Wiki or Word? Evaluating Tools for Collaborative Writing and Editing

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ABSTRACT

Businesses and other organizations are relying increasingly on virtual teams to perform a range of business activities. A key challenge in utilizing virtual teams is to support collaboration among team members who are separated by distance and/or time. In this paper we use a research model based on a combination of the Technology Acceptance Model (TAM) and the Task Technology Fit (TTF) model to examine two approaches to supporting students in collaboratively creating and editing a report for an introductory course in information systems. In our study, one group of students used MS Word with Track Changes turned on combined with emailing the document among students. A second group was provided access to a wiki where they created the report. Results show that students found the Word and email combination more useful and easier to use than the wiki environment in completing the project. Further, there was no perceived difference in the effort of collaboration between the two methods. This study raises questions about the widely held belief that web-based collaboration platforms are superior to emailing documents among collaborators.

Keywords: Virtual teams, Technology-Mediated Collaboration, Technology Acceptance model (TAM), Team Projects, Computer-Mediated Communication (CMC), Task Technology Fit (TTF)

1. INTRODUCTION

Organizations are relying increasingly on virtual teams to perform a range of activities (Hertel, Geister, and Konradt, 2005). Because members of virtual teams do not necessarily work in close proximity, finding ways to support collaboration effectively among members raises new challenges. In general, organizations that are more collaborative perform better (Frost and Sullivan, 2006). Although there are a variety of factors affect collaboration, including organization culture and de-centralized structure, technology is the primary tool in supporting collaboration in virtual teams.

A technology that recently has received the attention of both business and educational worlds as a collaborative tool is the wiki. A wiki is a web site that allows many people to edit the site very easily using nothing more than a web browser (Leuf and Cunningham, 2001). This has produced such stunning successes as Wikipedia (www.wikipedia.org), WikiHow (www.wikihow.com), and WikiBooks (www.wikibooks.org), as well as wikis on every conceivable topic, including Foodista (www.foodista.com) to develop collaborative recipes. Creating a new wiki is fairly simple, as several web sites offer free basic wikis (including WikiSpaces, Wetpaint, and Wikia). Wikis also are characterized by the free-form structure of wiki documents.

Business applications of wikis that recently have been studied include enabling organizational memory (Munson, 2008; White and Lutters, 2007), crystallizing knowledge in software development (Correia, Ferreira, Flores, and Aguiar, 2009), use as a publishing platform (Maxwell, 2007), and co-creation of knowledge (Hasan, Meloche, Pfaff, and Willis, 2007).

Collaborative work is equally pertinent to the educational field. Many college courses involve group work where teams of students are asked to create a report as the final result of a collaborative effort. Creating such a shared document often causes students great trouble in coordinating the effort.

The education community has grabbed onto the idea of a wiki as a way to increase student engagement and collaboration within the classroom (Parker and Chao, 2007). Educators have found many different ways to incorporate the use of wikis in classes. Common uses include creating a

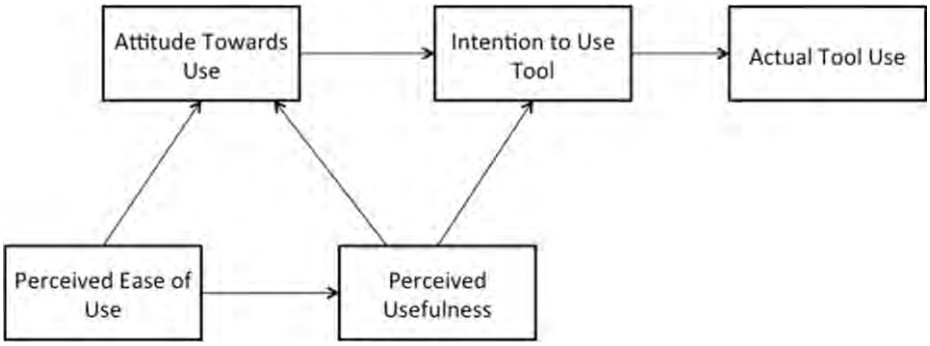

Figure 1. The Technology Acceptance Model (TAM)

shared annotated bibliography of class readings; developing shared lecture notes; publishing syllabi, assignments, and handouts; and having students collaborate on shared documents such as research papers, reports, study guides, article critiques, etc. (Chu, 2008; Hazari, North, and Moreland, 2008; Watson, Boudreau, York, Greiner, and Wynn, 2008).

In this research project, we use an adaptation of the extended Task-Technology Fit (Dishaw and Strong, 1999) framework to compare a wiki with a more conventional approach using word processing and email. Our overall goal is to examine which technology better supports a distributed group writing project in a higher education setting for undergraduate students. In the experiment, one group of students used MS Word with Track Changes turned on combined with emailing the document among students. A second group was provided a wiki where they created the report. The two approaches were compared in terms of Perceived Ease of Use, Perceived Usefulness and Perceived Effort at Collaboration.

2. THEORETICAL BACKGROUND

The idea that information technology could support communication and collaboration has been around for a number of years. The primary goal of this support is connecting individuals across time and space. However, a recent assessment suggests that collaboration technologies are not as effective as they might be (Nosek and McManus, 2008). Challenges facing effective e-collaboration include: 1) group process challenges, 2) theoretical challenges that limit the scope of work and new conceptualizations, 3) conceptual challenges that affect what individuals conceive of doing with the technology, 4) technical challenges that limit what the technology can do, and 5) use challenges that suggest usefulness is the only predictor for continued acceptance and use of a technology (Kock and Nosek, 2005; Nosek and McManus, 2008). Kock (2008) suggests that the basis for this lack of effectiveness may be rooted in the lack of media richness and media naturalness in e-collaboration technologies. When media lack richness and naturalness, they are thought to pose obstacles to communication because they do not have key characteristics present in face-to-face communication. Our goal is to examine the relative efficacy of two technologies that equivalently lack both naturalness and richness, to support collaborative writing. Therefore, our focus is primarily on the challenges related to usage of the technologies.

Recent research on collaboration includes the use of wikis in colleges and universities. Watson et al. (2008) suggest that wiki use in the classroom may promote student engagement, and Hazari et al. (2008) found that wikis can promote collaboration in group assignments. Further, a case study by Chu (2008), where students worked in groups to develop a chapter for a wikibook (an online book created with wiki technology), found that the students thought that the use of a wiki improved both their collaboration and the quality of their work. Although Chu's study suggests an advantage of using wikis in developing a paper by multiple authors to address a subject or problem, there is little empirical evidence to suggest that this new technology offers a significant advantage to the common practice of each author editing a word processing document and then emailing it to the other authors. Our research seeks to examine the potential advantage of wikis over the word processing document exchange using a standard research model.

Information systems research has used different approaches to assess the impact of a technology on the performance of a task and the utilization of the technology to perform the task. One widely accepted and used approach is the Technology Acceptance Model (TAM), which is used to determine the acceptance and eventual use of a technology based on the potential user's attitude toward using the technology (Davis, 1985). Figure 1 shows this model with arrows representing the effect of one variable on another. The TAM suggests that the user's perception of the technology's ease of use impacts his/her attitude toward use of the technology and his/her perception of its usefulness. Perceived usefulness, in turn, impacts the attitude toward use. Both perceived usefulness and attitude toward use impact the intention to use the tool, which in turn, impacts actual use. umerous studies have replicated Davis's (1985) study providing significant empirical evidence for the model (Adams, Nelson, and Todd, 1992; Davis, 1989; Grover and Sengars, 1993; Massey, Cronan, and Hendrickson, 1993; Subramanian, 1994; Szajna, 1994). The model has been used in more than 100 studies to examine technology acceptance in a variety of settings (Chuttur, 2009). However, Chuttur (2009) has criticized the model as having limited explanatory and predictive power as well as a lack of practical value.

The TAM also has seen significant use to examine students' use/acceptance of information technology in

education (Padilla-Meléndez, Garrido-Moreno, and Del Aguila-Obra, 2008). Dasgupta et al. (2002) studied electronic collaboration technology specifically and found that TAM works well in understanding its acceptance, and that perceived usefulness had a significant impact on actual use of the system. Other studies also confirm the efficacy of TAM in education. For example, Selim (2003) analyzed perceived usefulness and ease of use as predictors of the acceptance of web-based courses. Martins and Kellermanns (2004) also used TAM to determine that these two constructs impact the acceptance of web-based courses. Finally, Lee et al. (2005) and Gong et al. (2004) suggest that an enhanced TAM can improve understanding of information technology acceptance in education. One such extension is Task-Technology Fit (TTF).

Task-Technology Fit (TTF) assesses the perceived fit between a user's task needs and the functionality provided by the technology (Goodhue, 1995; Goodhue and Thompson, 1995). Dishaw and Strong (1999) combined TAM with Task-Technology Fit (TTF) to introduce the TAM/TTF model (Figure 2). The TAM/TTF model is a well-established extension to TAM that has more explanatory power than either model alone (Dishaw and Strong, 1999). The TAM/TTF model also has been used in over 100 studies to examine technology acceptance in a variety of settings. The TTF extension to TAM suggests not only that ease of use and usefulness indirectly impact acceptance of a tool, but also that ease of use and usefulness are impacted by the fit between the technology and the task, and that this fit also directly impacts acceptance (actual tool use in the model). This model also considers the effect of the user's experience with the tool on perceived ease of use and usefulness.

The increased emphasis on collaboration in both the workplace and education and the recent focus on wikis to support this collaboration suggest that understanding wikis' efficacy and acceptance is important to future decisions concerning deployment of this technology. Past research in information systems has relied upon the concepts of acceptance and fit to explore these questions. This study uses the TAM/TTF model to begin exploring these questions.

3. RESEARCH MODEL

Based on the combined TAM/TTF model, we developed a research model to examine the question:

> *Do wikis better support the task of collaboratively writing and editing a student paper than exchanging word processing documents via email in terms of perceived ease of use, usefulness, and effort of collaboration?*

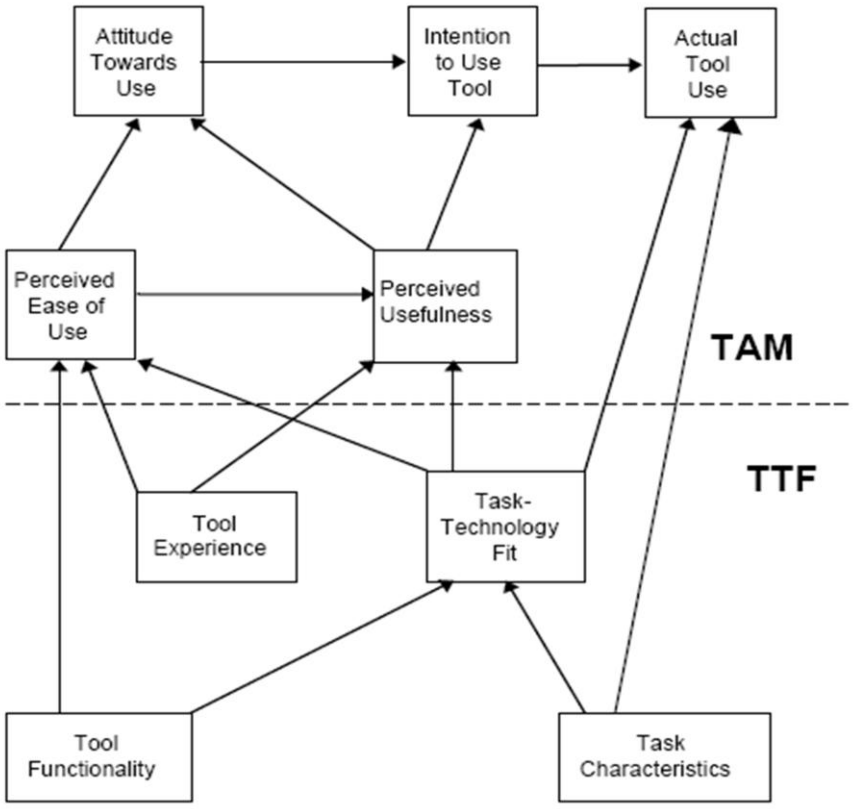

Figure 2. Combined TAM/TTF Model

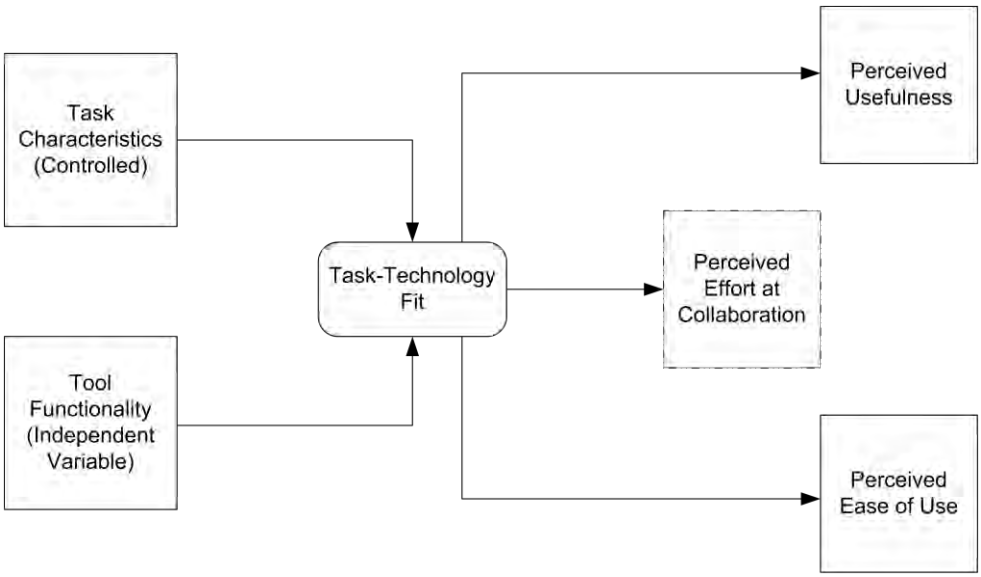

Figure 3. Research Model

Due to the controlled nature of the study, we do not fit all the variables in the original TAM/TTF model. Additionally, because our focus is on supporting collaboration we add the construct Perceived Effort at Collaboration. The research model is presented in Figure 3 and explained and justified in the following text.

Our research model includes two independent variables: Tool Functionality and Task Characteristics. In the study, Task Characteristics is held constant because all treatment groups performed the same task. Tool Functionality is varied by requiring one treatment group to use a wiki and the other group to use word processing documents exchanged via e-mail to perform the task. Task-Technology Fit (TTF) measures the interaction between these two independent variables. Previous research suggests that Task-Technology Fit better explains variability in the outcome variables than either of the two independent variables alone (Dishaw and Strong, 1999). The TTF variable is included in the research model as the interaction term of the two independent variables.

Perceived Ease of Use and Perceived Usefulness are included as two dependent variables in the study. A third dependent variable, Perceived Effort at Collaboration, is added to the model to directly address technology support of collaboration in classroom assignments.

The research model is examined with an experimental design that requires subjects to use a particular technology. This design limits the applicability of several of the variables in the original TAM/TTF model, and they are not included in the research. Because treatment groups were required to use the assigned tool (wiki or word processing document exchange), there would be no variability in terms of whether or not the technology actually was used within the treatment group. Therefore, the dependent variable, Actual Tool Use, is not included in the research model. Another independent variable in the TAM/TTF model, Tool Experience, also is not included in the research model. Almost all subjects in the study had essentially the same level of limited experience with wiki use from classroom exercises, whereas almost all had significant experience with word processing and e-mail. Therefore, measurement of this variable would be confounded with the tool assigned to the treatment group.

Further, because actual use is required, the measurements of Intention to Use and Attitude Toward Use add little to the understanding of the impact of the tool on collaborative writing and editing beyond measurement of Perceived Ease of Use and Perceived Usefulness. Intention to Use has no meaning because use is required. Attitude Toward Use also will be confounded by the requirement to use the technology

Attitude Toward Use may impact perceived usefulness, but that is not examined in this research because prior research on the TAM and TAM/TTF models established that Perceived Ease of Use and Perceived Usefulness variables impact attitude toward use and intention to use a technology (Davis, 1985; Dishaw and Strong, 1999).

In the absence of three of the five TAM variables (because Actual Use is controlled), a difference between technologies in Perceived Ease of Use and/or Perceived Usefulness will be inferred to mean that one technology better supports the task of collaboratively writing and editing than the other. Additionally, previous research suggests that Task-Technology Fit can directly impact actual tool use (Dishaw and Strong, 1999). Therefore, differences between the two technologies in Task-Technology Fit also will be inferred to mean that one technology better supports the task than the other.

4. HYPOTHESES

This research examines the appropriate technology for distributed group collaboration on paper writing and editing tasks. The assertion that there are benefits to using a wiki to support distributed collaboration is based on the assumption that there is a better fit between wikis and distributed collaboration tasks than there is between such tasks and word processing documents passed via e-mail. However, this assumption is based on little evidence. Therefore, the

primary research question is whether or not there is a significant difference in the Task-Technology Fit of the two technologies. If there is a difference, the value of the measures will indicate which technology is a better fit. We begin with the null hypothesis that there is no difference in Task-Technology Fit.

Hypothesis 1: There is no difference between the two technologies in terms of Task-Technology Fit.

Rejecting this hypothesis will provide evidence that one technology is a better fit with collaborative writing and editing tasks than the other. The next step is to determine if there is a difference in the technologies with respect to their perceived usefulness and/or perceived ease of use. Thus, the second set of hypotheses is concerned with identifying differences in the perceived usefulness and perceived ease of use of the technologies.

Hypothesis 2: There is no difference between the two technologies in terms of perceived usefulness.

Hypothesis 3: There is no difference between the two technologies in terms of perceived ease of use.

Tool use was required by the participants of this research. Therefore, it is not possible to examine TAM variables of Intention to Use or Actual Usage as outcome variables. Based on past research that demonstrates a relationship between Perceived Usefulness and Perceived Ease of Use and these outcomes (Dishaw and Strong, 1999), a difference in Perceived Usefulness and/or Perceived Ease of Use will imply that one technology is more appropriate for the collaborative writing and editing task than the other.

The Perceived Effort at Collaboration construct examines which technology requires more coordination and control to accomplish the task. Presumably, because wiki technology is designed to support collaboration, it would be perceived to require less effort than exchanging word processing documents. Nonetheless, the proposition needs to be tested. Therefore, the fourth hypothesis is:

Hypothesis 4: There is no difference between the two technologies in terms of perceived effort associated with collaboration.

5. RESEARCH DESIGN AND METHODOLOGY

The study uses a field experiment to test the hypotheses. The experimental design keeps the task constant as collaborative writing, and varies the collaborative technology. The subjects were students in different sections of the same course, and the task was the same across all sections. Technology was varied by section, with all students in a section using the same technology. The two collaborative technologies used in this research were MS Word documents distributed via e-mail and Twiki (www.twiki.org), which is billed as an *enterprise wiki*. The basic unit of analysis was the individual participating in the collaborative writing and editing task. Data to measure the research variables was collected via a survey at end of the course.

This research project is based on teaching the course "Essentials of IS," which is required for all business majors in the College of Business where the study took place. Data was collected in the Fall 2007, Fall 2008, and Spring 2009 semesters, with a total of 472 students participating in the study. All sections were taught face-to-face to a mostly traditional undergraduate college population (18-22 year olds). Most students take the course as Juniors. The course was taught in multiple sections by three faculty members. Instructors who taught multiple sections in a semester used the same technology in all sections. However, to eliminate bias, all instructors used both technologies over the three semesters. Within each semester, the technology varied among instructors. As the Results section shows, we did not detect any bias in the results between the technologies used by a single instructor. Table 1 shows how many sections each instructor taught, what technology students were instructed to use, how many students were enrolled, and how many responded to the survey. In all, responses were collected from 262 students who used wiki and 210 students who used word processing/e-mail to collaborate.

Students in sections assigned to use word processing and e-mail were shown how to use the Track Changes feature of MS Word to help identify changes made by different group members. They were not given specific instructions on how to collaborate; however, they were asked to use email for communication and exchange of documents.

Semester	Instructor	# Sections	Technology	Enrolled	Responses	Response Rate
Fall 2007	1	4	Wiki	88	74	84.1%
Fall 2007	2	1	Word+Email	28	27	96.4%
Fall 2007	3	3	Word+Email	79	56	70.9%
	Fall 2007 Total	***8***		***195***	***157***	***80.5%***
Fall 2008	1	1	Word+Email	27	24	88.9%
Fall 2008	2	2	Wiki	57	54	94.7%
Fall 2008	3	3	Wiki	75	68	90.7%
	Fall 2008 Total	***6***		***159***	***146***	***89.7%***
Spring 2009	1	3	Wiki	80	66	82.5%
Spring 2009	2	2	Word+Email	60	57	95%
Spring 2009	3	3	Word+Email	58	46	79.3%
	Spring 2009 Total	***8***		***198***	***169***	***85.4%***
	Grand Total	**22**		**552**	**472**	**85.5%**

Table 1. Details of study

Because students are less familiar with wikis than with MS Word, detailed written instructions, as well as demonstrations and practice exercises, were given to students in the sections that used the wiki. The instructions were given as part of the regular classroom teaching routine. Students were given a written set of instructions on how to edit wiki pages, and the instructor demonstrated the most common features of the wiki site. In addition, to give students experience using the wiki before the large project, they were given 3-4 small assignments to complete using the wiki.

A wiki site was established, with clearly marked links to each group's location. The wiki was open only to the participants of the course. The site for each group was left blank with no templates, so students were responsible for creating the structure among the pages created.

The collaboration project used for the research was a group research paper where students in groups of three were asked to find and describe an emerging and/or disruptive information technology that would provide some competitive advantage to a fictitious company. The company varied by semester and included a small manufacturing firm (making pallets), a regional hotel chain, and a small specialized retailer (selling snowboards and accessories). All students taking the course in one semester were given the same assignment regardless of the section or technology they were assigned. The core part of the assignment was for students to apply the value chain model as well as Porter's Five Forces Model to determine the technology's effects on the firm.

Group memberships were determined randomly by the instructor, and students were asked to avoid face-to-face meetings. This was done to force students to experience how projects are conducted in organizations where participants may not see each other, and often live in different time zones, making real-time communication difficult. The varied schedules of students helped to make it naturally difficult for them to schedule real-time meetings.

To ensure that students worked seriously on the assignment, the paper was a significant part of a student's overall course grade (approximately 20%). To avoid differences between treatment groups, the weighting of the grade was similar across sections and instructors.

After the paper was turned in at the end of the semester, students were asked to fill out a web-based survey about their experience with the project. Students were given a small number of extra credit points to complete the survey. This resulted in a very high response rate, but because students were given the extra credit only after the project was graded, and were clearly instructed that the specific answers given would in no way affect their grade, this should not affect the specific answers to questions. To reinforce this, students were given clear guarantees that their instructor would not be able to see their answers to any of the questions.

The online survey asked detailed questions about the participants' experience with collaboration on the project. The survey was based on the instrument developed by Dishaw and Strong (1999) to integrate the Technology Acceptance Model (TAM) with Task-Technology Fit (TTF) concepts. The wording in the survey was adapted to fit the technology used in this study and task at hand (Appendix A). The survey results were anonymous, but students were sent individual links, allowing the survey tool to keep track of which students had completed the survey in order to facilitate awarding extra credit points and sending reminders to complete the survey.

While analyzing the results, incomplete surveys were discarded. The survey was relatively quick to complete, with the median time to take the survey at 17 minutes and 18 seconds for completed responses.

6. RESULTS

Task and technology were controlled in this experiment. However, the instructor teaching the class and the technology could have a potentially confounding effect on the dependent variables. To examine if this was the case, we first used ANOVA to examine if there was a difference among instructors. It was determined that there was a significant difference among instructors on two of the three TTF constructs (Knowledge, Plan, and Work) and the Perceived Ease of Use construct. Further analysis found that there was very little difference between two of the instructors, but the results for the third instructor were different. To determine if this difference would impact the results, the hypotheses were tested for each instructor. The primary difference was in the mean level of each variable score where the values for both wiki and word processing for the third instructor were higher than for the other two instructors. However, the difference between the mean levels was the same for all three, indicating that the third instructor may have done something differently than the other two instructors. Because the difference between the mean levels for the two technologies was the same, this difference didn't influence the overall result. Therefore, we chose to present a combined analysis of all three instructors.

6.1. Construct Measurement and Validity

The research examines the impact of technology on fit with a collaborative writing and editing task. Four variables from the research model (Task-Technology Fit, Perceived Ease of Use, Perceived Usefulness, and Perceived Effort of Collaboration) are measured and statistically analyzed to understand this impact. Perceived Ease of Use and Perceived Usefulness are measured as single constructs. Perceived Effort of Collaboration is measured as a set of two constructs: Perceived Effort of Face-to-Face Collaboration and Perceived Effort of Distributed Collaboration. Likewise, Task-Technology Fit is indirectly measured as interaction between task characteristics and technology functionality (Dishaw and Strong, 1999). The Task Characteristics variable was represented using three constructs from Dishaw and Strong (1999): Knowledge, Plan, and Work. Knowledge is defined in terms of the perceived effort in examining and evaluating the work that had been done. Plan is defined in terms of the perceived effort in determining the work that needed to be done and how to do it. Finally, Work is defined as the actual completion of work on the project. Technology Functionality, which is defined as the perceived support of the technology for tasks associated with creating and editing a paper. These four constructs represent the interaction of task and technology in terms of perceived effort in

examining and evaluating the work that had been done (Knowledge), perceived effort in determining the work that needed to be done and how to do it (Plan), doing the work of the project (Work) and technology characteristics (Tech).

The constructs were measured based on the subjects' responses to a set of questions on the survey used to collect data. Each question was answered on a 7-point Likert scale. The responses for each question that made up the construct were averaged by subject to provide a single construct measurement for the subject. To calculate task-technology fit, the mean for the Technology construct was multiplied by the mean of each of the other constructs that make up fit: Knowledge, Plan, and Work. The survey items that were used for each construct are included in Appendix A. Although the survey was previously validated, construct reliability was assessed in this research. Cronbach's Alpha is reported in Table 2 and shows that the construct measurements are reasonably reliable.

Construct	**Cronbach's Alpha**
Perceived Ease of Use	.741
Perceived Usefulness	.940
Perceived Effort of Collaboration	
Perceived Effort of Face-to-Face Collaboration	.949
Perceived Effort of Distributed Collaboration	.783
Task-Technology Fit	
Knowledge	.731
Work	.673
Plan	.598
Tech	.769

Table 2. Cronbach's Alpha results showing that the construct measurements are reasonably reliable

6.2 Statistical Tests

Descriptive statistics for the variables are presented in Table 3. Higher means indicate better fit, usefulness, ease of use, and effort of collaboration. The technology with the higher mean is in bold in the table. ANOVA was used to test for significant differences in the variable means. These results are presented in Table 4. The calculations find a statistically significant difference in the means for all model variables except Perceived Effort of Collaboration.

6.3 Evaluation of Hypotheses

Hypothesis 1 postulated that there was no difference in the task-technology fit of the two technologies. Statistical analysis finds that Word/E-mail has a higher mean than Wiki, indicating that Word/E-mail has a better fit. ANOVA finds that the difference in task-technology fit is significant at the 0.000 level. Hypothesis 1 is rejected.

Hypothesis 2 postulated that there was no difference in the perceived usefulness of the two technologies. Statistical analysis finds that Word/E-mail has a higher mean than Wiki, indicating that it was perceived to be more useful than wiki. ANOVA finds that the difference in perceived usefulness is significant at the 0.000 level. Hypothesis 2 is rejected.

Hypothesis 3 postulated that there was no difference in the perceived ease of use of the two technologies. Statistical analysis finds that Word/E-mail has a higher mean than Wiki, indicating that it was perceived to be easier to use than wiki. ANOVA finds that the difference in perceived ease of use is significant at the 0.000 level. Hypothesis 3 is rejected.

Hypothesis 4 postulated that there was no difference in the perceived effort of collaboration of the two technologies. Statistical analysis finds that Word/E-mail has a higher mean than Wiki, indicating that it was perceived to be easier to collaborate with Word/E-mail than with wiki. However, ANOVA finds that the difference in perceived effort of collaboration is not significant. Hypothesis 4 is not rejected.

Three of the four hypotheses are rejected. There is a difference between the two technologies with respect to their fit with the collaborative writing and editing task. Students perceived word processing to be a better fit than wiki. There is also a difference between the two technologies in perceived ease of use and perceived usefulness. Students perceived ease of use and usefulness to be higher in word processing than in wiki. Finally, the study cannot conclude that students perceived any difference in effort at collaboration between the technologies. These findings are discussed in greater depth in the next section.

7. DISCUSSION

The results of this study are interesting. First, hypothesis 4, which postulated that there was no difference in the perceived effort of collaboration of the two technologies, was not rejected. That is, there was no evidence to show any difference between the effort of collaboration of students writing and editing the group paper using MS Word and exchanging the document via e-mail and of students using wiki. Wikis, however, were designed to support collaboration, and thus would be expected to need less effort to collaborate. It is important to note that although the current data do not show any difference, it doesn't rule out this possibility. Second, students identified the task-technology fit of word processing documents to be better than that of wiki. This is surprising because the task was to collaboratively edit a document, for which one would expect wikis to be better suited. Third, students found that using Word and email was more useful than using wiki, which was surprising given that wiki is designed for collaboration and ought to be more useful for this task. Finally, students rated the ease-of-use of the Word and email combination higher than that of wiki. This is not surprising because the word processing capabilities of Word are far superior to what is available in wiki, and both Word and email are very well-known technologies to the students.

These results need further exploration. Users face several challenges when attempting to collaborate electronically (Kock and Nosek, 2005; Nosek and McManus, 2008). These challenges can be divided into five categories: 1) group process challenges related to the interactions among the individuals in the group, 2) theoretical challenges that limit the scope of work and new conceptualizations, 3) conceptual challenges for individuals that affect what they conceive of doing with the technology, 4) technical challenges that limit what the technology can do, and 5) use challenges that

suggest usefulness is the only predictor for continued acceptance and use of a technology. Theoretical challenges are applicable mostly to researchers and developers of collaboration tools and likely do not have a bearing on the findings of this research. This research examined the use challenges of two collaborative technologies, and our focus is on understanding the differences we found in the perceptions of the students. The remaining three challenges (group process, conceptual, and technical) may offer some explanations of the differences we found in the students' perceptions.

First, prior to taking this course, students are likely to have a cognitive model of how group processes are supposed to be carried out, which involves using word processing and e-mail to write and edit a paper. The students work on group projects in most of their courses at the university, but they are neither required to use a specific tool to support their work, nor provided with alternatives. Hence, they use MS Word and e-mail because these are available and familiar. Because using a wiki requires a change in process, the adaptation may cause challenges that are reflected in their perceptions of the usefulness and ease of use of the new tool. As an example, one group that was assigned to use wiki for the paper instead used Word and email until the day the assignment was due when a designated member uploaded the final paper to the wiki site.

Second, conceptual challenges for individuals could be important. The potential impact is similar to that of group process challenges. However, in this case, the cognitive model brought to the task by the students is writing a paper with a word processor rather than by group process. Students have a lot of experience using word processing software, and likely have a very strong model of how to use this tool in editing a document. In contrast, although Twiki has some features similar to word processing software, its editing capabilities are much less sophisticated and students have to spend more time formatting and editing. This difference in the capability of the tool may have led to the perceptions of lower usefulness and ease of use even though students

Variable	Technology	N	Mean	Std. Deviation	Std. Error
Work	Wiki	261	30.9418	10.21606	.63236
	Word/Email	200	**36.7950**	9.82506	.69474
	Total	461	33.4811	10.44914	.48666
	Model Fixed Effects			10.04841	.46800
	Random Effects				2.95081
Plan	Wiki	261	29.3406	9.64606	.59708
	Word/Email	200	**34.6670**	9.14928	.64695
	Total	461	31.6514	9.78716	.45583
	Model Fixed Effects			9.43390	.43938
	Random Effects				2.68515
Knowledge	Wiki	261	27.9902	8.69941	.53848
	Word/Email	200	**31.6420**	8.08545	.57173
	Total	461	29.5745	8.62205	.40157
	Model Fixed Effects			8.43871	.39303
	Random Effects				1.84031
Perceived Usefulness	Wiki	260	4.9581	1.70468	.10572
	Word/Email	200	**6.5487**	1.23593	.08739
	Total	460	5.6496	1.71029	.07974
	Model Fixed Effects			1.51889	.07082
	Random Effects				.80192
Perceived Ease of Use	Wiki	261	4.6555	1.52452	.09437
	Word/Email	200	**5.7829**	1.39310	.09851
	Total	461	5.1446	1.57039	.07314
	Model Fixed Effects			1.46899	.06842
	Random Effects				.56848
Perceived Effort of Collaboration (face-to-face)	Wiki	261	5.1552	2.04042	.12630
	Word/Email	200	**5.4300**	2.08430	.14738
	Total	461	5.2744	2.06184	.09603
	Model Fixed Effects			2.05956	.09592
	Random Effects				.13742
Perceived Effort of Collaboration (distributed)	Wiki	261	4.7146	2.47952	.15348
	Word/Email	200	**5.0150**	2.51773	.17803
	Total	461	4.8449	2.49789	.11634
	Model Fixed Effects			2.49616	.11626
	Random Effects				.14993

Table 3. Descriptive statistics

received instruction on the wiki and not on the word processor.

Finally, technical challenges are likely related to the conceptual challenge previously discussed. The wiki does not have a sophisticated interface with the same power as the word processing software. The quality of the interface has been suggested as potentially playing a key role in the success of collaboration technologies (Garza and Kock, 2007)**.** Additionally, tracking changes in a Twiki document requires reviewing its history of different versions in different windows, which can be more confusing than tracking changes in MS Word. On the other hand, the history function of Twiki is far more robust than in Word, as it reliably keeps every version of the document. Students reported anecdotally that they found it very useful to be able to see who had made recent changes to the document in Twiki. Also, the Twiki procedure for a group preventing others from seeing their work is both difficult and error prone. All these issues may contribute to the lower usefulness and ease of use perceptions of the wiki collaboration technology.

This study found differences between wiki and word processing technologies when used in a student group writing project. Students found word processing to be easier to use and more useful than wiki technology. The study suggests there currently is no advantage for students in using wiki technology in a collaborative writing assignment.

Variable		Sum of Squares	df	Mean Square	F	Sig.
Work	Between Groups	3879.376	1	3879.376	38.421	.000
	Within Groups	46345.498	459	100.971		
	Total	50224.874	460			
Plan	Between Groups	3212.486	1	3212.486	36.096	.000
	Within Groups	40850.263	459	88.998		
	Total	44062.749	460			
Knowledge	Between Groups	1510.013	1	1510.013	21.205	.000
	Within Groups	32686.260	459	71.212		
	Total	34196.273	460			
Perceived Usefulness	Between Groups	285.997	1	285.997	123.969	.000
	Within Groups	1056.613	458	2.307		
	Total	1342.610	459			
Perceived Ease of Use	Between Groups	143.928	1	143.928	66.697	.000
	Within Groups	990.487	459	2.158		
	Total	1134.415	460			
Perceived Effort of Collaboration (face-to-face)	Between Groups	8.552	1	8.552	2.016	.156
	Within Groups	1946.986	459	4.242		
	Total	1955.538	460			
Perceived Effort of Collaboration (distributed)	Between Groups	10.221	1	10.221	1.640	.201
	Within Groups	2859.940	459	6.231		
	Total	2870.161	460			

Table 4. ANOVA tests for significance

8. LIMITATIONS AND FUTURE DIRECTIONS

The study has limitations that could affect the generality of the findings. First, subjects were students who had very limited, if any, exposure to wikis prior to the class. To minimize this problem, students assigned to the wiki treatment were given more extensive instructions and training than those assigned to the word processing technology. However, the limited experience with wiki still could be biasing the outcome of the study.

Second, students were required to use the assigned technology, which could have given them a negative attitude toward what they were assigned if they preferred a different tool. Some students may, indeed, have used additional technologies not specifically assigned to them.

Third, students were given extra credit for completing the survey, basically forcing them to complete it. Some may have done so in a manner not consistent with their true feelings, although they were warned that they would not get the credit if they completed the survey carelessly, resulting in inconsistent responses. They also were instructed to take the survey seriously because it was part of a research project.

Fourth, the way students used the technology was not monitored. Students could have met face-to-face as a group to do the assignment together, and/or used a tool they liked and later entered it into the wiki or word processing document. We attempted to limit this by instructing students that distributed work was the world of the future and the assignment was an attempt for them to learn the tools required for that. An additional effort to limit this was done by randomly assigning students to groups and providing only names and e-mail addresses as contacts. Student feedback collected as part of the requirement indicates that they used face-to-face meetings very rarely.

Fifth, group size was relatively small. Collaboration in a three-person group isn't as difficult as it is in larger groups. The problems of keeping track of multiple revisions of documents may not be as severe in small groups as in larger ones. This would seem to make the editing capabilities of

each technology more important than its collaborative capabilities.

Sixth, because wiki is not a mature technology, the specific product used in the study (Twiki) may not be representative of wikis in general. Wiki technology has evolved rapidly since this study started, and wikis today are more user-friendly than in the past. However, there still is room for significant improvement in the basic support for collaboration and editing.

Finally, some of the construct reliability values for the TTF variables were lower than what is desirable for reliability of the measure, which could impact the reliability of the statistical difference in the Task-Technology Fit analysis.

This study provides insight into the efficacy of using wikis to support student group projects. Additional work to expand on these findings should explore the impact of the individual's group process model of the collaborative task on the student's perceptions of the tools. Understanding this impact could lead to identifying ways to improve the tool's support of collaboration or a need to improve training for collaborative work.

Examining the impact of an individual's conceptualization of the paper writing and editing task on the perception of the tool also could be productive. Identifying a difference between the cognitive model currently used in the task and the tool's task support may enable the development of better tools for paper writing and editing. Another avenue to pursue could be the individual's perceptions of the tool's interface, functions, and features. Developing this understanding could lead to the improvement of collaborative tools.

Further research along some or all of these lines has the potential to improve technology support for collaboration. As businesses continue to perform work over a broader geographic region and require more collaboration among their workers, technological support becomes even more important.

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Appendix A
Construct Items

Knowledge Construct Items
I obtained information about changes to the document from data in the document itself.
I made extensive use of my knowledge of the software with which the document was created.
If I needed information to solve a problem, I knew where to look or who to ask.
I asked someone for technical information about the designated software during this project.
I consulted manuals to obtain information regarding Windows Operating System.
I consulted manuals to obtain information about the software.
I examined the document to obtain clues as to the quality of the paper.
I obtained information about the paper being produced through examining the document.
I learned a great deal about the topic of the paper by mentally processing the information provided in the document.
I frequently consulted the software documentation.
I learned a great deal about the topic by using the designated software tool.
I had to weigh and evaluate a large volume of information about the document I was creating/editing.
I had difficulty deciding which source of information to employ in attempting to solve a particular problem.

Plan Construct Items
I had no difficulty in editing/changing the document.
I did not have difficulty in figuring out how to create/edit the group paper.
I frequently re-evaluated my plan of action with regard to completing the project.
I had a number of choices to make regarding which source of information to consult in order to solve a particular problem.
I frequently had alternative approaches to writing the document.

Work Construct Items
I frequently made changes to the document in order to get feedback from other group members.
I revised the document.
I often evaluated other group members' changes to the document.
I read the document and made additional changes as a result of my reading.

Distributed Collaboration Effort Construct
I frequently e-mailed/text messaged my group to work on this document.
I frequently e-mailed/text messaged my group to discuss this document.

Face to Face Collaboration Effort Construct
I frequently met my group face to face to work on this document.
I frequently met my group face to face to discuss this document.

Ease of Use Construct Items
I found it easy to get the designated software to do what I wanted it to do.
My interaction with the designated software was clear and understandable.
I found the designated software to be flexible to interact with.
I found the designated software easy to use.

Usefulness Construct Items
Using the designated software enabled me to accomplish my tasks more quickly.
Using the designated software enabled me to improve my performance on this project.
Using the designated software increased my productivity on this project.
Using the designated software enabled me to enhance my effectiveness on this project.
Using the designated software made it easier to complete this project.
I found the designated software useful in this project.

Technology Construct Items
To what extent did the software environment available to you supply the following functions?

- Create and write text.
- Edit existing text.
- Share a text document among individuals.
- Track changes in the text document.
- Identify the source of changes in the text document.

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