good.—*Erin*

Although students started by looking up information, information seeking was not just a first step. Students searched for information again and again throughout the assignment, and their strategies and criteria were tied to the rhetorical goals that would be met by writing and citation tasks. For example, students invoked unknown audiences to help them write for the purpose of providing a resource. This affected the kind of information-seeking strategies they adopted. If students wanted to write in a way that was compelling and understandable to the general public, they needed information sources that provided them with compelling and understandable material from which to write. Likewise,

if they wanted to write from sources that would meet the requirement of using peer-reviewed journals, they needed to find sources that met these criteria. As the assignment progressed, we saw that students used different strategies to meet these needs. The changing goals help explain the inconsistency we saw when students claimed they do not use *Wikipedia*, yet demonstrated that they use it all the time. Using *Wikipedia* to learn and hone one's ability to search and using it as a citation are two different tasks associated with two different goals.

Once students had an idea of what they needed to know, they switched to the websites PubMed and Galileo as instructed by their teacher to inform the writing of the biochemistry sections of their wiki pages and to obtain the necessary peer-reviewed sources. In the second round of interviews, students were in the middle of writing the biochemistry sections of their pages and tended to talk about finding primary or peer-reviewed sources from which to draw material. They described how they supplemented their use of peer-reviewed sources with websites and other sources. If they couldn't find what they needed, or did not understand something, they returned to the "regular" Internet to fill knowledge gaps.

I went through the PubMed thing, and a lot of them that said it had something on it, I either couldn't open it for some reason or when I went to Galileo they didn't have it. So then I just went to the regular Internet and did some research there. That's where I found the information about like mutations and what amino acids are switched and things like that.—*Jana*

To find most of the sources I went under like the PubMed, I went to Galileo, and looked at those articles . . . and then I would try to go to Google which I still need to do, but the biochem part of it was just easy enough to find articles from like Galileo.

INT: So, what do you mean when you say you still need to go to Google?

Just to maybe find the more basic information like, how do you diagnose it? What's the treatment? Just something I wouldn't need to spend like two and a half hours researching. Because biochem, like, not only do I have to research, but then I have to read all and understand it and be able to put it in, like, into the thing.—*Becca*

It got very specific when they were talking about the exact genome, the HLA-DQ-1102, and it just talked in a language that I wasn't familiar with. And like everything I had to google. Or medical dictionary it. Or find some help from someone; it just seemed like every—every—I couldn't just go through it. It was a lot of work just to become familiar with the information that I gathered.—*Jerry*

We had to use, like, primary journals and stuff like that, and, like, Underwood is connected to a lot of, like, JournalQuest programs so you can, get in and move out into, like, a university's access to journals, medical journals and stuff like that. So I used pretty much all of those . . . for this specific part, like, for the stuff that we are doing right now, that is kind of, like, what you have to use. But I mean, for all the basic stuff that, like, I have been looking at and stuff like that, I have used, like—I don't know—like E-Medicine Health Online or something like that.—*Sara*

As they searched for information to meet the assessment criteria for the assignment, some students invoked the teacher mentally or sought out her help and approval.

If it didn't look like I could open the Web page and have Dr. Baker look at it, I wouldn't use it just because I felt like if it didn't look legit then it probably shouldn't be used.

INT: So, when you say open up the website and have Dr. Baker look at it?

Like if I had been in front of her and she was reading it, would I think that she would think it was okay?—*Hans*

She told us how to go in there and find which ones were good, and I had to check with her a couple times 'cause I kind of like, I freak out about that kind of thing.—*Erin*

I could not find anything on PubMed, and I was really struggling, and the librarian and I—she is, like, one of my good friends in the library, so she always helps me out—and she goes, "Well, can you use this Web site?" I said, "I have no idea. I know just Dr. Baker told us Galileo, PubMed," and that was all, like, I am

operating off of . . . and then I actually caught Dr. Baker on a Tuesday going to pick up her kid, and she said that was fine, so I just kept going, going, and going.—*Jerry*

Crafting Content

Students felt unsure about what exactly their teacher was looking for or how they would be graded. As they described their actual writing process, students revealed several criteria for deciding how closely they were approximating the teachers' expectations. First, because the writing was done on a wiki, which is a public writing venue, they looked to one another's work for cues:

I looked at other people's pages and just kind of got an idea of what I needed to put on there and stuff.—*Lina*

I just came up with the topics. It was just kind of general stuff I guess. I looked at other people's and saw what they've done, and I was like, oh, ok, yeah, that's a good one.—*Sarah*

I went to like five or six pages just to see if it was like under another category, if it was like "image" or if it was on their actual page, and if it was on their actual page I would text them—'cause Alli, I think Alli's is linked to another page and I think Lina has it actually on her page and I knew it was her page and I was like how did you get it up there?—*Becca*

I like to see how they like organize theirs or like how long theirs were.

INT: And did you do that before you started writing or?

I did it after I wrote it. I was just making sure that mine was a good length.—*April*

I looked at my friend Erin's paper to see, like, how she had, like, organized it and written it. And so after that, I am like, okay. So I got a good general idea of what length it should be, like, what type of words to use, because she always gets really good grades in class—is, like, perfect—so I am like, okay, I need to structure something like this, so then I wrote mine.—*Jerry*

I heard some other people have really intense stuff on their sites, like Erin. So I have to add some more information to it.—*Lisa*

Students did not simply come up with standards for written work on their own. They used the open nature of the wiki medium to begin constructing a shared understanding of what kind of written artifact might satisfy the demands of the assignment. By looking at one another's work as they progressed, they were able collectively to build this interpretation and gauge their work and process against others'. The wiki medium allowed students to see aspects of article production that helped them calibrate their own work. For example, the referencing tools in *Science Online* allowed students to see others' citations as they worked. When a student is entering a citation and types in an author or title, the wiki offers a list of matching sources that have already been entered. Students could see if others had used information from the same sources:

When you do the reference and you type it in, it will [show] you other things from there. So when you start typing in Mayo on the side, it shows up. So I saw I think Erin's thing came up as Mayo Clinic, and that was the title of hers. And then once you start typing in more information it goes away, so I just happened to notice it as I was typing that in that other people have used the same site. . . . It was nice—at first I was having trouble with figuring out how to put stuff—how to get like the reference stuff in like what it's supposed to look like when I type it in. So you can click edit on somebody else's and see what it looks like and you know, so I kind of figured it out that way.—*Jaime*

In addition, students could use information from the wiki editing history to understand whether they were keeping up with other students:

I wanted to see if I did it at the same time as everyone else. I did. I wanted to see the history of who's updated lately.—*Hans*

As they wrote, students balanced the need to write something that would earn them a good grade with a sense of responsibility toward their readership. Students were aware of the fact that their writing was visible for the public to view and use. As they wrote, this awareness led them to use writing strategies such as simplifying their language, evoking an audience, and using models in order to write and organize their text for public consumption. One student observed

that “it’s not like we’re just doing a paper that we return and get a grade on and it’s over with; this is still going to be used for something bigger than just, like, a grade” (Jana).

How did students organize their texts to ensure that they were readable and informative and served a purpose beyond the grade? Students described a variety of strategies that helped them create texts that would be useful and interesting for readers. One recurrent strategy was to explicitly invoke an audience with specific characteristics such as background knowledge and interests. Often, the audience students invoked resembled themselves, but they also considered that many readers would not have the advantage of having taken honors biochemistry and may have less background knowledge.

What do people want to know about [this disease]? That’s kind of like what I was thinking about. Like what would I be interested in if I was trying to look at one of these sites? And I wouldn’t say I’d be really interested in the biochemistry, but since it has to be included, it shall be included. I mean, you want to know what happens when you have this disease, so I included symptoms. Or how do you fix this? Is it treatable? Can you live with this disease?—*Sara*

If I was researching—which I am technically researching—then I’d want to know what it was, what it looks like—like what are the signs, symptoms, treatment, diagnosis, things like that. And so that’s how I got my subtitles.—*Julia*

If you started off the first paragraph with the structure of the amyloid beta protein in [this disease], people would be like, “Wait, what are you talking about? You know, what is [this disease]? Is it devastating?” And so that is why I start out with statistics, symptoms, just in case, you know, someone is really ignorant and does not know what it is.—*Kimberly*

I don’t want it to be too vague and just—I don’t know how to say it—free from information. I’m trying to go a little bit of detail but not so much that it gets too wordy and people don’t want to necessarily read through all that.—*Jana*

I know when I go on Web pages and see that I don’t understand the first couple of lines I just like go back and pick another Web page. So I put the stuff that people are less likely to know about in the bottom.—*Alli*

In addition to organizing their texts to serve the needs of an imagined readership, another strategy that students used to design their wiki articles was using other sources as a model. Students were selective about what they took from other sites and frequently reported that they had patterned their articles after only the parts that seemed interesting or useful.

On a lot of the other websites it was broken down into like treatment, diagnose, and like all that kind of stuff. Yeah, like, there—treatment, prognosis, and everything. So I figured, well, that’s how they do it and people seem to get to that easily, I just might as well do it like that too.—*Lina*

I looked at how it was broken down on other websites like because we had to get sources. So I combined a bunch of like—I looked at—you’d go to one website and they’d have different categories for what they talked about. So I kind of picked the ones I thought would be the best suited to like cover all of it, and I just did those.—*Erin*

I was looking at other sources and how they kind of went about explaining the disease and mimicked that a little bit. So that is what I did.—*Kimberly*

Some students used the encyclopedia model as established by *Wikipedia* to guide their efforts and either emulated or explicitly attempted to improve upon it to add value to *Science Online*.

I was writing the biochem part of it, and I didn’t know some of the words, so what I wanted to do—so on *Wikipedia*, if there is like a word you don’t know, it will tell you like, the definition. I wanted to try to do that.—*Becca*

I think *Wikipedia’s* just so general. Like you can’t really get the little details that like, are really important. And like when—in our case, we each have our own thing and our topics are so specific that you have down every detail about it and that would be helpful for people.—*Lina*

This is going to be a really good article, because I mean, in the *Wikipedia* one—not that I quote from that—but the *Wikipedia* one does not go into any detail regarding the biochemistry, I do not think. Or it did not go into enough that I thought, “Oh, I understand this.” So this will be even better. That is the aim.—*Julia*

Many of the students’ writing strategies involved selecting information and organizing wiki articles to serve the purpose of informing the general public about science. When it came to actually composing the text of their articles, students also had to decide how to serve the two goals of earning a grade and providing a resource. A common strategy the students used in writing a public resource was to simplify the scientific language they were reading in journal articles in order to make the ideas accessible to a wider readership:

I want it to be, I guess, readable for everyone. ‘Cause like some of the articles I’ve been finding on PubMed, I have no idea what they’re saying. So I want to be just more understandable.—*Jana*

So I mean, I had to take words and I mean, I wanted to make it readable for people, too, because I knew other people were going to look at this, so I was not going to use, like, huge words, just kind of make it simple.—*Lina*

I think this kind of does a good job of bringing it down from the scientific community so that it can be understood by the general public to some degree.—*Hans*

I had to go back and define everything in terms of, like, what it was exactly and break it down to a very, like—I do not want to say a lower level, but I mean truly it was, like, a lower level—so that took a lot of work, because I had to go back for the vocabulary. At first I was just taking stuff and putting it into my own words, but I could not do that. I actually had to go back and do the vocab, look up everything, what it meant.—*Jerry*

The articles I found had those words in it, and I was like, “Wow, I really don’t know what that word means. Maybe people won’t either.” So, like, I figured if I’m going to put it in my

paper, and I need to probably know what it means just in case someone was like, “What does this mean?”—*Becca*

One student admitted that she felt she did not understand everything she wrote about, and expressed concern that it would not be understandable for her readers either.

If you looked at some of the stuff I put on there, I do not really understand what it says completely, and I do not know if other people understand what it says either. I do not know. It is kind of weird to me. So I mean, hopefully they understand what I meant by what I said. . . . I mean, I tried to pick the really smart stuff and make it more normal.—*Lisa*

Simplifying scientific language is hard work. In order to reexpress the ideas from scientific journal articles, students needed to engage deeply with the scientific content and understand it thoroughly. One student noted that 40 percent of his effort “was collecting information. Sixty percent was actually trying to understand what on earth are we talking about” (Jerry). Having a “real” audience brought about natural opportunities for engagement with science content by creating an authentic need for students to work with scientific ideas and by creating a sense of responsibility among students to get things right and express themselves well. For these students, the communicative goal of providing a public science resource meant becoming enough of an expert on their science topic to mediate between the language of the scientific community and laypersons like themselves.

The strategy of simplifying scientific language was frequently aligned with the goal of earning a grade. As one student noted, the teacher would know if they simply restated things they did not understand. “I know if I put really, really intense stuff about it, she will know. She would not understand how I knew that, so I tried to take all the really big information and just scale it down to where I could actually understand” (Lisa). In addition to serving as a kind of watchdog, Dr. Baker reinforced students’ sense of audience throughout the assignment. She had anticipated the learning value of having students write for a real audience (this was one of her motivations for participating in our research), and she periodically reminded students to think about the fact that their writing would be public.

At times, students felt they had to make a choice between the goal of providing a public resource and earning a grade. In every case where the student raised this issue, the grade won out.

I think about, like, what she wants and then in the back of my mind I'm like I hope someone uses this because I'm like helping someone with their project.—*Erin*

I want it to be understandable, but I don't want it to be so simple that it looks like I didn't put enough like time or thought into it.—*Jana*

Well, "causes," I was like, well, if someone was to look at this, it would be like "causes of the disease," like, and then I was, like, well, maybe they will not understand that, and then Dr. Baker was like, "Well, you are supposed to find the etiology of the disease." I was like, "Okay, I am going to use the word *etiology*."—*Lina*

I kind of have reorganized mine to fit a paper format compared to, like, what you might find on *Wikipedia*, just because I think that is the way she wanted it to go is, like, a term paper-type issue . . . like, whenever I do something with *Wikipedia*, it seems like they will always have, like, just a little blurb right at the beginning of something if you just need information, like, right away. And this seems more like someone is going to have to sit here and read. If they want to know about [this disease], they are going to have to read what I wrote in terms of symptoms and statistics like that, compared to just "a person with [this disease] is this." This is, I guess, in more detail than I would expect if I was just trying to get a quick answer.—*Hans*

Although students were taking into account unknown audiences and writing to provide a useful science resource, they were balancing this rhetorical goal with the goal of a good grade. Whatever other goals they might adopt, they were there to earn a grade.

Sourcing Content (Citation)

Citation played different roles for students depending on the communicative goal they were trying to meet. Students were concerned about whether their information sources met the teachers' criteria for the

required peer-reviewed source citations. In addition, they were required to cite five "good" Web sources. In order to earn a good grade, they needed to conform to these requirements, but because they were providing a public resource they also were concerned about the responsibility they had as authors. For these students, citation was not only a requirement; it also played a role in supporting the legitimacy of their wiki as a public information resource.

To decide when and what resources to cite to meet assessment criteria, students not only used Dr. Baker's instructions; they also frequently invoked rules about citation that they had learned in other classes and from other teachers in other scholarly writing contexts. They drew on a history of academic experiences that shaped their practices in ways that helped them define and satisfy the criteria for successful citation.

I know that, in my American Studies class, they said was if it is a fact or if it is a direct quote or if it is paraphrasing, that is when you cite it. I guess that is when you cite stuff—when it is not something that you are saying, that someone else is saying. I do not know if it is the same for science articles, but that is what it is for history.—*Diane*

In English or in history or in papers like that I never use or I never can cite *Wikipedia*; we are not allowed to do it.

INT: So would you let students cite it?

Probably not . . . just because of the culture that I have been exposed to here at Underwood. They won't let us—you know, it's kind of like a parenting thing. You know you grow up with your parents and they tell you not to do X, Y, and Z, so you know just part of—you know, you pass it on to your kids. So the teachers tell us not to do it, so then if I was a teacher I would probably pass it onto the next students that I would have. So probably not just because they tainted my mind, they got me. A little brainwashing thing.—*Jerry*

They just tell us, like, how to cite things, like if you are going to take something directly from your source, it has to be put in quotations and you have to state where you are taking it from—like I stated the lab I took it from and then wrote about it.—*Lina*

Decisions about when to cite were often related to avoiding plagiarism and staying out of trouble. This aspect of citation took on particular importance to the students because they knew their work would be available to the public.

It is scary that it is the first thing that comes up on Google, because if I have not referenced anything correctly, if what I am doing is incorrect anyway, then I could get into trouble.—*Julia*

In terms of like, other people's work, this is one big thing I went to the librarian about, because in all the information or journals that I had is that, like a big "C"—copyright information that says, "Do not . . ." Here, I will show it to you, actually, because I was really scared. I said, "I do not want to get, like, in trouble for, like, having some kind of legal action against me!"—*Jerry*

Students' citation performances were designed in large part to satisfy the requirements of their teacher and to follow the conventions of school writing. But what role, if any, did citation play in supporting the goal of providing a public resource? Because their work was public, students felt a responsibility to their readership. They repeatedly expressed concern about the fact that they were contributing to a real science resource and that they had an increased responsibility to get things right. Students recognized that publication can be a powerful tool and that it also implied responsibility.

Because you are being monitored by so many people and people are using your work as well. I mean people can misuse that power and write—but I don't want to do that.

INT: What do you mean, people can misuse that power?

People know that other children are going to look at their work and use it. So they could write down a load of rubbish and find it funny when people believe them. Do you know what I mean? Write their own opinions, not necessarily for fun but if they strongly believe in an opinion that isn't supported by many other people and they have full freedom to express themselves on something like SciOnline.—*Julia*

I mean like anybody can access it. So it puts more pressure on you to make sure that what you're putting on the Web is true and accurate information, because other people could be reading it and could access that for their website or something like that. So it could be like an upward spiral if everyone has true information then everybody will keep getting true information, but if one person has false information and the next person uses that, uses that—then you just have a downward spiral and no one really knows what's true.—*Sara*

I guess it is weird that people can actually use my work, and so that is why I was going to Doc Baker to make sure that things were okay, because I did not want to put, like, faulty or poor information up on the Internet.—*Jerry*

Many students felt that their work would be suspect because they had no credentials. Said one student, "If someone was searching and trying to learn about [this disease]? I know that I'm going to have my facts right because I'm doing it, but how would they know that I do? I'm just a high school student, I don't know anything about it" (Jamie). Citation played an important role in students' writing by legitimizing their contribution to a public information resource. Through citation, they felt they not only satisfied their assignment requirements but also satisfied the responsibility to their readership to provide a sound and useful resource.

I have no credibility behind my name, I'm a student still. But all the work that I was—all the information I put up had sources, had everything, had a credible background to it. So I think if it's going to be so open for other people to use, your work should be credible. You just don't want to lead people wrong.—*Jerry*

If it was me and I was writing a research paper and I found something like this, I would probably look at the references and go to them and use that for information. Like if I was writing a paper on [this disease] and I came across this, I would probably say okay they used this article a lot, I would click on it, and I'd find that article and use it myself. That's the way I would use it, because you can't really trust a student's work.—*Jamie*

I think the information is pretty accurate, because most of my sources were very good, so I think [people] can use it as a general source. I guess it would be better for them to look at the sources that I got it from.—*Diane*

I mean, I got it from somewhere else, so I have no problem. And it says it everywhere, like, it is right by where I wrote something, it would say the name. So I mean, I have no problem doing that. I do not feel bad if it is wrong. Yeah, it is not really mine; it is more like I am putting it out there, making it easier to access. So I really do not feel bad. It is not like I did the research.—*Alli*

When viewed through the lens of genre, it makes sense that citation practices are closely linked to the form and communicative purpose of a written artifact. Citation is a critical component of enacting scholarly genres. The writing environment itself played a role in supporting citation as an activity. Students in both the initial and the second study suggested that they did not like having to cite things. Extra citations meant extra work: “I have lots of sources. That is going to be a pain because that means I am going to have lots of work citeds” (Jerry). Citation is onerous in part because of detailed formatting conventions and the need to follow guidelines that do not have meaning for students. *Science Online* was built to make the task of citation easier. In both rounds of classroom studies, students remarked on the utility of the citation tool in formatting and saving references.

Discussion: New Media and Genre in Schools

Used carelessly, *genre* is one of those words that means much and says little. Genre connotes big ideas: media forms and discourse practices; situated action and collective meaning making. Genre is a concept that binds a number of theoretical interests for new media and learning scholars, but unless it is tied to students’ actual experiences of writing and learning it will fail to deliver a meaningful framework for understanding learning with new media. The notion of genre emerged for us only after working with our data. Genre explained for us why students’ writing strategies varied as they worked through the assignment, and it explains students’ experiences of school writing and why they struggled to understand how to write on the wiki.

Students’ experiences of school are saturated with written performances. They write tests, papers, essays, poems, and lab reports. Moreover, they may write distinct versions of these genres for different subject areas. By the time we encountered these science students in 11th and 12th grade, they were adept producers of many kinds of scholastic genres, and they intuitively understood their writing abilities and experiences in terms of genre:

I don’t think I’d know how to write a paper for science because I’ve always written for English or history. When it comes to science I don’t know how to do it—with my term paper I have like a thesis and your topic sentences but like, I don’t know, I don’t know how you’d phrase it. ‘Cause I read these journals that we have to read online, and they’re not anything like an English paper.—*Erin*

The first time we heard a student express the sentiment that “I thought we would be writing a research paper, but now it’s on a wiki,” we were confused by their focus on the tool. If the students believed they would be writing a research paper, and indeed the teacher presented the assignment as a research paper on a wiki, then writing one using a wiki instead of a word processor or pencil and paper seemed perfectly reasonable to us. But, in fact, we soon realized the students were talking not about the tool but about everything the tool made possible. The communicative purpose and form of their assignment had changed from a research paper into something else. The introduction of a new writing tool brought about a new audience and a new purpose for their writing. The impact of this change was twofold: (1) making the assignment public had implications for how they thought about writing and citing; and (2) because they were unfamiliar with Web publication, they used the affordances of the wiki as a transparent, incremental writing medium to align their understandings of what their work should look like.

Based on existing learning theory, we would expect that creation of a public artifact would prove advantageous for learning (Papert 1991). We demonstrated that what brings about opportunity for reflection and learning is not simply the act of sharing an artifact but the purpose for and audience with which the creation is shared. Like Harel’s young software designers who needed to understand fractions in order to create learning experiences for younger students

(Harel and Papert 1991), these wiki authors found that they needed to engage with science and citation in ways that the traditional audience of the teacher did not require.

In his book *Art Worlds*, Howard Becker (1982) suggests that conventions are often embedded in the tools that people use to produce creative works. Just as camera lenses, paintbrushes, word processors, or wikis can embody familiar conventions, they can also structure production in ways that run counter to the social, technical, and cultural conventions of a community. In the case of wikis in the classroom, the introduction of a wiki disrupted familiar aspects of writing a research paper by introducing a new purpose and audience for students' work. We demonstrated that despite the fact that teachers did not structure assignments as collaborative efforts, the transparency of the medium proved critical for students as they coped with the unfamiliar aspects of the wiki writing assignment. Although the students generally did not collaborate on text production, the wiki supported them in coming to a collective understanding of what their writing should be like. As students struggled to come to a new, common understanding of their writing goals, they took advantage of the wiki as an incremental publishing medium to track how other students' pages were shaping up. Some used affordances of the wiki such as page histories and the shared citation database to see into the process and product of their peers' writing efforts. This suggests that wikis and other collaborative tools can be designed in ways that allow individuals to "see into" the productive processes of their peers. This social function of wiki transparency is related to the concept of modeling in the literature on cognitive apprenticeship (Collins et al. 1989) and legitimate peripheral participation (Lave and Wenger 1991), which stresses the importance of giving novices access to expert models. In the case of *Science Online*, students were not emulating expert practice as much as they were looking to one another to establish a set of shared practices. Designing for transparent process could help not only in the context of coming to a shared understanding of genre (as we have described here) but in circumstances when newcomers seek to understand and emulate the established practices of a community. Moreover, incremental publishing means the barriers to getting started are low, so it's easy to begin making small contributions.

A challenge for designers is to surface features of process that are interesting and critical to learners, and some of these features may be social information rather than characteristics of the artifact. For example, in *Science Online*, students used the shared citation database to decide what information sources were acceptable and viewed the work of their peers, but *which* peers? Interviewees mentioned looking to the best students to gauge their own performance. In a small, physically co-located class, where all the authors are known to one another, looking to the best students as models is a source of support for less accomplished and confident writers. But what happens when students are not as well known to one another or when individuals who do not know one another come together online? Reputation systems in wikis and other collaborative production environments may play a critical role in supporting process transparency.

The findings presented here suggest that using social media such as wikis in schools to create a public information resource can bring about opportunities for reflection and learning. These opportunities include

- transforming the value of citation;
- creating a need to engage deeply with content; and
- providing both a need and a foundation for assessing information resources.

Furthermore,

- wikis as an authoring environment support students in building a shared understanding of genre as they struggle with unfamiliar rhetorical situations.

The design of new media to support writing in different classroom contexts is an interesting direction for new research. How might the story differ with students who are not able to produce school genres well to begin with? Or with students who are not accustomed to using digital media for school purposes?

Learning how to produce a scholastic genre well can be an excellent learning experience for students. However, school genres that are perceived as assessment devices can also shield students from important intellectual work. Introducing new media like wikis in the classroom can transform school genres by introducing new audiences and rhetorical purposes that encourage critical

engagement with content. Carefully orchestrated, with the right technological supports, schoolwork can become rich with new opportunities for reflection and impact when learning goes public. We have presented a vision of wiki not as a staging ground for producing texts for the edification of students but as a canvas on which students themselves can engage in the intellectual work of publication and knowledge production.

Acknowledgments

The *Science Online* project was supported by grants from the National Science Foundation (#0537251) and GVV Center, Georgia Institute of Technology.

Notes

1. The *Science Online* website, originally available at <http://www.scionline.org>, is no longer available online.
2. *Science.net* is currently offline. A brief description of the project can be seen at <http://epistemicgames.org/eg/sciencenet/> (accessed April 4, 2010).
3. The names of both schools and all study participants have been changed to comply with confidentiality agreements.

References

- Barab, S. A., T. M. Duffy, and S. Land. 2000. From practice fields to communities of practice. In *Theoretical foundations of learning environments*, ed. D. Jonassen and S. Land, 25–55. Mahwah, NJ: Lawrence Erlbaum Associates.
- Bazerman, C. 1988. *Shaping written knowledge: The genre and activity of the experimental article in science*. Madison: University of Wisconsin Press.
- Becker, H. 1982. *Art worlds*. Berkeley: University of California Press.
- Bolter, J. D., and R. Grusin. 2000. *Remediation: understanding new media*. Cambridge, MA: MIT Press.
- Collins, A., J. S. Brown, S. Newman, and L. Resnick. 1989. Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In *Knowing, learning, and instruction*, ed. R. Glaser and L. B. Resnick, 453–94. Mahwah, NJ: Lawrence Erlbaum Associates.
- Flower, L. 1994. *The construction of negotiated meaning: A social cognitive theory of writing*. Carbondale: Southern Illinois University Press.
- Forte, A., and A. Bruckman. 2006. *Wikipedia to the classroom: Exploring online publication and learning*. Paper presented at the International Conference of the Learning Sciences, Bloomington, IN. <http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.71.4210> (accessed April 7, 2010).
- Forte, A., and A. Bruckman. 2007. Constructing text: Wiki as a toolkit for (collaborative?) learning. In *Proceedings of the 2007 International Symposium on Wikis (WikiSym), Montreal, Canada*, ed. A. Désilets and R. Biddle, 31–42. New York: ACM Press. <http://portal.acm.org/citation.cfm?id=1296951.1296955> (accessed April 7, 2010).
- Forte, A., and A. Bruckman. 2008. Learning information literacy in the age of Wikipedia. *Proceedings of the International Conference of the Learning Sciences, Utrecht, Netherlands*, 237–44. n.p.: International Society of the Learning Sciences.
- Glaser, B., and A. Strauss. 1967. *The discovery of grounded theory: Strategies for qualitative research*. New Brunswick: Transaction Publishers.
- Grant, L. 2009. “I DON’T CARE DO UR OWN PAGE!” A case study of using wikis for collaborative work in a UK secondary school. *Learning, Media and Technology* 34 (2):105–17.
- Grudin, J. 1994. Groupware and social dynamics: Eight challenges for developers. *Communications of the ACM* 37 (1):92–105.
- Guzdial, M., P. Ludovice, M. Realff, T. Marley, and K. Carroll. 2002. When collaboration doesn’t work. In *Proceedings of the International Conference of the Learning Sciences, Seattle, Washington*, 125–30. n.p.: International Society of the Learning Sciences.
- Harel, I., and S. Papert. 1991. Software design as a learning environment. In *Constructionism*, ed. I. Harel and S. Papert, 41–84. Norwood, NJ: Ablex Publishing.
- Hatfield, D., and D. Shaffer. 2006. Press play: Designing an epistemic game engine for journalism. In *Proceedings of the International Conference of Learning Sciences*, 236–42. n.p.: International Society of the Learning Sciences.
- Jenkins, H. 2006. *Convergence culture: Where old and new media collide*. New York: New York University Press.
- Knorr-Cetina, K. 1981. *The manufacture of knowledge: An essay on the constructivist and contextual nature of science*. Oxford, UK: Pergamon.
- Kolodner, J., J. Gray, and B. Fasse. 2003. Promoting transfer through case-based reasoning: Rituals and practices in Learning by Design classrooms. *Cognitive Science Quarterly* 3:183–232.
- Lave, J., and E. Wenger. 1991. *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.
- Lenhart, A., M. Madden, A. Macgill, and A. Smith. 2007. Teen content creators. Press release. Pew Internet and American Life Project. <http://pewresearch.org/pubs/670/teen-content-creators> (accessed May 12, 2010).
- Leuf, B., and W. Cunningham. 2001. *The wiki way*. Boston: Addison-Wesley.
- Miller, C. 1984. Genre as social action. *Quarterly Journal of Speech* 70:151–66.
- Orlikowski, W. J. 1992. Learning from notes: Organizational issues in groupware implementation. In *Proceedings of the 1992 ACM conference on Computer-Supported Cooperative Work*, 362–69. New York: ACM.
- Orlikowski, W. J., and J. Yates. 1994. Genre repertoire: the structuring of communicative practices in organizations. *Administrative Science Quarterly* 39 (4):541–75.
- Papert, S. 1991. Situating constructionism. In *Constructionism*, ed. I. Harel and S. Papert, 1–11. Norwood, NJ: Ablex Publishing.

- Renninger, K. A., W. Shumar, S. Barab, R. Kling, and J. Gray. 2004. The centrality of culture and community to participant learning at and with The Math Forum. In *Designing for virtual communities in the service of learning*, ed. S. Barab, R. Kling, and J. Gray, 181–209. Cambridge: Cambridge University Press.
- Rieh, S. Y. 2005. On the Web at home: Information seeking and Web searching in the home environment. *Journal of the American Society for Information Science and Technology* 55 (8):743–53.
- Russell, D. 1997. Rethinking genre in school and society. *Written Communication* 14 (4):504–54.
- Scardamalia, M., and C. Bereiter. 1996a. Computer support for knowledge-building communities. In *CSCL: Theory and practice of an emerging paradigm*, ed. T. Koschmann, 249–68. Mahwah, NJ: Lawrence Erlbaum Associates.
- Scardamalia, M., and C. Bereiter. 1996b. Student communities for the advancement of knowledge. *Communications of the ACM* 39 (4):36–37.
- Shaffer, D. 2006. Epistemic frames for epistemic games. *Computers and Education* 46 (3):223–34.
- Shaffer, D. W., and M. Resnick. 1999. Thick authenticity: New media and authentic learning. *Journal of Interactive Learning Research* 10 (2):195–215.
- Strauss, A., and J. Corbin. 1998. *Basics of qualitative research: Techniques and procedures for developing grounded theory*. London: Sage.
- Wallace, R. M., J. Kupperman, J. Krajcik, and E. Soloway. 2000. Science on the Web: Students online in a sixth-grade classroom. *Journal of the Learning Sciences* 9 (1):75–104.
- Wiley, J., and J. Voss. 1996. The effects of “playing historian” on learning in history. *Applied Cognitive Psychology* 10:63–72.