

GOOGLE WAVE: INTERACTIVITY POTENTIAL FOR EDUCATIONAL CONTENT

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ABSTRACT. Schools often use textbooks and teachers as providers of information, expecting students to be little more than receptacles. With interactivity pervasive in our information-rich society, the educational process in this country is noticeably insufficient for preparing today's students for tomorrow's expectations. In this paper, Google Wave, a new product still in public preview, is suggested as a technology that is both familiar enough in its approach as to be approachable by teachers and students alike and unique enough to serve as a valuable tool in helping solve the problem of student engagement. Johnson's "User-Centered Design" model is discussed and adapted to education; a contrasting approach to learning-centered engaged education is then presented. Google Wave is shown to fit many unique needs of education in an interactive environment.

1. INTRO TO GOOGLE WAVE

Introduced on 28 May 2009 (*Google Wave Dev. Preview*), Google Wave is a new communications technology that combines current expectations for a number of platforms and combines them into one idea. As such, it is rather difficult to explain outright and nearly impossible to do so without comparatives: It is like email, instant messaging, wiki sites, blog comments, and whiteboards...but again, all within one system. Those interested in a brief overview from the developing company would do well to read the short text on the About Google Wave webpage¹; those with a

12 December 2009

J. Blake Scott | ENC 6800

Intro to Texts & Technology

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¹<http://wave.google.com/help/wave/about.html>

great deal of patience and technical interest should consider watching the eighty-minute Developer Preview keynote video available on that same page.² An over-simplified explanation would be this: Waves are documents stored on a server that invited users can edit, comment on, and add features to at will. Edits are reflected in real time on all user's computers, so multiple simultaneous edits can take place with all users working with the same up-to-date content. Conversations are attached to points in the document, so discussion or markup is relevant by its placement. Additional content, such as photos, YouTube videos, Google Maps, yes/no/maybe voting tools, or surveys/questionnaires can be added to provide a richer experience that is not solely text-based. From that simple and unassuming foundation grows a vast and complex system that allows an unprecedented degree of idea sharing that, perhaps most importantly, can happen live. Additional details about the operation and abilities of Google Wave will be presented later on, but the most essential defining characteristic of the new technology known as a "wave" is the basic premise of multiple simultaneous distributed editors of one document with various conversational threads attached, providing unprecedented interactivity for collaborators. The ability to edit simultaneously in real-time has specific ramifications in education.

2. THE USE OF GOOGLE WAVE FOR INTERACTIVE LEARNING

"Interactivity" as typically suggested in studies of hypertext allows students to choose their own paths through a text by clicking on user-determined links. A student is given a list of links from which to choose; the ability to choose any of those predetermined links is considered "interactivity". Manovich refers to this ability of the user to select relevant text and composite a narrative at the time of reading as a feature unique to new media; however, this process of choosing among

²Or watch it directly from YouTube by searching for "google wave developer preview"—it will likely be the first result, as it has had over seven million hits in the six months since its posting (as of 28 November 2009).

provided links is analogous to using a table of contents for a text to read a standard book non-linearly (123–160). To be sure, hyperlinks make the process of connecting information simpler for the reader, but the process is hardly “new”. Landow compares hypertext linking to academic citations (66). While the random-access approach of hypertext can help prepare students for interconnected nature of academic study, it is hardly a novel use of technology or a previously unrealized ability. Infusing a document with hypertext links serves only to simplify the process of page-turning that could otherwise be done without the assistance of the technology. However, more modern (often called “web 2.0”) implementations of user interaction involve production more than direction: users can develop ideas and post them in threads to initiate, continue, or enhance a conversation. While this conversation, too, can be non-linear, the important development is that of consistent content creation by the user. A discussion of the distinction between basic interactivity and true user interaction appears in Friend (9–15). Before analyzing the benefits of using Google Wave in education and initial shortcomings of this technology, it will be helpful to first couch the discussion in the context of reader/user interactions with various sources. This brief survey will identify a current critical shortcoming that Google Wave is uniquely poised to address.

2.1. Interactivity on the Computer.

2.1.1. *Interacting with the Interface.* Due to the general influence of “computer culture” in modern society, students are more apt to think of themselves as users rather than simply as readers, a predisposition that allows for a greater influence of interactivity. Students are accustomed to being able to interact with devices because they have been raised with toys that use interaction as a default. As today’s youth have aged, they developed an expectation for interaction in their video games, then their personal computers, then their cellular phones. With every advance in

technology, the promised outcome remains the same: greater interaction with the device. From this perspective, it should come as no surprise when a child or adolescent complains that a book is “boring”—it simply cannot provide the level of interaction to which they’ve grown accustomed. This expectation of interaction is not limited to the consumption of information but can apply equally to its production, as well. Presenting a blank piece of paper to a student and asking that student to write an essay might be more intimidating than freeing. When working with young people for whom “cut and paste” had a digital representational meaning long before the scissors-and-glue stick reference was ever explained, the inability to manipulate content produced on a piece of paper is vastly separated from the production process children are so familiar with. Adults, of course, are equally susceptible to finding the occasional blank piece of paper daunting. Sherry Turkle, writing as one who has been analyzing the role of the computer in identity development for decades, phrases her frustrations with the scenario this way in *Life on the Screen: Identity in the Age of the Internet*:

The windows on my computer desktop offer me layers of material to which I have simultaneous access [...]. When I write at the computer, all of these are present and my thinking space seems somehow enlarged. The dynamic, layered display gives me the comforting sense that I write in conversation with my computer. After years of such encounters, a blank piece of paper can make me feel strangely alone. (29)

With clickable interfaces on computer screens and touch-sensitive interfaces on mobile devices bringing a tangible sense to data and devices, students are growing accustomed to physically interacting with digital data and will become increasingly hard-pressed to produce written work on white pages that do not allow on-the-fly edits. Google Wave holds the potential to facilitate both

the reading and writing processes for students in ways that align with the expectation of interaction common in today's students. Additional detail regarding the intricacies of each approach will be presented in greater detail, but the general philosophy is this: Text being read in Google Wave can be annotated and discussed in real-time, allowing interactive digestion of the material; text created in Google Wave can be edited and, again, discussed by any intended participant at any time, causing the process of creation to itself be an interactive discussion among all contributors.

By allowing a document to be the focal point of conversation and collaboration, Google Wave highlights the discussion (and the people involved) as the centerpiece of document development. This emphasis on the user is reminiscent of Johnson's User-Centered Design theories from *User-Centered Technology: A Rhetorical Theory for Computers and Other Mundane Artifacts* (See Figure 1(a)). With this model, Johnson places his emphasis on the central role a user must play in the development of any technological system. He illustrates that an "artifact" (a device or a system) necessarily has an interface, which is necessarily created by a designer, and that each of these components is necessarily filtered through the user's situation before ultimately influencing the user. When the user in question is a student, Johnson's model of design must be altered slightly—see Figure 1(b)—due to the constraints of an educational system. The "artifact" is almost invariably a text, and the "interface" is almost always defined by the educational program in which that student is involved. Rarely does a student, especially one in primary or secondary school, interact with a text under other circumstances. Therefore, when a student is the user, the model must be changed to highlight how the content or interface creator, the text, and the educational program affect the student. The Student-Centered Design model emphasizes that the student is at the heart of an array of interactions, many of which are technological in nature. What follows is a discussion of the interactions that are essential to the operation of a classroom and that shape the role of technology in the learning process.

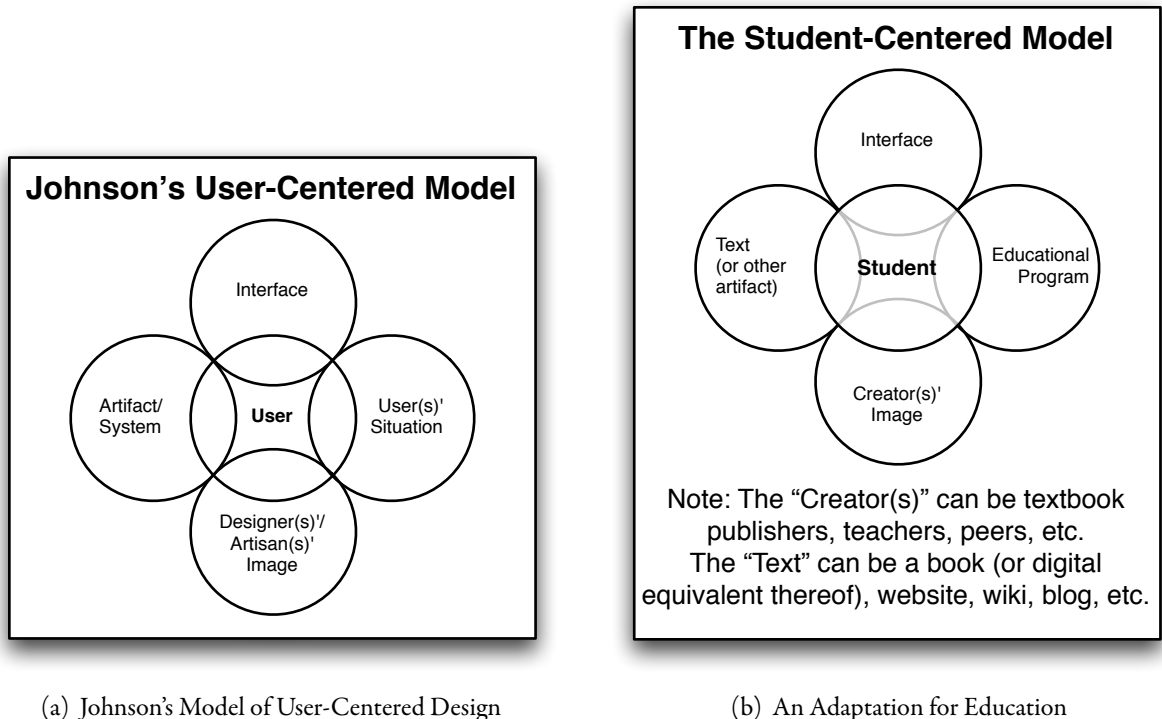


FIGURE 1. Models of Systems Design

2.1.2. *Synchronous & Asynchronous Interaction.* One of Google Wave's most unique features is its ability to simultaneously and transparently facilitate both synchronous (live, real-time) and asynchronous (delayed, back-and-forth) communication styles. In one wave, users can view and edit the document at their convenience, whenever they choose to visit the wave. They can also hold back-and-forth conversations that are even more instant than most instant-messaging systems currently provide: users can see what other users are typing as they type, character by character (and, coincidentally, typo by typo—Google Wave allows no secrets but does, thankfully, provide spell-check; see Figure 2(b)). If multiple users choose to edit the same content simultaneously, all changes appear on all users' screens exactly as the changes are being made (see Figure 2(a)). However, if a user only views a wave on occasion, all changes that had been made since

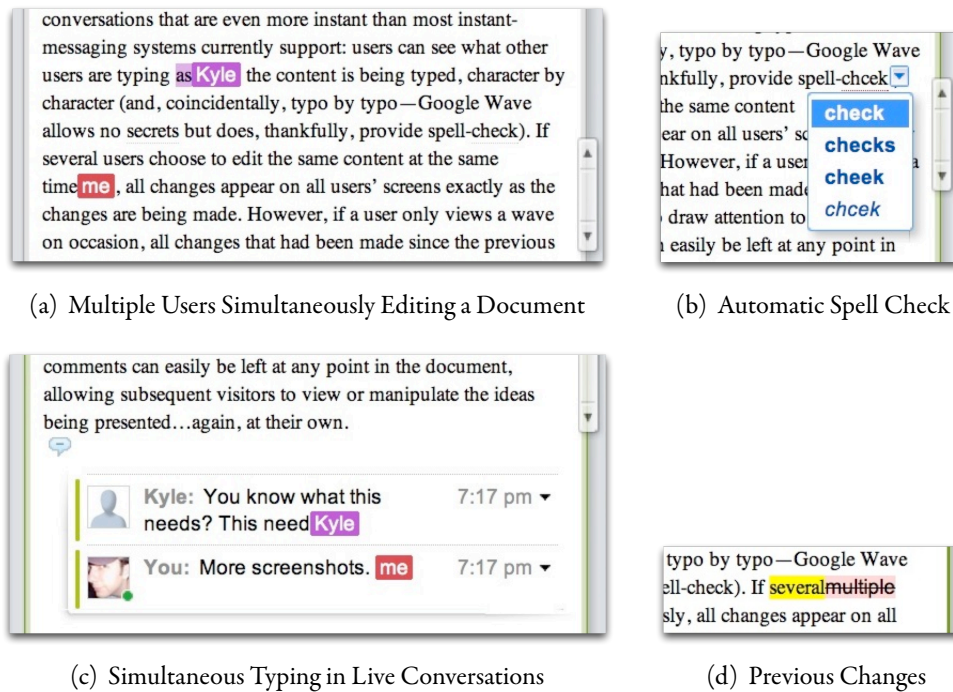


FIGURE 2. User and Interface Interactions in Google Wave

the previous visit are highlighted to draw attention to the updated content (see Figure 2(d)). Notes or comments can easily be left at any point in the document (see Figure 2(c)), allowing subsequent visitors to view or manipulate the ideas being presented...again, at their own convenience.

This confluence of communication styles might seem somewhat overwhelming at first glance, but placed within the context of the forms of interactivity discussed above, it becomes more clear: rather than becoming a cacophonous conglomeration of communications tools, a single wave becomes a focused holding place for various approaches to interactivity that can be manipulated according to the intentions of the user. With so many opportunities for shared editing and creation, students could easily find the level of interactivity they expect out of computer systems. Rather than being faced with a blank piece of paper (or, in this case, a blank screen), students

have the ability to interact with other producer-participants on a shared goal of document creation.

Existing writing assignments could easily be “ported” into Google Wave to add new levels of collaboration in the writing process. Students could choose a topic to discuss and brainstorm ideas about it, as usual. Then, instead of making an outline on paper, converting the outline to paragraph form, then sharing the completed draft with a peer as typically happens in writing courses today, students could go to a computer lab, create a new wave for their paper, and write the outline there. Peers and the teacher could check the organization of ideas before the draft was expanded, providing feedback, suggestions, or even changes as they saw fit. Then, as the student writes the draft, those same collaborators could continue their interactions, watching the paragraphs form and the ideas develop. Instead of waiting until an entire draft had been created before getting feedback, the student-author would have a constant flow of feedback throughout the writing process. Students wouldn’t need to think of “the writing process” as a sequence of discrete steps—a rather vague concept to teach—but could see the process of organizing, exploring, and expanding ideas as a continuous evolution of a text, rather than a process that progresses through predictable, chronological phases.

Because collaboration can happen synchronously, students either in the same lab or in separate states could collaborate on the production of the same document. Because collaboration can be asynchronous, students on different schedules or in different time zones can work together just as easily. The “playback” feature in Google Wave allows users to see all changes made to a document step-by-step, in the same order in which the changes were made (See Section 2.3.3, p. 20). Students who miss a group (or class) meeting can quite literally replay the events that led the document to reach its new state, even seeing the name of each user responsible for each change. This level of flexibility, accountability, and reproducibility makes for previously unseen levels of

adaptability to the changing environments of both face-to-face and distance learning. Students in any location, in any situation, and at any time can enjoy the same benefits of interaction with the content and with other editor-creators.

2.2. Interacting With Content.

2.2.1. *In Mass Media.* The idea of a “producer-participant” or an “editor-creator” is by no means unique to computer interactivity. Instead, it has been developed through modern productions of mass media. Though mass media is not often considered a strong force within classroom walls, it has for years been successfully interacting with our society’s youth. The level of interaction it provides becomes a standard for students—one that schools would do well to emulate, if not match. Television has become more interactive by providing an outlet for viewer opinions. Interaction in decision-making via viewer voting has surged in popularity and influence (particularly in terms of revenue) with the advent of *American Idol*, a television show featuring vocal-performance contestants who are voted on by the viewing audience after each show’s performance. Winning performers remain on the air for additional shows, creating a viewer-driven elimination-based decision system. A detailed study of the impact of viewer involvement on such a scale appears in *Convergence Culture: Where Old and New Media Collide* (Jenkins 59–94). He argues that “*American Idol* offers up a fantasy of empowerment—‘America’ gets to ‘decide’ upon the next Idol. This promise of participation helps build fan investments...” (64). Educators would be wise to adopt that sort of investment as a goal for their students’ approach to learning. This is not the simple “point and click” interactivity of hypertext; this is, as Jenkins says, empowerment.

Media producers are keenly aware of the value of consumer influence over content; however, that value has mostly gone unnoticed by content producers in the educational arena. Textbook

producers still make static, unresponsive books that, at best, have “interactive” CD-ROM accompaniments. With those computer programs, students can often explore the material from the text at their own pace, but no user-level control over the content can be exerted. Members of today’s society expect greater degrees of interaction with—and control of—the content they consume, and our education system should respond to this trend by helping teach students how to be effective contributors to the process of influencing mass media from the bottom up. We should provide texts that students are able to alter and direct. Google Wave provides just such an opportunity: to give students access to a dynamic document that allows user comment, contribution, and control. To put control of the text in the hands of the reader is to reverse the normal reader-writer relationship traditionally found in academic texts, which creates what Barthes calls a “writerly” text. He is particularly critical of the inactive role played by a person with its antithesis, a “readerly” text commonly found in printed books.

[T]he goal of literary work (of literature as work) is to make the reader no longer a consumer, but a producer of the text. Our literature is characterized by the pitiless divorce which the literary institution maintains between the producer of the text and its user, between its owner and its consumer, between its author and its reader. This reader is thereby plunged into a kind of idleness—he is intransitive; he is, in short, *serious*: instead of functioning himself, instead of gaining access to [...] the pleasure of writing, he is left with no more than the poor freedom either to accept or reject the text: reading is nothing more than a *referendum*. Opposite the writerly text, then, is its countervalue, its negative, reactive value: what can be read, but not written: the readerly. (4)

Barthes’ comment that the reader of a readerly, “classic” text is unfavorably considered “serious” echoes a common complaint of many students: that materials studied are not “fun” enough. Here,

the suggestion is that much of that restricted fun comes from a limited engagement on the part of the writer; having a participatory experience would enhance the reading experience. Indeed, texts can be written to encourage, support, and rely on contributions from readers. Written materials are no longer limited to one-way, read-only communication from authors to readers. The communication should be bi-directional, allowing those who are traditionally limited to reading the opportunity to create as well. This is now the argument of Lessig, who presents his ideas of a “remix culture”, in which people interact with texts and other media in just that way, as opposed to our current culture of copy protections, use restrictions, and digital rights management. What he calls “RW culture” involves content and material that is not so much permanent or final as it is manipulable and extensible: “it asks something more of the audience. It is offered as a draft. It invites a response. [Citizens could] develop a kind of knowledge that empowers as much as it informs...(Lessig 85). “Knowledge”, “empowering”, and “informing” should be at the forefront of the educational process, so any system that holds the ability to achieve the standard of Lessig’s RW culture should be encouraged. Google Wave provides the infrastructure for bi-directional information flow that is essential for this sort of development and learning. Students can become engaged in their “writerly” texts, actively participating in the creation and discussion of the information, not just passively absorbing ideas through a “readerly” text.

2.2.2. Through Textbook Content. Google Wave holds the potential to simply and dramatically reinvent the way textbooks are used in schools by providing the engagement that is currently missing. The content of a textbook could be published as a series of waves, perhaps one per chapter, allowing simple organization and a modular design that permits flexibility on the part of the instructor. Waves could be tagged by the publisher, providing pre-built tools for easily locating relevant material or planning a unit of study. Students could be granted access to appropriate

waves as that unit of study arrived, helping to keep students focused on the material currently being taught. The cost of producing and shipping books would obviously be saved, and additional benefits of digital texts would also be realized. Digital texts support convenient access from multiple devices (Google Wave is already functional on devices running Mobile Safari [iPhone and iPod touch] or Android OS). Instead of carrying around a bulky textbook, students could access their course materials from a lab computer, personal laptop, or handheld device. Because Google Wave services are hosted on a remote server, the same content (including revisions and comments) would be presented from any device the student uses. Work done at school in class would be seen when checking the content on the bus from a smartphone; changes made on the way home would be reflected on the server when the student logs in from a home computer. Students would be able, if they wanted, to contribute to the product being produced from nearly any location on a wide variety of devices. Limiting the learning experience to the classroom is a restriction teachers can no longer afford, and one that arguably is outside the expectations of students—students very frequently check text messages, email, Twitter feeds, and/or Facebook pages between or during classes, showing they depend on a feeling of online connectedness that could very easily be extended to the material being studied, if given that opportunity.

An additional feature unique to digital texts is the ability to perform instant fulltext searches. Teaching students to use an index or table of contents to find an idea is perfectly appropriate for a world saturated with printed and well-indexed information. However, with the development of ever-increasingly complex search algorithms, the concept of ‘indexing’ is becoming outdated. The ability to perform fulltext searches on textbook content would dramatically increase the engagement of students in the process of recalling text. Instead of feeling frustrated by flipping through countless random pages hoping to find the one sentence stuck on the tip of the proverbial tongue, a student can simply search for the words in mind and find the result. Better still, teachers could

take the opportunity to teach students about effective search techniques or strategies, helping to make them better online consumers or researchers in the process. Similarly, activities using Google Wave could provide a natural next step by expecting students to collaboratively process the information they gather. After researching a particular topic, students in a small group could compile their information in a wave and work together to ensure the organization and style of the information presented remains consistent throughout. Like the process of creating large corporate reports or periodical publications, this process would give students experience creating documents that draw from various sources (both human and informational) and combine them to share a unified style. When a classroom activity mirrors a real-world scenario, student buy-in increases along with subject relevance (Williams et al. 108–110; Schank 430–432). Along with the ability to search, the digital-document characteristics of a wave also provide hypertext references—the ability to link to other parts of a wave or even other waves entirely. The benefits of hypertext in increasing engagement and user control of information are thoroughly discussed in Landow, Bolter (32–46), and Manovich (268–73).

Impressive as they are, none of those features is beyond the capabilities of a standard PDF document. Where Google Wave changes the nature of student interaction is when collaboration is taken into account. The shift in thinking is that a wave allows the initial content to be manipulated and altered by anyone given access to it. If students are told to read a chapter from a textbook today, they are given explicit instructions not to write in the book as they read; however, annotation and interaction with a text is beneficial to understanding its content (Friend). If that same content is placed in a wave, students could comment on, or ask questions about, the information as they went. More significantly, they could make changes. Shared experiences from their lives could be integrated into the source material to make it considerably more relevant to their existing knowledge base. For instance, elementary students learning about hexagons could enhance

the text by referring to the shape of a table in their classroom (or, as in my school experience, the shape of the pizzas served in the cafeteria). Students in earth/space science courses could include specific information about upcoming astronomical events and include links to news stories about them (such as upcoming meteor showers, eclipses, etc.). Students in physics classes could refer to audio files to demonstrate sound waves or videos to demonstrate concepts such as trajectory. Better still, students could create, capture, and edit their own films, upload the content to YouTube, and embed the YouTube video in the wave of their textbook. Ownership of the material would become real as students directly worked with and on the content which they were studying. Older “interactive” CD-ROM versions of textbooks seem like efforts in futility by comparison.

Giving students the ability to influence their own textbooks opens possibilities for meaningful instruction that do not yet exist. To facilitate this potential use, textbook publishers could create an original wave of the material which teachers could then duplicate for each class they taught. Relatively small groups of students would have their own version of the text to manipulate, free to make whatever changes they wished. The following year, a fresh copy of the content could be put in place, ready to be annotated and enhanced all over again, each time specifically in response to the experiences and abilities of the students in the class. Better still, corrections, updates, and content changes could be propagated nearly instantly, without the need to reprint subsequent editions of books. Teachers would have unprecedented control over the material they present to students, just as students would have unprecedented control over the content as it is being studied.

2.3. Collaboration. Interaction is at the heart of an engaged education, but it can be difficult to determine how best to position interaction within the classroom. The “Student-Centered Design” model (See Figure 1(b), p. 6) is appropriate when developing systems for education, but that presupposes the use of customized systems in a classroom. If the aim of the classroom is to prepare students for the “real world”, the systems used in the classroom should be the same tools

that students will be using in the field. (What teacher expects students to use a customized word processor to write a school paper? Microsoft® Word has become the de facto standard in business and, therefore, the classroom.) Therefore, technology used in the classroom need not be developed specifically for students; rather, the students should be taught to use technology that best enables them to learn the skills they need and the content of their curriculum. On a more practical level, classrooms serve not to design artifacts but rather to educate students. From that perspective, a design model may not be the most appropriate way to evaluate an approach to classroom technology, though a student-centered focus does inform the way a classroom works. Students should not operate in isolation—as discussed in Section 2.3.1, students should work collaboratively with their peers. Students also expect technology to provide an interactive experience in which they can manipulate the materials they are asked to learn. The technology therefore becomes only a component in a vast education infrastructure designed to support the growth and development of a student (Grabill 91–94).

In this light, the technology used in schools is no longer a design focus, and the student is essentially viewed as a user again. This does not reduce the importance of the student; rather, it emphasizes that a student is functioning within an educational ecosystem in which both the student and the technology play specific roles, each supported by a culture of learning. A more appropriate view of how technology can facilitate (not dominate) classroom interaction appears in Figure 3. By viewing the course content, rather than the student, at the center of the equation, it becomes possible to focus on the development, the implementation, and the use of the content as discrete steps in a process. Content creators, when working on educational material, must work within the programs and curricula established by a separate entity. For example, textbook authors from Prentice Hall had to carefully evaluate and integrate Florida's Sunshine State Standards into their materials as well as include preparatory materials for the Florida Comprehensive

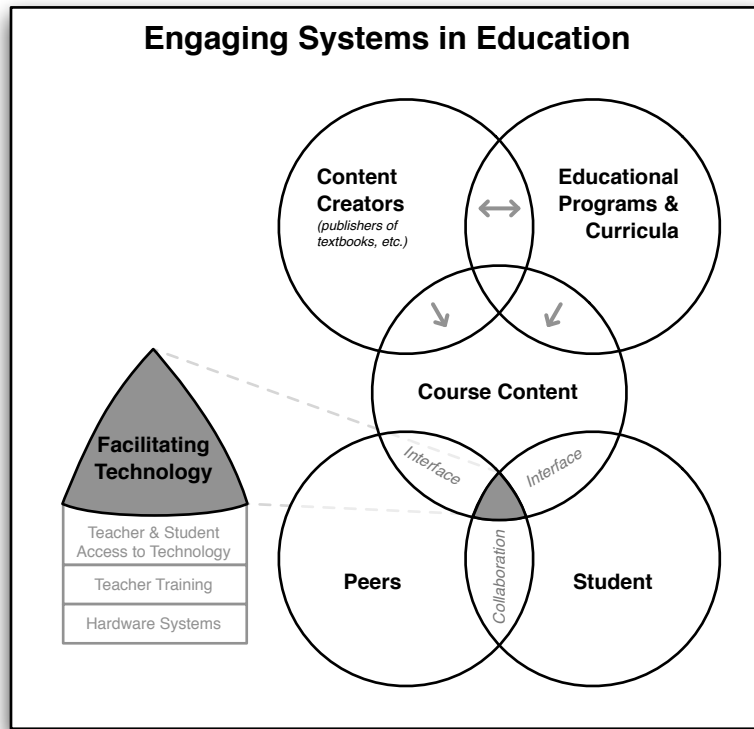


FIGURE 3. Engaging Systems in Education

Assessment Test (FCAT), the state's annual standardized evaluations before their textbook was considered for adoption in my public school district. The links between content creators and educational programs and curricula ultimately produce the course content used by teachers to help educate students. Only after the production and distribution of course content do teachers enter the system; they are then tasked with engaging students in the material. It is at this point that effective technology can facilitate the learning process by enabling student collaboration and meaningful interactions with the course content. Useful technology almost invariably requires infrastructural support, including adequate hardware, sufficient teacher training, and availability

of access to both teachers and students. Within this complex framework of negotiated give-and-take, learning is supposed to happen. Clearly, a facilitating technology must be one that allows students to learn without being hindered or obstructed in their efforts. To properly evaluate the potential of Google Wave in meeting those criteria, it is best to evaluate the ways students learn interactively.

2.3.1. *Peers/Mentor Knowledge Sharing.* The experience of working collaboratively with another person in order to achieve a goal, complete a project, or solve a problem is hardly foreign or rare. Brown and Duguid provide a relevant example of a study of copy-machine service representatives whose job it was to diagnose and troubleshoot customer copier issues over the telephone and dispatch technicians for on-site calls, as needed. The company in question spent a great deal of money on a computer system designed to help the representatives find solutions to customer problems; productivity did not increase. Call-center operators were unable to find the solutions they needed, and repair technicians were often sent on simple calls that could have been fixed through over-the-phone solutions. The remedy suggested by the researchers was not a redesign of the computer system or thorough re-training of the staff, but simply “longer phone cords.” The greatest source of effective and efficient knowledge for the call center employees were the employees themselves: by providing more opportunity for collective problem-solving and open discussion of issues, the company was able to increase its productivity and reduce unnecessary service visits. It was the ability to interact with peers, not any classroom training regiment, that enhanced the ability of the employees to do their jobs effectively (Brown and Duguid 131–133). If allowing peer interaction and involvement with knowledgeable mentors can create more effective knowledge-building than a systematic database, why are students still being referred to textbooks (a database of information of sorts) to guide the curriculum and discussion, rather than

being encouraged to interact with their peers to help achieve common goals? Students should be given the ability to share insights at time of problem-solving.

Children in today's information-rich society are accustomed to having virtually unlimited access to shared resources, referring one another to websites, online videos, etc. via quick links posted through social-networking sites (such as Digg, CiteULike, Facebook, MySpace, and Twitter, to highlight but a small sampling). Then, in school, they are often told to do their own work, at their own desk, with peer interaction limited to the occasional group project. This edict of isolation from the teacher flies in the face of the expectations and normal behaviors of today's students. Indeed, creativity that is based on outside influences has a history of being valued in society. Students expect to be able to rework previously created material and to work together to create solutions to their current problems. In effect, students expect to work in spontaneous, adaptable teams that use available resources in creative ways. Teachers often experience scenarios similar to that of the longer phone cords in which collaboration among students could solve problems more efficiently than teacher-directed instruction. For instance, when studying Shakespearean literature, a teacher could read the text to the students and interpret the lines for them, or the students could work in groups and collaborate on the interpretation. The teacher-led scenario has only one source of idea generation; by working in groups, students can draw from one another's unique perspectives. This particular example still involves a limitation that is a relic easily mitigated by modern technology: students read from multiple copies of the text that they are not to annotate. Their discussions, interpretations, modernizations, and other notes must all be kept separate from the original work; students create their own notes, rather than contributing to a pool of knowledge created for the group.

2.3.2. *Interactive Content Creation.* Google Wave presents a novel approach to collaborative document creation. With this technology, the wave (so named because it is more a flow of information than a static document) is hosted on a server, and all participants access the wave through their web browsers. Document storage location is no longer an issue; it is hosted online. Software is no longer an issue; the system is supported by all major modern browsers³ and requires no proprietary software to run.⁴ While any user is editing a wave, those edits appear near-instantly on the screens of other editors if they are viewing the wave at the same time. If not, the changes are highlighted for later review (but they are already implemented, so the “review” here is simply informational, rather than procedural, as it was for the distributed-copies theory). The opportunity presented here is for collaborative document creation in a manner that hasn’t been possible: distributed, optionally synchronous, open-access collaboration. Seen through an educational lens, this technology provides several unique opportunities for group-based assignments. Students in a computer lab could work simultaneously on the same document, either composing different sections or even reviewing and revising each other’s work as it is being created. For example, if one student is typing new content and a second student notices a typo, the second student can have the typo fixed before the first finishes composing the sentence.

Because users have the ability to comment as well as edit, students can ask questions of one another or make suggestions for changes before officially committing them to the document. Feedback could be provided the same way: instructors could view the wave, contribute to any discussions taking place, and add comments or suggestions to any point in a document. Through the Google Wave interface, teachers could join in an existing dialog about student writing. By

³At the time of this writing, Google Wave supported Apple’s Safari (Mac, PC, or Mobile), Google’s Chrome (Mac, PC, or Android), Microsoft’s Internet Explorer, and Mozilla’s Firefox.

⁴The feature of Google Wave allowing users to drag content from elsewhere on their computer and drop it into a wave requires the open-source Gears plugin, but all other features and functionality are based solely on the HTML-5 specifications.

using the same tools as the students, the teacher no longer wields The Red Pen that holds the final say in all discussions; shared conversations encourage students to view themselves as peers and to critically consider feedback from every contributor. Allowing the teacher to be a peer in a collaborative environment shifts the responsibility for quality control and empowers students to hold greater sway in the process (King). With the flexibility for all participants to provide feedback or input at the exact time and place they desire, Google Wave promises to create completely new levels of student interaction in the composition process. Revision would no longer be seen as a step that is chronologically separated from the process of drafting; the two actions would co-exist within the same wave. Students would see the benefit of peer review as it was happening, rather than having to wait for back-and-forth communication that might not seem immediately relevant. With the increasing popularity of distance learning, the ability for geographically separated students to simultaneously edit the same document provides yet another way that distance is becoming less and less relevant in today's world.

2.3.3. *Tracking and Accountability.* Several issues predictably arise when students complete work in groups, not the least of which is knowing who was responsible for which parts of a product's completion. If one student writes a draft, but another student revises it later, which one did "all the work"? If one student deletes the group's files, how can those files be recovered? How can the teacher effectively evaluate the individual contributions of students when the product is presented as a group? Google Wave provides several tools that directly address these and other concerns related to ownership and group publication. First, it must be clear that a participant in a wave must be signed in to the system: all access to the system (or its waves) requires that a user be identified before access is granted. In this way, every action performed by a user can be attributed to the correct user. This attribution and tracking is particularly helpful in conversations, when all participants are able to see who contributed each idea to the conversation. For students engaged in



FIGURE 4. The Playback Toolbar in Google Wave

a reviewing/revising process, this is invaluable, as they see who provided which feedback and can respond to the individuals involved based on who is responsible for which part of the assignment. If students are working simultaneously on a wave, they see who is typing new material as it is being added; this allows them to create a better mental model of how the work is being done; it encourages students to feel like they are connected to other people, not just an isolated screen in front of them. They can also more effectively maintain the division of labor as needed, knowing who has made each change to the wave.

A unique feature of Google Wave is its “playback” ability—at any point during the development of a wave, any user is able to review the progression of changes that led the document to its then-current state. Users begin playback by pressing a button with a familiar “play” arrow (▶) to be taken to the beginning of the document’s history...in most cases, back to an empty wave. From there, the user is presented with a toolbar (See Figure 4) containing familiar buttons to move backward/forward or to the beginning/end of the wave’s history and a slider to move to any point in that history. With these tools, any participant can literally watch the creation of the document step by step, including identification of which user was responsible for each change. The utility of this feature becomes clear when one considers the entirely plausible notion of one vindictive student highlighting all the work of the group and pressing the delete key on the keyboard. Under any other circumstances, the expectation is that the work would be lost. However, with the Playback feature, not only can the work be recovered, but the identity of the perpetrator can easily be determined. Similarly, when a teacher reviews the progress of wave construction,

the contributions of each student are easy to determine, making meaningful, individual evaluative feedback far more accurate and far easier to provide. In order to produce a clean, polished, comment-free finished document, the “Copy to New Wave” menu option converts the current-state document content into a separate wave without including the history or comments. With this feature, students have the ability to consider their work “complete” and submit a final version of the document; teachers could refer to the comment-filled wave to score individual contributions and the final draft to evaluate quality of presentation.

3. MISSING SOMETHING: THE SHORTCOMINGS OF GOOGLE WAVE IN EDUCATION

3.1. Not Enough: Nonlinear Brainstorming. While the flexible, interactive nature of Google Wave is an excellent tool for drafting or revising documents collaboratively, it almost requires a document to have a linear structure from the beginning. The format of documents in Google Wave is entirely linear: the user is presented first with the top of the document and must scroll down to see more. No link system appears to exist to facilitate inter-wave hyperlinks, so reading the wave must happen linearly. Natural thought processes are associative (Bruning 68–72), not linear, so composing text in a wave is as restrictive as most any other writing style. Even the presentation of the playback feature is linear: the user is presented first with the initial document and must step through individual changes in chronological order until arriving at the desired state. No options are presented to skip through the history based on alterations made by a specific editor, edits made in a specific section of a document, or changes of a particular kind (comments vs. edits). Without flexibility in presentation, this format is limited to structured, linear thinking, which is often activated after initial idea brainstorming takes place. In other words, while Google Wave can be very helpful in drafting a specific document, the tool’s usefulness only comes into

play once the ideas for the document have been solidified to a certain degree. In short, Google Wave is a collaborative-writing tool, but not a collaborative-brainstorming tool.

3.2. **Too Much: Plugin Availability.** In a clear case of the need for a “less is more” approach, teachers (and systems administrators of federated Google Wave servers) will need to carefully evaluate the availability and use of extensions—small programs that can be dropped into a wave to enhance the wave’s functionality—and bots—intelligent programs that can be added to a wave and that function as another person, contributing or editing content. Extensions are already available for embedding video conversations, voting systems (of Yes/No/Maybe choices), and games (such as sudoku or chess) into any wave. Teachers and schools must conscientiously decide whether they wish students to be presented with some or all of these options or simply eliminate their availability altogether. If the option to embed all available extensions is presented to students, those students would need to understand the difference between helpful and superfluous extensions—a relevant discussion for media and technology literacy. On the other hand, it is not yet possible to exclude various extensions within a preview account, as there is no such thing as “administrative control” over the server or other accounts; whether such functionality will be available for federated servers would only make sense but remains to be seen. While no clear answers are available at this early-preview stage, it is most likely that schools will wish to use their own server resources to host waves and control the content that can be activated on them.

3.3. **Learning Curve: System Design.** One concern regarding the use of Google Wave in an educational environment is the training required to implement and support it, both in terms of server-side support and teacher administration of the students’ accounts and products—essentially, the concern of sufficient infrastructure to support a creative community (Grabill 36–38). Unfortunately, at this stage in the public preview, very limited information is available about server

setup; however, generalizations can be helpful in this instance. Revisiting the Engaging Systems in Education (p. 16), three major components support the implementation of technology in a classroom: hardware systems must be capable to support the demands of the system, teachers must be sufficiently trained not only to know how to use Google Wave effectively themselves but also to clearly and simply instruct students in the best methods of the productive use of this technology. The last component required is access to the technology. For Google Wave implementation to be successful in a school, students would need ample access to computer labs and high-quality network connections. In a time when privacy concerns, especially for students, are at the forefront of nearly every conversation of online information storage and sharing, IT leaders should be cautioned to avoid blocking outside access to any Google Wave systems set up by a school—imagine the disservice to students if the only place they can collaborate is while they are on campus, sitting in the same computer lab with one another! Access to these systems is critical to allow students to integrate information processing into their daily lives and not simply consider it yet another feature only of a classroom and not of “real life”.

Within Google Wave itself, the interface for an end-user can be a bit overwhelming. The biggest challenge in adapting to Google Wave is that it is not a type of product or technology with which users (either students or teachers) are likely to be familiar. As mentioned previously, Google Wave shares similarities with email, instant messaging, wiki systems, and bulletin boards, but it blends the familiar with unique features in ways that require users to adjust to shifting assumptions about technology use. For any new technology to be considered simple and natural, the interface and the design must be transparent, and support or help must be accessible and relevant. If the feature set or interface is obtuse, it will be more of a struggle to use than a tool to implement. Google Wave, specifically because it combines so much into one system, runs a very high risk of introducing unnecessary complexity, which could lead to confusion or frustration.

Schools must ensure that teachers are sufficiently trained in the Google Wave system *and* in how to train others in using it effectively. We don't need to spend all our time and energy teaching Google Wave; we need to be teaching *with* Google Wave. Better yet, we need to let students *produce* with Google Wave.

4. CONCLUSIONS

Despite its limitations, which primarily stem from the nature of text-based communication in general, Google Wave is impressive in its potential to reshape collaborative document creation, particularly in the education environment, where collaborative learning has effectively become a standard expectation across curricula and grade levels. Given sufficient familiarity with the basic operation of a wave, teachers will have access to a powerful tracking and accountability system that supports individualized assessment while contributing to group production of finished work. Students have the unprecedented ability to work simultaneously on the same document, a task not even possible under the pen-and-paper standard. By giving students the freedom to interact directly with their texts, whether they be self-created or acquired from other sources, we are encouraging a degree of engagement and interaction that until now has been severely lacking in our school systems. Students who have the ability to voice their opinions and questions about the material at hand have a direct connection to their studies, and a greater sense of responsibility for the outcome of their work. When students can collaborate in real-time, they feel a sense of urgency and life behind their efforts; Google Wave allows for this live connection by ensuring that all participants in a wave are working with identical copies of the document, updated essentially instantly as changes are made. Students who are unable to join the discussion as others are doing work can relive the experience through step-by-step playback of the creation of the material. With communications supported by this technology, time is removed as a potential barrier to

student success. Interactions become nearly a level playing field for those interacting live versus those revisiting later.

Preparing students for life in our media-rich culture, we must consider the role that effective interaction plays in an information-age society, and we must bring that interaction into the classroom, making sure our students develop the skills to engage with others in a meaningful and effective manner while they are in school. Mass media is already teaching students how to be an active part of their connected world; why should their experiences in the classroom be any different? Teachers have attempted (some successfully) to incorporate wikis and blogs into their instructional methods, and these technologies allow for a sense of community and a sense of sharing, but access, management, and accountability are often roadblocks to smooth operation and integration within a course. Google Wave presents a system that is self-contained for simplicity yet extensible for flexibility. With the right controls, teachers can provide an engaging environment for both student-to-student and student-to-text interactions in a very immediate and real way. Allowing students to interact in Google Wave will be sharing with them a piece of technology that can help them engage with the material in ways we have yet to consider; it will help prepare them for life outside the classroom by expanding the classroom into the present world of new media.

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