2009

Wikis in the Classroom: An Agenda for Studying Collaborative Writing in Information Systems Research

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ABSTRACT

This paper proposes a research agenda for a relatively new area of research in information systems: wikis in collaborative writing. We introduce wikis and the concept of collaborative writing using four different educational cases of wiki-usage for collaborative writing in the classroom setting. Eight research questions are suggested related to this area of research. We propose that Adaptive Structuration Theory (AST) is a useful theoretical framework to study these questions. The paper suggests the importance of this new area of research through four case studies and identifying research questions that need to be addressed using the AST framework and suggesting implications for educational practice.

Keywords

Wiki, education, training, collaboration, collaborative writing, collaborative learning, groupware, social software, Adaptive structuration theory

INTRODUCTION

Writing is fundamentally a technology (Ong 1987). From the clay tablet to the World Wide Web, the technologies of writing not only effect, but define what writing is. The written word does not exist separately from the technology that preserves or erases it, conveys or cements it in place. While technologies that support collaborative writing (CW) have been studied in information systems, the tools studied supported other activities as well, so the focus on CW has not been developed as a specific research agenda.

Information systems research is broadly concerned with the development and use of information systems from the individual to the societal level (Oates 2005). Generally, these systems are part of information technology. In this paper we argue for more specific attention to a particular IT implementation, the wiki, that supports very first information technology, writing. Collaborative writing has been practiced well before IT as we know it today reached even a rudimentary form (Ede and Lunsford 1992). A wiki is a web-based technology that is growing in popularity, largely due to the success of Wikipedia, and has refocused public and scholarly attention on collaborative writing (Kane and Fichman 2009). Information systems research can play an important role by bringing the IS perspective to the study of this important collaborative technology.

This paper reviews wiki technology and the concept of collaborative writing as part of the collaborative learning paradigm. We report on four cases of wiki use for CW in an academic institution as exploratory research to generate further research questions in this area. The cases are considered in order to show some of the diversity of real-world wiki application in the higher education classroom so that the research agenda is grounded in use and experience rather than speculation. Adaptive structuration theory (DeSanctis and Pool 1994) was applied to the cases to frame the relevant elements and to guide further research. The paper suggests important research questions for IS researchers to pursue in the area of wikis and CW using the adaptive structuration theoretical framework. The paper identifies new opportunities for research in IS that would have implications on design of wikis as well as the design of CW processes.

It has been shown in the IS literature that the interactions between the technology artifacts and the users' norms and work practices play crucial roles in successful assimilation and application of technologies in organizations. IS scholars have been using theoretical frameworks such as Adaptive Structuration Theory to understand these interactions. There has been anecdotal evidence of such interactions in the context of computer supported CW. For example, in a study on how technology was used to support CW, Rimmershaw (1992) found that participants of CW groups either modify technologies available to them, or change their work practices to improve the task-technology fit. However, there has not been a study that takes a systematic and theoretical driven approach to understand these interactions. Therefore, we believe that recent advances in our understanding of CW processes (Lowry 2004), combined with the long tradition of studies on technology assimilation in the IS literature, gives us a fertile ground for investigating how technologies such Wiki would interact with users' writing practice to form an effective solution for computer supported CW.

In summary, to better understand how users use CW tools and how those tools should be designed, we need a better understanding of how technology interacts with CW processes. We believe that the application of adaptive structuration theory could help us to fill this gap.

Wiki Technology

Wiki technology has been in use since 1995 when Howard G. (Ward) Cunningham launched WikiWikiWeb (http://c2.com/cgi/wiki), focusing on patterns for software development. Wikis became known to wider audiences particularly after the Wikipedia was launched in 2001, and became more visible in 2002 through today with many Wikipedia articles ranking high in search results. Wikipedia is just one wiki among many that use varying features and underlying technologies to support different goals. The main commonality among different wiki implementations and projects is that they involve collaborative authorship on the web. It is possible for a wiki to be used by one person, but this will not be covered in this paper.

The technology of most Wikis is very simple to use. It has been described by Ward Cunningham as "the simplest online database that could possibly work" (2002). It is a web page where the user can click an edit button and change the content of that page or create a new page in a simplified markup language. What you see is what you get (WYSWYG) formatting is also possible although not widely available. In most wiki implementations, changes are saved to a history log and can be reversed. Some Wikis allow anonymous users to edit and view the pages while others do not. The organization of Wikis has been described as "very much free form. Across the whole wiki there is a hypertext structure, but on a given page, within the versatility of your command of your natural language, you can say whatever needs to be said" (Venners 2003)

Growing familiarity and recognition of this form of software's potential for CW has lead to increasing use in organizational and academic contexts. Most of these cases are reported informally if at all. There are few published scholarly cases of how people use wikis (e.g. Raitman, Augar and Zhou 2005), although introductory, speculative or technical articles are common. There is an abundance of relevant literature to draw from, however, from collaborative learning, CW and studies of the technologies that support these activities.

Collaborative Learning

Collaborative learning is a term popularized by British scholar Edwin Mason (1970). Educational collaboration has been observed in the efforts of autonomous peer groups in America since the eighteenth century (Bruffee, 1999). The definition of collaborative learning, however, differs greatly among practitioners (Dillenbourg, 1999). One key distinction that is often emphasized is the difference between collaborative learning and cooperative learning. “In cooperation, partners split the work, solve sub-tasks individually and then assemble the partial results into the final output. In collaboration, partners do the work 'together'” (Dillenbourg, 1999, p. 8). Both types of learning tend to happen over time during group projects, and distinctions can easily blur between the two in practice. In this paper we use the term collaborative learning to indicate both processes. Following Stahl et. al. (2002) we take the core of collaborative learning to be “negotiation and sharing of meanings—including the construction and maintenance of shared conceptions of tasks—that are accomplished interactively in group processes” (p. 3).

Collaborative learning has been shown to enhance critical thinking (Gokhale 1995) and generally help students to learn course material more thoroughly and in-depth than on their own, although different theoretical approaches to measurement and different levels of analysis have complicated results (for a review see Bruffee 1999; and Dillenbourg, 1996). The process of collaborative learning helps to generate a body of active knowledge, while individualized learning can become passive (Van Merrienboer and Paas 2003). Computer supported collaborative learning (CSCL) is an active area of research in learning sciences (Stahl et al, 2006).

Collaborative writing is centrally important to collaborative learning. Learning to write effectively is key to the ability to contribute to the joint construction of knowledge. Collaborative writing is also a key part of workplace practices, and is taught in the classroom as a way to introduce students to professional genres of writing (Sutton 2007). It is through writing and reading that we acculturate and reacculturate ourselves in the conventions and languages of the communities that we are part of or that we hope to join. This is because when we write we adapt and reconstruct the communities that we are part of by renovating the inherited linguistic material that makes up these communities (Brufee 1999).

Collaborative Writing (CW)

Collaborative writing has been studied in various disciplines using different definitions. Each discipline or research stream emphasizes certain aspects of the complex and multifaceted CW process (for a review see Lowry et al 2004 and Forman 2004).

Whereas information systems specialists are concerned with the choice and use of an IS tool to manage development of a product that, incidentally, is a collaboratively written document, business communication specialists may want to know about the writing processes and products of groups as influenced by technology. (Group process specialists are likely to emphasize the collaborative in CW; the writing itself being incidental, a mere example among many of a group-developed product.) (Forman 2004 pp.33)

Also, several of the social sciences as well as the education and language disciplines have their own perspectives from which to approach the topic. The authors of this paper, from the communication and IS disciplines, will define CW based on the work of Bosley, who stated that CW is the process in which two or more people work together to produce a written document such that the entire group takes responsibility for having produced the document (1989). It is also important to note that writing itself is a technology (Ong 1982). There is no writing without something to write on and something to write with. Human systems of writing have always had a complex interrelationship with technologies, from clay tablets to stone to paper to electronic forms, each potentiating different relationships and activities with writing and between writer and reader. We will focus on group responsibility and the interrelationship with technology.

Effective CW practices rest on the concept that social creativity can be more productive than individual creativity in certain settings (Ede and Lunsford 1992; Fischer et al 2005). Effectiveness is influenced by many interrelated factors such as motivation, consensus, communication skills, consensus building, coordinating, socializing and planning. Collaborative authoring situations are dynamic systems where the forces of control, authorship, responsibility, authority, originality, creativity and knowledge are continually interacting to create a delicate and somewhat unstable balance. This tenuous balance is in many ways dependent upon the interrelationships between the authors and the power configuration of the group (Ede and Lunsford 1992). For instance, the freedom to explore and create is balanced by limitations of time, focus and structure.

Strategy	**Definition**
Group single-author	One person is directed to write for the entire team
Sequential single author	One person writes at a given time; each writer completes his or her task and then passes it on to the next person, who becomes the next single writer
Parallel - Horizontal Division	A team divides CW work into discrete sub-sections to be completed by an individual and the team works in parallel
Parallel - Stratified Division	A team divides CW work into roles for each team member, such as editor, author or reviewer team works in parallel
Reactive	Writers create a document in real time, reacting and adjusting to each other's changes and additions without significant preplanning and explicit coordination
Mixed Mode	A combination of two or more of the above strategies

Table 1. Collaborative Writing Strategies (Lowry et al 2004)

Studies of CW often have difficulty expressing the high-level strategies used for CW. These strategies are "a team's overall approach for coordinating the writing of a collaborative document" (Lowry et al 2001). We will draw upon this existing taxonomy reproduced in Table 1 to define the strategies used in wikis and in our case studies below.

Computer Supported Collaborative Writing

Since the early 1970s, various computer tools have been built to support CW. These tools, such as groupware or group support systems were, however, designed to support the broader area of computer supported collaborative work (Newman and Newman 1992; Posner, Mitchell, and Baecker 1995). Specialized systems have also been developed to support CW, especially, distributive CW over computer networks (e.g., Jones 1993). More recently, the advent of the Internet has brought a host of web-based CW systems (Noël and Robert 2003). As an open standards-based and readily available technology, the Internet allows individuals distributed around the globe to collaborate on a single task from different computing platforms. In Noël and Robert (2003), they identified and review fifteen different web-based CW applications, including Wiki Wiki Web. Most recently, there have also been attempts to adapt wiki for CW in classroom settings (e.g., Wang and Turner 2004).

Despite the significant amount efforts invested in the past three decades in development of computer technologies for supporting CW, studies have suggested that these tools are not being used as expected. Noël and Robert (2004), for example, conducted a field survey and found that the majority of the respondents are relying on individual word processors such as Microsoft Word and email as their main tools for writing documents collaboratively. In Noël and Robert's study, respondents reported that there is a set of common features they look for in CW tools: synchronous access to the document, version control, change tracking, comments and notes, etc. However, in the same study, it was also found that there was great variability among CW projects in terms of group membership, management, writing strategy, or scheduling issues.

A key element of any collaborative technology is how it enables participants to relate to each other over time, its synchronicity. Dennis (1999) proposes a theory of media synchronicity composed of two fundamental processes, conveyance and convergence.

> Conveyance is the exchange of information, followed by deliberation on its meaning. It can be divergent, in that not all participants need to focus on the same information at the same time, nor must they must agree on its meaning. In general, low media synchronicity is preferred for conveyance. Convergence is the development of shared meaning for information. By definition it is convergent, in that participants strive to agree on the meaning of information and agree that they have agreed. This means that participants must understand each other's views. In general, high synchronicity is preferred for convergence. (p. 5)

Since collaborative writing involves developing shared meaning, a convergent technology might be presumed to be more effective, but some evidence suggests that it is possible to produce effective collaborative learning outcomes using asynchronous technology (Ocker and Yaverbaum 1999). The temporality of the medium is important and can be counter-intuitive. For example an affordance of instant messaging technology is its temporal flexibility, rather than just its immediacy (Nardi 2000).

Researchers have highlighted the importance of understanding group level behavior for designing collaborative tools in the past. Cole and Nast-Cole (1992), for example, identified eight areas of group dynamics that are crucial for groupware designers. These areas include the group's purpose, communication, content and process, task and maintenance activities, roles of group members, shared norms, group leadership, and stages a group go through during its life. Similarly, Gutwin and Greenberg (2000) suggested seven major collaboration activities such as coordination, planning, and monitoring that have to be taken into consideration by groupware designers. However, such insights seem to be mostly unheeded by designers of CW tools. A few researchers have noted that our general lack of understanding of the dynamics in a CW group may have contributed to the limited success in developing useful CW tools in the past. As pointed out by Posner and Baecker (1992): "Although this existing work has uncovered ubiquity and consequence data on CW, it does not inform us about the joint writing process sufficiently to guide the design of CW technology.

It is also worth noting that some researchers have acknowledged the importance of "technology in use" and emphasized on the user aspects in guiding system design (Neuwirth et al. 2000). However, their approaches generally rely on heuristics rather than theoretically informed understandings of how users integrate their norms and writing processes with technologies.

Adaptive Structuration Theory (AST)

Adaptive Structuration Theory (DeSanctis and Poole 1994) has been developed to study the role of advanced information technologies in organization change. The theory integrates the major perspectives on technology and organizational change from the decision-making school and the institutional school. The theory relies on examining the types of structures provided by the advanced information technologies as well as the structures evident in interaction of people with these technologies. Organizational change is theorized to occur when the group members appropriate the technology and other structures (tasks, group's internal system, and the larger organizational environment) during the group decision activities (idea generation, participation, conflict management, influence behavior, task management). The impact of the technology on the decision

outcomes (measured by efficiency, quality, consensus, commitment) are dependent on the technology structures and the appropriation of the technology and other structures.

The social structures of advanced information technologies are described by their structural features and the spirit of these features. The structural features consist of the resources and capabilities offered by these technologies. As an advanced information technologies are often characterized by a set of loosely bundled resources and capabilities, they can be implemented in different ways. This can effect the outcome of the tasks for which the technology is used.

The spirit of a technology is a property of the technology as it is presented to the users' (DeSanctis and Poole 1994). Spirit is an intrinsic part of the technology (including its features, interface, and guidelines) that reflects the goals and values of the technology. It serves as a guiding principle to use the technology, interpret its features, and adapt it for specific purposes. Spirit of the technology is characterized by various dimensions such as the decision process (the type of decision process being promoted), leadership (likelihood of the leadership emerging), efficiency (length of interactions as compared to ones where the technology is not used), conflict management (orderly or chaotic interactions), and the atmosphere (formal/informal, structured/unstructured interactions).

Traditionally, AST has been used by IS researchers to study Group Support Systems (GSS). Specifically, AST has been used to study the adoption and use of GSS in project teams (Dennis and Garfield 2003), the dynamic effects of GSS on group meetings (Reinig and Shin 2002), the effect of mediators such as facilitation, GSS configuration, and user training on group decision techniques and outcomes, and the description of the GSS process itself (Gopal, Bostrom and Chin 1992). Further, AST has been used to examine the electronic communication in global virtual teams (Maznevski and Chudoba 2000).

Using four case studies from classroom setting and the CW taxonomy discussed above (Lowry et al 2004) We preliminarily describe the structures, decision activities, and the outcome of the decision processes for each case. Further, we elaborate on why it is important to study the structuration and appropriation aspects of wikis and their use for CW.

METHOD

We first describe the structure of wiki technology according to AST (DeSanctis and Poole 1994). This description was constructed by analyzing wiki documentation and recommendations, descriptions by the originator of the technology, collaboratively written descriptions of the technology by users, and our own experiences. Next we describe the structure of the college classroom situation because it is common structure for each case we will examine.

We describe the group's internal system and task for each of the cases as background information to inform the interpretation of the edit log analysis. Each of the wikis analyzed provided a detailed log of every edit with its content, time and the author. This type of detailed record of interaction is extremely valuable for the study of action as structure that structurational approaches require. This type of data has been difficult to obtain (Barley, 1996), so this data set provides a unique opportunity to further this type of detailed research of practice. The log data were analyzed according to Strauss & Corbin's (1998) grounded theory methods, starting with an open coding approach. Key codes included cooperation and coordination, as well as task specific learning objectives.

The cases were chosen based on two criteria, availability of meaningful data, and diversity of implementation. The four cases of wiki usage illustrate a range of different applications of this technology. The authors have participated in many instances of wiki use. These four were chosen because they differed from each other in significant respects, such as incentives for participation, department, level of study (graduate versus undergraduate) and face-to-face with online support versus online only. The authors have extensive personal knowledge of each case.

The structures and cases are used as a heuristic device to point toward a research agenda for IS. Cases where the wiki was actively used were chosen for analysis, but unsuccessful cases are also considered in the discussion.

APPLYING AST TO WIKIS

Social and Technical Structure of Wikis

As stated above, there are two aspects of an advanced information technology that make up the structure of an advanced information technology tool, the technical capabilities and rules of the system, and the spirit that this embodies.

The nature the wiki technology is the subject of debate. At the time of this writing the Wikipedia page about wikis (http://en.wikipedia.org/wiki/wiki) contained the following notice, "As a result of recent vandalism, or to stop banned editors from editing, editing of this page by new or unregistered users is currently disabled." Open and vigorous debate is part of

many Wikis, particularly Wikipedia, as is evident from this article's discussion page (http://en.wikipedia.org/wiki/Talk:Wiki).

The free, open and independent spirit of wiki technology is manifest in many ways. The idealized implementation of a wiki is publicly available on the Internet, has no restrictions on who can edit content, allows anonymous editing, is quick and easy to use, and is edited frequently by many editors. The inherent difficulties with this idealized implementation are widely recognized as vandalism, edit wars, lack of verifiable sources, and difficulty obtaining a consistent organization of information. Ideally, the difficulties are to be overcome with a dedicated and active community of collaborative writers that monitor and improve the wiki's content *ad infinitum*. The wiki is envisioned as a *tabula rasa*. Its flexibility is emphasized and experimentation is often encouraged.

The most prominent wiki is Wikipedia. Wikipedia allows anonymous editing of any page, but only allows page creation by users who login. It also reserves the right to suspend anonymous editing of a page, and users can be temporarily banned from editing based on an arbitration decision (http://en.wikipedia.org/wiki/Wikipedia:Arbitration_policy). In other respects it follows the ideal model. It explicitly promotes community formation, social norms and practices around the tool through the many aspects of the Community Portal (http://en.wikipedia.org/wiki/Wikipedia:Community_Portal) and through events such as WikiMania (http://en.wikipedia.org/wiki/Wikimania).

The spirit is also demonstrated by the licensing of most wiki software as free and open source. There are many implementations of wiki technology, each with different features. The core features of a wiki are that a user can edit its content (create, change and delete) and this is accomplished in a free-form or very loosely structured way. The type of content is largely hypertext documents, although graph editing is possible. The primary order of a wiki is not chronological, but ontological. The structure is flexible, unlike other collaborative systems such as weblogs and email lists that are primarily chronological. Other central but not universal features of wikis are a shared locus of control, and page history. While many wikis allow or require a login to edit or view content, once a user is able to edit, each one has the same level of privilege to add, edit, or delete content, this includes teachers and students, managers and employees. Like all wiki features there are some exceptions where hierarchical levels of privileges are implemented but this is not a typical feature. Page history is an automated feature that saves all changes to a wiki page and allows one to view the content of changes over time, who has changed it, when it was changed, and allows editors to revert to prior versions of the page. This was not part of the original WikiWikiWeb, but it is a very common feature.

The cases we describe below are different in several respects from the ideal. The groups of writers were discretely bounded by participation in a particular course, and editing was restricted by login. In two cases, the report case and the virtual case, the projects had an end-point and were not meant to continuously evolve over time. In the virtual case, the software was proprietary rather than open source. Wiki use in a classroom setting necessarily involves some deviation from the ideal wiki scenario, but does not fundamentally violate the spirit of wiki technology because appropriations of the technology are encouraged. Certain cases of wiki use in the classroom deviate from the ideal more than others.

Structure of the College Classroom

The classroom environment of higher education has traditionally and continually placed a value on writing itself as one of the primary ways to promote and evaluate learning objectives. It is one of the few cross-disciplinary values to be embraced quite widely. An example is the writing across the curriculum movement that has been accepted in universities across the United States and beyond (see Anson, Schwiebert and Williamson 1993).

Collaborative writing, however, is not central to the college classroom in many disciplines. The level of acceptance or encouragement of collaboration in general and CW in particular varies considerably across cultures, universities, disciplines, and individual instructors. These attitudes and values heavily influence task structures, and IT support choices for these tasks. Below we will discuss four cases where CW through wiki technology and the higher education classroom have intersected.

The Notes Case

Group's Internal System and Task

On the first day of a social science graduate seminar course at a large public Midwestern university in the Fall of 2004, the professor said that there was so much reading on the syllabus that the students would have to work together to manage it. All students were responsible for the course material individually because the grades were individual, but they could and should work together to understand the readings. One student suggested using a wiki to facilitate note sharing among the class. Another student, was enthusiastic about the idea and after class all of the students met to coordinate who would post notes for

which articles on the wiki. Each reading was assigned to two students who would be jointly responsible for posting the notes to the wiki by the agreed upon deadline, although all were welcome to contribute to the notes of any article. Note posting assignments were then given by the students themselves each week for the following week's readings. Assignments were given according to student interest or prior familiarity. The first person to post their notes simply posted them, and the second person would extend the notes or add comments. Sometimes this would lead to a conversation on the wiki or in class. The two student leaders acted as technical facilitators when questions about the technology arose. According to the Lowry et al taxonomy (2004) the writing strategy was mixed mode. Primarily, there was a horizontal division according to student coordinated assignment of texts, but reactive writing also occurred because the writers were divided into teams of two reactive writers.

The class consisted of 11 first year masters students from the same department and one PhD student from a different department. None of the students had taken classes together before and they did not know each other. Also, none had used a wiki extensively before, although Ericka and Gary were familiar with the concept. The professor did not want to interfere with their process and, although invited, choose not to edit the wiki or observe its development.

Outputs

Pages	Editors	Number of Edits	Remarks
1-12	3	24	Week 1 Readings
13-22	11	111	Week 2 Readings
23-29	8	85	Week 3 Readings
30-35	9	33	Week 4 Readings
36-42	6	35	Week 5 Readings
43-49	5	73	Week 6 Readings
50-57	10	67	Week 7 Readings
58-65	6	37	Week 8 Readings
66-75	5	23	Week 9 Readings
76-83	6	46	Week 10 Readings
84-89	7	21	Week 11 Readings
Total	11	555	

Table 2. The Notes Case

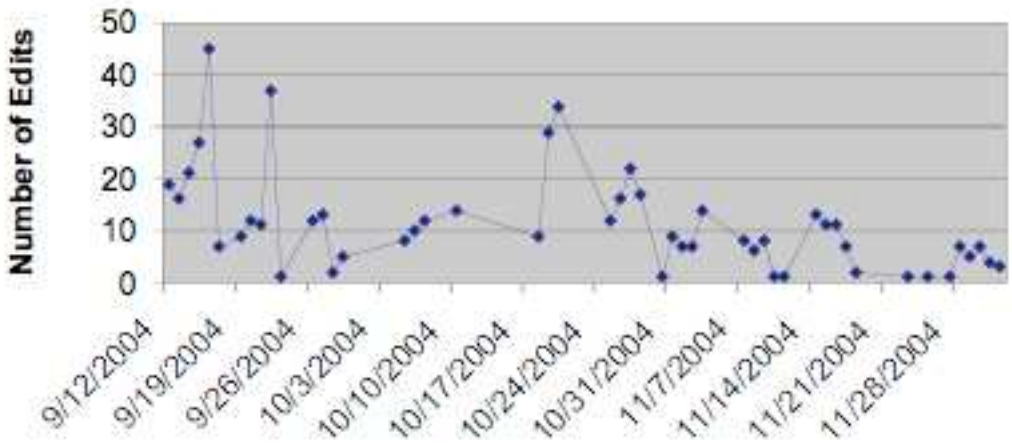

Figure 1. Notes Case Editing Time-line

A summary was produced for 89 readings, with 46 having a single author and 43 with multiple authors. It seems that the status of an assignment among students themselves did not produce a strong commitment from all students, however, a remarkable amount of CW occurred over the semester and all students voluntarily participated in wiki editing.

Outcomes

The professor remarked several times that the class discussions were very good, and that we were a particularly collegial class. The wiki itself was not graded so there is no quality measure available. The notes are permanent part of the department's evolving wiki, and are available for revision by future classes.

The Report Case

Group's Internal System and Task

A wiki was in use for this graduate course in research methods in the same social science department as the notes case, the subsequent semester. It was required for posting field notes and scheduling trips to the field site, but was not used in an extensively collaborative way until the end of the semester. The class had been working with a local community group on a joint research project. The class had required eleven separate reports from the students, but the community group needed a single report. One aspect of the take-home final exam was that students must create a single report from the eleven reports. The instructor and teaching assistant assigned each student a role and determined the high level structure of the document. A student was assigned either as captain or assistant in charge of a certain section or sections, such as introduction or a sub-section of method, or as an overall editor who was to delete redundancies and grammar errors throughout the document. Students were slotted into available roles based on their abilities as assessed by the professor and teaching assistant. The writing strategy was mixed mode. There was a horizontal-division, a stratified division, and significant reactive writing because multiple authors were assigned to each role and division.

The class consisted of 13 authors, six first year graduate students who had and five students who had not participated in the notes case, the same professor in whose class the notes case occurred, and one of the authors as the teaching assistant.

Outputs

Page	Editors	Number of Edits	Remarks
1	6	17	Executive Summary
2	8	99	Introduction
3	12	69	Literature Review
4	12	222	Results
5	6	24	Conclusion
6	7	11	References
7	3	8	Appendix
Total	13	450	

Table 3. The Report Case

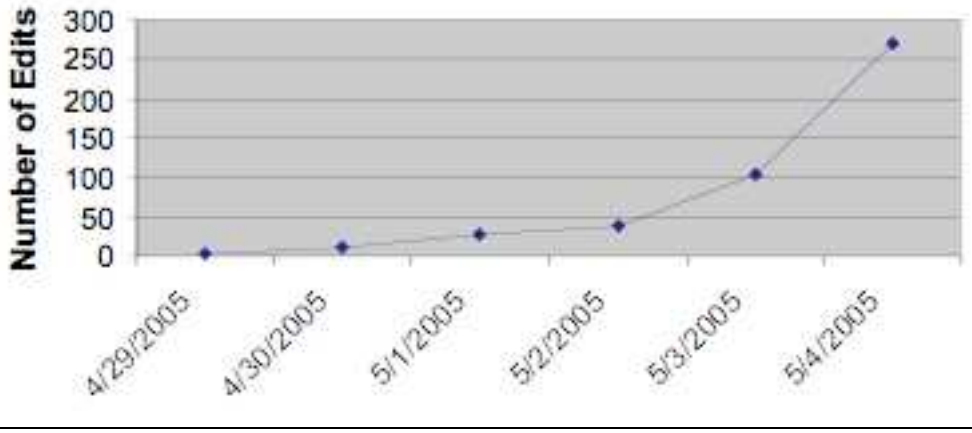

Figure 2. Report Case Editing Time-line

This case took place over a significantly shorter time frame than the notes case and was far more complex in strategy and in the type of document produced. It also had an end-point, with a crescendo pattern of editing until the deadline. Participants described the process as frenzied, as we can clearly see in the number and close time frame of editing by different authors.

Outcomes

Although individual contributions varied in quality and quantity, the overall document was evaluated as good quality. The finished document itself was not graded, individuals were given grades based on the quality of their contributions as judged by a review of the wiki 's history. The community organization was pleased with the final report.

The Virtual Case 1

Group's Internal System and Task

A class of 12 students in a Public Health Informatics class were asked to use a wiki to generate a co-authored document on a given topic within a specific time-frame. The class was taught online and hence the individual members were geographically distributed and did not have any face-to-face interaction. The students were graded for their contribution towards the single document as measured by the number and quality (subjectively assessed by the instructor) of their revisions to the document. The students were not assigned any particular roles and all had equal authority on the document. The writing strategy was primarily reactive, although the students seemed to have organized horizontal division writing as well. The students were prompted to read assigned material and create the document based on these readings. The students were also encouraged to go beyond the assigned readings to develop the topic. It is important to note that all of these students were using a wiki for the first time and were provided some initial technical support to enable their CW task.

The same class of students were split into four groups of three students each in a second CW exercise. The grade, however, was based on not only their individual participation but also the group result in creating a good manuscript. The students were not assigned any particular readings and were open to refer to any available literature.

Outputs

Page	Editors	Number of Edits	Remarks
1	12	30	A single coauthored document on a specified topic

Table 4. The Virtual Case I

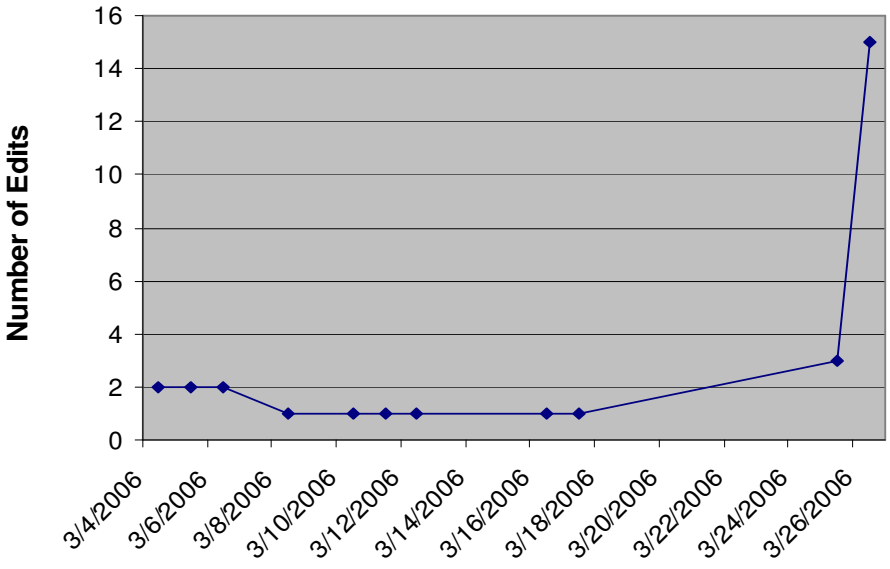

Figure 3. Virtual Case 1 Editing Time-line

As expected, editing activity increased toward a peak as the deadline approached. It is likely that the wiki was not the site of all negotiation around this document even though this was an online only course. Email and other forms of communication likely supplemented any on-wiki negotiations but any such communications were not available to the researchers.

Outcomes

The initial set of revisions to the document were haphazard and did not reflect any structure or planning from the students. The final document, however, reflected a good logical structure and coherent arguments as judged by the instructor.

The Virtual Case 2

Group's Internal System and Task

The same set of 12 students in the Public Health Informatics class were split into four groups (randomly) of three students each in a second collaborative exercise. The grade, however, was based on not only their individual participation but also the group outcome in creating a good manuscript. The students were not assigned any particular readings and were open to refer to any available literature.

Outputs

Page	Editors	Number of Edits	Remarks
1	3	9	Students were divided into four groups. Each group coauthored a separate document. The topic specified was common across all the groups. The corresponding four charts were not included for brevity.
2	2	5	
3	2	14	
4	3	6	
Total	10	34	

Table 5. The Virtual Case II

As can be inferred from the table, the number of edits differed widely among the groups. This is a rough indicator of the extent of the collaborative activity performed by the members in these groups.

Outcomes

The initial observation from this case was that the quality of the documents (assessed by the teaching assistant) varied with each group.

Case Discussion

Each of the cases discussed had some degree of success as judged by the wiki creators. The notes case was the most remarkable because there was no grade-based incentive for participation and a large amount of content was generated. There have been cases where the wiki technology has not been adopted (Krause, 2004). In our own experience this happened with next year's class of students in the social science graduate seminar where the notes case occurred the prior year. Although they had the professor's encouragement (although not direct incentive) and technology introduction, there was very little editing of the content and the project faded. This was attributed, informally, to a poor group dynamic due to one particularly argumentative student, lack of incentive, and lack of ownership.

Wiki technology seems to support reactive writing better than information technologies have in the past. In each case the reactive writing strategy was used either as a supplement to the overall strategy or as a primary method. With more effective technological support for reactive writing, the potential of this strategy can be fully investigated. In the report case, thirteen authors contributed to the same document in a very short period of time. Although there were reports that the experience felt somewhat chaotic, it is likely that the same product could not have been produced in such a short period of time without such an effective version control system as the wiki provided. The automated version control of a wiki seems to allow for larger teams to use a reactive writing strategy. Further investigation of this question is needed.

The group of students in the first virtual case had never used a wiki before and were not familiar with the concept of CW at all. As a part of the first assignment, they were introduced to the wikis and some assistance was provided for them perform their collaborative tasks. It was observed that the groups did not use the discussion feature in the wiki to plan their activities. This might be due to their lack of familiarity with the wiki environment. However, the same set of students used the discussion feature in the wiki to communicate with other on the document. This can be perceived as an indicator of some planning of CW tasks by these groups. This also indicates that the groups were able to adapt the wiki structure to their needs.

AN AGENDA FOR COLLABORATIVE WRITING RESEARCH IN INFORMATION SYSTEMS

This section integrates few of our observations from the cases with the AST framework to propose a set of research questions for IS researchers to pursue in the future.

Topic	Research Questions
1. Wikis as social structures	What are the different social structures of a wiki?
	How do wikis differ in their spirit and structural features sets?
2. Other sources of structure in CW tasks	What are the content and constraints of different CW tasks?
	How do wiki structures vary according to the structures of the CW tasks and environment?
3. Appropriation of wikis	How are wiki structures appropriated in a specified context of CW?
4. CW processes and outcomes	What are the ideal appropriation processes to achieve desired outcomes of using wikis for CW?
	What are the different decision processes required for a successful CW outcomes using a wiki?
5. Social dynamics	What are the social dynamics that emerge in CW using wikis?

Table 6. An Agenda for IS Research into Collaborative Writing (CW) with wikis using AST Framework

Structure of Wikis

Although a wiki can be considered as a simple, easy to use technology for CW, its openness and adaptability allow for many uses that wikis were not originally intended to support. For example, as a wiki is web-based, it could be used as a way to keep a chronological journal (as a blog), to communicate with group members (as an e-mail) or even be used for single-author writing (as a text editor). These alternative uses can be successful in some cases, but they do not fully use the strengths of wiki technologies. New functions are being added to certain wikis, such as restricted access, private workspaces, hierarchical organization and even integrating with the centralized content management systems (Lamb, 2004). Such an increase in complexity of the structure of wikis change the original intent of the system. This is a part of adaptation of the technology to new contexts, but it also changes the spirit of the system to fit, rather than change and possibly enhance current practices.

In our cases, the user interfaces of the wikis used in the Notes and Report cases differed from the one used in the Virtual cases. In the virtual cases, the interface was more similar to a text editor and the students did not need to use a simplified markup to write the content as required by the traditional wikis. In the Notes and Report cases, the wiki required the students to become familiar with the markup conventions required to add content to the wikis. It is possible that these groups would have appropriated the wiki technology differently based on such differences in their structure. This can effect the outcomes of the CW task. Based on varied structures offered by different wikis, IS researchers can pursue the following two research questions:

- **Research Question: What are more effective social or organizational structures that would contribute to the success of wiki technology as a CW tool?**
- **Research Question: How do wiki implementations differ in their spirit and structural features sets; i.e. what are the socio-technical assumptions of design and are they born out in practice?**

Other Sources of Structure

Wikis are information technologies that simplify the process of CW. The groups involved in CW interact with one another using using a wiki technology. There is also appropriation of the technology involved based on the structure of the wiki, task, environment in which it is used, and the nature of the task for which it is used. It is also dependent on how the groups involved in CW interact, their knowledge and experience with the wikis, and their perceptions toward the knowledge of other group members. The reported "speed" of a wiki is also a very important factor for CW. Prior research has shown that "commitment can wane in writing tasks that take place over extended periods" (Lowry et al 2001 pp. 70). It needs to be investigated by future research to see if the increase in the speed of the writing process leads to increased commitment by the group members.

The group structure, the tasks specified, and the planning or lack of planning of CW tasks are some of the attributes for CW process that were identified from the cases we had observed. For example, CW tasks in law firm can have an entirely different set of constraints compared to CW tasks required in a classroom. Depending upon the context in which the wikis are used, IS researchers can concentrate on the following research questions specific to the context:

- **Research Question: What are the content and constraints of different CW tasks?**
- **Research Question: How do wiki structures vary according to the structures of the CW tasks and environment?**

Appropriation of Wikis

Appropriation moves associated with individual writing acts, when compiled across certain phases of CW or the entire CW may reveal dominant patterns of appropriation in the group. This is also indicative of the fact that any form of shared writing is part of a conversation, either displaced over time or more immediately communicating to co-authors or editors (Bruffee 1999). The reactive writing paradigm, enabled by a wiki, has an effect on the individual appropriation moves over the period as they gain more knowledge about the structures embedded in the wiki, the group's style of interacting, other members' knowledge of the structures, and in general their agreement on how the structures should be appropriated. It has been suggested that reactive writing can foster more creativity (Lowry 2004).

In the notes and report cases appropriation happened through face to face conversation as well as content visible on the wiki. The professor who was involved with notes case the prior semester suggested its use for the report case, even though he had never edited the wiki during the notes case. Also, other students sometimes suggested using the wiki for new tasks, even though they weren't necessarily the most frequent editors of the wiki. This re-adaptation of the tool and knowing where it would work appropriately seems to evidence a deep structuration process. This type of structuration seems to take quite a long time for most people, although some, such as the professor, need only peripheral exposure to appropriate it. We observed in the virtual cases that the same group of people further appropriated the wiki as they became more familiar with the tool and the CW process. This is evident in their use of "comments" feature for planning the CW task in the second assignment but completely ignoring it in the first assignment. It would be interesting to see what factors motivate groups to successfully appropriate the spirit of the wiki technology in a given context. Hence, IS researchers can pursue the following research question to study the factors in depth:

- **Research Question: How are wiki structures appropriated in a specified context of CW?**

Collaborative Writing Processes and Outcomes

Lowry et. al (2005) in their research on novice, virtual CW teams found that these groups need appropriate procedural support to improve CW capabilities. The research finds that by explicitly defining group processes, the group performance of novice, asynchronous-distributed teams in CW can be improved. Although the research hints at the appropriation effects on the group performance, it does not explicitly test for any such effects. IS researchers can further develop this research by explicitly looking at how the wiki's structure, its intended spirit, and the group's internal system have an effect on how the group members appropriate the technology and hence affect the CW outcomes.

A wiki may be most useful for less structured creative projects. "A wiki works best where you're trying to answer a question that you can't easily pose, where there's not a natural structure that's known in advance to what you need to know" (Venners 2003). In the notes case we were exploring a new field of research and adopted the structure of the syllabus, but in a flexible, modular way. In the report case the high level structure of the document was determined, but because the students had done original research projects, it was a creative process of writing and integrating their work with that of others.

Many aspects of the CW process are highly iterative such as outlining, drafting and revising. Also, the goals, strategies and roles can change throughout a project (Lowry et al, p. 70). Given this highly contingent process, future research can specifically investigate if version control in a wiki makes the CW process more manageable. In general, the following research questions need an in-depth examination of the appropriation moves and the decision processes affected by such moves. These were not very apparent from the basic observations derived from our cases.

- **Research Question: What are the most favorable appropriation processes to achieve desired outcomes of using wikis for CW?**
- **Research Question: What are the different decision processes required for a successful CW outcomes using a wiki?**

Social Dynamics

The notes case we saw collegiality growth through the semester. We cannot say that this was caused by the wiki use, there were many other factors, but collaborating voluntarily on a project whose incentive was to enhance group discussion and learning seems to have a positive effect group dynamics. In the report case, this was a final project of a group that had been working closely in teams for several months. It does not seem that the task was structured, so that it could enhance collegiality or openness. The emergence of particular social dynamics was not obvious in the virtual cases. It is likely that wiki structures would be adapted to the existing social dynamics rather than wikis having a significant influence, however, a wiki could better facilitate a group's social dynamics if they are similar to the wiki's spirit. A wiki could also better facilitate reactive writing and tasks. The technical support of this writing strategy could enhance group dynamics. The usage of wiki use could also conceivably hurt particular relationships among group members if an unwelcome change is made to an author's writing. An in-depth examination of CW cases in future might reveal the change in attitudes and perceptions of the group members over the period. For example, it needs to be investigated if group awareness is in general promoted in CW projects. Hence, we propose that the following research question be studied by the IS researchers.

- **Research Question: What are the social dynamics that emerge in CW projects using wikis?**

CONCLUSION

This paper has six authors and was written using a wiki for collaboration. One reason is that it was a philosophical necessity to be consistent with the topic of the paper, another is that it was the right logistical choice for our particular task. The process of writing this paper was a relevant learning experience for our interdisciplinary group that we can continue writing and learning about in the future. It reinforced the fact that there is no purely technical solution to the task of CW, but the technology is crucial to the planning and execution of any CW task.

The case studies illustrate key practical lessons for teachers using a wiki for CW in the classroom. For some assignments, the structure of the document must be determined and actively managed by students. This may be an unfamiliar and perhaps socially awkward situation where one student needs to change or move the work of another, yet it can provide very useful collaborative writing learning opportunities. If no one manages and structures the content the wiki content can quickly become very difficult to understand. In the notes case, the wiki was conceived created by the students and thus they had complete ownership of it. The more that the students determine the wiki content and structure, the more they need to take ownership of the process, and the less involvement the instructor may have.

The increasing popularity of the wiki in recent years has highlighted the importance of CW for practitioners and scholars alike. Although, the core concepts related to CW emerge from the communications discipline, we believe that it is important for IS researchers to study the use of advanced information technologies such as wikis as it would lead to better design of wikis as well as CW processes. We hope that the structuration and cases of wiki use presented above foster future research in the IS field.

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