Computer-supported Writing: A Comparison of Wiki and Daedalus*

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This study compared the effects of two different computer writing tools (Daedalus and Wiki) on students' writing proficiency and their learning attitudes. The participants in the study were 26 college students in two Multimedia English courses. They were asked to complete a writing test and attitude questionnaire twice, in Week 2 and Week 8. Between the two tests, the students in one class performed writing tasks using Wiki, whereas the students in the other class performed the same tasks with Daedalus. The findings from the data analysis indicated that both Wiki and Daedalus were more valuable for collaborative writing than for individual writing. The differences in the writing tools did not have differential effects on the students' writing proficiency or writing apprehension. Student responses to the questionnaires showed that the students found the two tools useful. This may be partially because the tools help to alleviate affective pressures writers often feel when writing. The accessibility to those tools makes feedback exchange and revision efficient. This leads writers to readily improve their writing. The prospects of a better outcome can prompt and thus motivate students to engage more in their writing process. We argue that Daedalus and Wiki can be successfully incorporated into collaborative tasks in writing classrooms.

I. INTRODUCTION

One of the important contributions that the socio-cultural approaches have made was to demonstrate the importance and benefits of social interaction for learning. Accordingly, the field

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of second language learning and teaching has endeavored to make classroom instruction more collaborative and interactive (Swain & Lapkin, 1998).

This shift toward collaborative learning has been accelerated with the advancement of computer technology. Computer supported writing has provided tools and resources to move away from traditional paper-and-pencil writing to collaborative interactions as they make collaboration more convenient. Computer technology, for example, can help to increase L2 writers' writing practice and therefore their learning motivation (Penington, 2003). Students who used computers for their writing produced longer and better output and were more engaged in writing according to a recent synthesis of research that examined 26 research studies (Goldberg, Russell and Cook, 2003). The benefits of computer-based writing are observed not only in individual writing but also in collaborative writing (Alexander, 2006; Craig, 2007; Driscoll, 2007, Passig & Schwartz, 2007).

The development of computer technology has generated many useful tools for computer-supported collaborative writing (CSCW), such as Daedalus and Wiki. Daedalus is a network-based program that facilitates process-oriented CSCW, whereas Wiki is a Web 2.0 communication tool that allows writing and revising in the form of threaded discussion. Both Wiki and Daedalus have pedagogical potentials for writing classrooms and thus deserve exploration. While attempts have been made intermittently to examine each tool (Chávez, 1997; Kern, 1995; Mak & Coniam, 2008), these tools have rarely been examined together. Thus, this study aims to compare the effects of these two computer-assisted writing tools on students' writing proficiency and attitudes.

II. LITERATURE REVIEW

As the socio-constructivist theory suggests, social interaction is a key to collaborative learning because an individual learner can perform at a more advanced level when s/he receives support from another interlocutor (Lightbown & Spada, 2006). Collaborative learning has its theoretical basis in Rogers' (1983) humanistic psychology and Kohonen's (1992) experiential learning. Experiential learning allows learners to become active and self-directed while collaboratively transforming knowledge rather than passively receiving knowledge transmitted by teachers. In other words, learners can acquire a language while negotiating meaning with their peers as well as with their teacher.

SLA researchers have also suggested that collaborative learning as a venue of modified

interaction can help to increase the quantity and quality of comprehensible input for students not only because the students can have an opportunity for negotiation of meaning but also because they can work in a more comfortable environment (Donato, 1994; Long, 1980; Long & Porter, 1985; Swain & Lapkin, 1998).

Despite the beneficial aspects of collaborative learning, most of the previous studies on collaborative learning have been limited to the study of oral interactions. Few studies have examined written interaction, particularly collaborative writing (Lowry, Curtis, & Lowry, 2004; Seong, 2006; Storch, 2005). Furthermore, the studies on collaborative writing are limited in scope, in that the nature of collaborative work was confined to the brainstorming stage or the peer review stage (Ferris, 2003; Leki, 1993; Nelson & Carson, 1998; Nystrand & Brandt, 1989; Villamil & de Guerrero, 1996). It is unfortunate that collaborative drafting or writing has received little attention from writing researchers (Daiute, 1986; Glendinning & Howard, 2001; Storch, 1999, 2005; Wells, Chang & Maher, 1990). Thus, writing is still largely considered to be a solitary, independent, and individual exercise. For this reason, the nature of the collaborative writing process has been rarely examined in comparison with the nature of the individual writing process (Flower & Hayes, 1981; Krapels, 1990; Raimes, 1985; Zamel, 1983).

Traditionally, collaborative writing was carried out through the exchange of each individual's work on paper or on word processors. This practice was not sufficient to facilitate the collaborative process in writing as the work focused on the final product of the writing. The development of computer technology, however, has brought changes in the way writing is taught in class. Wiki, for instance, is useful as a second generation Web tool (Godwin-Jones, 2003). According to Mak and Coniam (2008), Wiki has many advantages for language learning. It is easy and fast to create a hypertext document, and "as students work towards the final document, all intermediate copies are retained" (p. 441). Mak and Coniam reported the case of Hong Kong secondary school students' experiences in using Wiki. Their study focused on how Year 7 students in a Hong Kong secondary school engaged in Wiki-integrated collaborative writing to produce a final product: a printed school brochure. These students learned to produce more words and more complex structures over time. Mak and Coniam's study also noted that a considerable number of changes were made, such as expanding, reorganizing, and correcting; this resulted in improvement in textual coherence.

Another study that examined the pedagogical value of Wiki, particularly in the Hong Kong elementary school context was Woo, Chu, Ho, and Li (2011). In an examination of the Wiki-based collaborative English writing process, their study found that Wiki could effectively support the students' critical thinking and problem-solving, let alone collaborative writing. In the

Korean context, Pae (2007) investigated whether Wiki-based English writing would affect Korean EFL students' English writing proficiency and anxiety. Her study found that the Wiki-based English writing classes positively affected the students' English writing proficiency but had little influence on their writing anxiety. All the participants in Pae's study perceived Wiki as a powerful tool for collaborative writing, although some students found it inconvenient to use because of the absence of spell check or auto-correction functions.

Another tool that is known to support collaborative writing is Daedalus. It is a network-based program that "allows students to focus on the process of writing, not the mechanics of using a word processor" (Chávez, 1997, p. 28). Daedalus contains several learning modules, such as Invent, Write, Respond, Mail, Interchange, Bibliocite, and others. One of the most commonly used modules in earlier studies is Interchange. Kern (1995) examined the quantity and quality of discourse produced by French students in different contexts. In a comparison of an oral discussion and an Interchange-mediated discussion, he found that the students generated more turns and more sentences and used far more varied discourse functions when they communicated via Interchange.

Sullivan and Pratt (1996) also compared two ESL writing contexts (an Interchange-mediated classroom and a traditional classroom) in terms of learners' writing apprehension, attitudes toward writing with computers, and writing quality. Although Sullivan and Pratt failed to find significant differences for all the three quantitative measures, in a qualitative analysis of the data they noted that the patterns of discourse were different across the groups. When communicating in a large group, for instance, the teacher was the least dominant in the computer-assisted classroom, while it was reverse in the traditional classroom. Chávez (1997) also highlighted the beneficial features of Interchange. In the descriptions of how Daedalus can be used for teaching Spanish grammar and composition, Chávez suggested that the computer-supported writing environment allowed students to use grammar in real-life contexts. In addition, she reported that most students enjoyed their learning-to-write experience in the networked classroom. While these earlier studies on Daedalus offer implications that Interchange is definitely useful for written discussion in L2, we should note that the most prominent benefits can be found in other modules that support process-oriented writing: Invent, Write, and Respond.

Prior literature seems to suggest that both Wiki and Daedalus have the potential to greatly facilitate collaborative learning in L2 writing practices. The problem is that these potential benefits have not been adequately demonstrated through many rigorous empirical studies. It is important then to clarify what benefits and problems these computer-assisted writing tools can engender in the writing process before we decide to design specific instructional modules or

programs. While this exploration can take many forms, it would be meaningful to examine whether and how these tools support process-oriented writing, which is often considered to be the norm in the EFL context. It would be also helpful to know L2 writers' attitudes and perceptions with respect to these tools.

Writing is still considered to be a solitary and individual exercise; therefore, its quality is often attributed to the writer's knowledge and skills. If there are resources to transform this solitary exercise into a more collaborative and interactional enterprise, it would pave the way for renovating traditional writing pedagogy. The present study explores this possibility by comparing the two computer-assisted writing tools for EFL writers.

III. METHOD

1. Research questions

The present study examined if and to what extent different computer-assisted writing tools affect students' writing proficiency and their learning attitudes. Specifically, this study compared the effects of two different computer writing tools: Daedalus and Wiki. The purpose is specified in the following research questions:

1) Do different computer-assisted writing tools have differential effects on students' writing proficiency?
2) How do students in different contexts feel about writing? Do students experience different levels of writing apprehension according to context?
3) How do students in different contexts approach the task of writing with computers?
4) Do students' attitudes toward writing differ according to computer-assisted writing tools?

2. Participants

The participants of this study were 26 college students enrolled in two Multimedia English courses offered in the Department of English Education. The number of students enrolled was originally 29, but some students (n=3) who did not take either the pre-test or the post-test were excluded from the data set.

The participants in both classes performed a total of four writing tasks: two individual and

two collaborative. One class (n=11) that used Daedalus for writing comprised six sophomores, four juniors, and one senior student. Five of the students were male, and the rest were female students. The other class (n=15) that used Wiki were all junior students; seven of them were male students.

As to the hours of computer use, more than half of the students in the two groups reported that they used computers for between one and three hours (see Table 1). Regarding computing skills, the students in the Wiki group were found to be slightly more competent than those in the Daedalus group as shown in the table. The students' self-rating of their proficiency levels were also found to be higher for the Wiki group than for the Daedalus group. In terms of experience in using the computer tools, the students in the two groups were found to be novice.

〔Table 1〕 Students' Computing Skills and Language Proficiency

		Daedalus	Wiki
Hours of computer use	Less than 1 hr.	1 (9.1%)	5 (33.3%)
	1-3 hrs.	8 (72.7%)	8 (53.3%)
	3-6 hrs.	2 (18.2%)	2 (13.3%)
	more than 6 hrs.	-	-
Computer skill: Can use ...	email	11 (100.0%)	15 (100.0%)
	Internet	10 (90.9%)	15 (100.0%)
	web boards	10 (90.9%)	15 (100.0%)
	online chatting	11 (100.0%)	15 (100.0%)
	word processors	11 (100.0%)	15 (100.0%)
	PowerPoint	8 (72.7%)	11 (73.3%)
	HTML, Java script	2 (18.2%)	1 (6.7%)
Self-assessment of their English writing ability	0 - less than 20	2 (18.2%)	-
	20 - less than 40	1 (9.1%)	-
	40 - less than 60	6 (54.6%)	5 (33.4%)
	60 - less than 80	2 (18.2%)	8 (53.3%)
	80 - less than 100	-	2 (13.4%)
Experience with Daedalus/Wiki	Never heard of it	8 (80.0%)	15 (100.0%)
	Read a posting	1 (10.0%)	-
	Posted a writing	-	-
	Opened the site/page	1 (10.0%)	-

3. Research Instrument

1) Computer-assisted writing tools

Daedalus and Wiki were chosen as computer tools to support writing. Daedalus is a network-based program that facilitates computer-supported collaborative writing. The program contains several learning modules that support process-oriented writing: Invent, Write, and Respond. The Invent mode facilitates the process of idea generation, whereas the Write mode helps students in the drafting stage. The Respond mode helps students exchange feedback.

While Daedalus is an intranet-based software, Wiki is a Web 2.0 communication tool commonly used for writing. According to Franklin and Van Harmelen (2007), Wiki is "a system that allows one or more people to build up a corpus of knowledge in a set of interlinked web pages, using a process of creating and editing pages" (p. 5). Wiki helps to support group learning processes since it facilitates multiuser participation and allows users to construct and enhance knowledge and revise and manage versions of their writing in the thread mode and the document mode (Cole, 2009). In the thread mode, users can read a document and add their opinions regarding the original document, whereas in the document mode, they can edit and change the original text. Thanks to this thread mode, Wiki becomes a community of shared knowledge, which changes and grows over time (Godwin-Jones, 2003). Godwin-Jones regarded Wiki as a second generation Web tool that allows opportunities for online collaboration for language practitioners as well as learners.

2) Writing Test

A writing test was developed to measure the students' writing proficiency. It was given in the form of an essay test. The test prompt was as follows: "What recent news story has affected you the most? In what ways has it affected you? Use reasons and examples to support your response." In other words, the students were asked to write about the news story that had affected them the most. The same test was used for pre- and post-tests.

3) L2 Writing Questionnaires

In order to measure the students' writing apprehension and their attitudes toward writing with a computer, a set of questionnaires was specially constructed. First, a Writing Apprehension Scale (WAS) was developed from Cheng's (2004) L2 writing anxiety scale. The WAS contained 18 items on a 6-point Likert scale ranging from 1 (not at all true) to 6 (very true). In addition,

another 6-point Likert scale was designed to measure the students' attitudes toward writing with a computer. The pretest questionnaire included additional questions to obtain the participants' background information: students' computing time, computer skills, self-perceived writing proficiency, gender, pre-exposure to Wiki or Daedalus, and so on.

The posttest questionnaire contained items that examined the students' reaction to Wiki or Daedalus. These items focused on how the students perceived the pedagogical value of Wiki or Daedalus as a writing tool.

4. Data Collection Procedures

Table 2 summarizes the timeline of the data collection process.

〔Table 2〕 Timeline of the Data Collection Process

Wk.	Goal	Course details for Daedalus	Course details for Wiki
1	Orientation	Course introduction	
2	C1. Experiencing Daedalus/Wiki	Learning about Daedalus Learning about process writing Learning about peer-reviews	Learning about Wiki Learning about process writing Learning about peer-reviews
	C2. Pre-test	Essay writing test Questionnaires	
3	C1. Individual 1	Topic: Which one do you think is appropriate: English only or English-Korean instruction?	
		Task description (5 min.) Individual Searching (10 min.) Brainstorming: Messenger chatting (20 min.) Pre-writing: Using Daedalus Invent (20 min.) Writing: Using Daedalus Write(20 min.)	Task description (5 min.) Individual Searching (10 min.) Brainstorming: Messenger chatting (20 min.) Pre-writing: Using a worksheet and uploading postings on the Wiki site (20 min.) Writing: Using the Wiki site (20 min.)
	C2. Individual 1	Feedback: Using Daedalus Respond (30 min.) Checking: Checking feedback from peers (15 min.) Revising: Using Daedalus Write (30 min.)	Feedback: Using Wiki to post reviews or feedback (30 min.) Checking: Checking feedback from peers (15 min.) Revising: Using Wiki to revise and edit (30 min.)
4	C1. Holidays	No class	
	C2. Individual 2	Procedures are the same as individual writing task 1 except for the topic (Human cloning in terms of its pros and cons)	
5	C1. Individual 2	Topic: Should P2P file sharing be stopped or supported?	
	C2. Collaborative 1	Task description (15 min.) Searching as a group (20 min.) Group pre-writing: Using Daedalus Invent (20 min.) Group draft-writing: Using Daedalus Write (20 min.)	Task description (15 min.) Searching as a group (20 min.) Group pre-writing: Using Wiki site for the group (20 min.) Group draft-writing: Using Wiki site for the group (20 min.)

Wk.	Goal	Course details for Daedalus	Course details for Wiki
6	C1. Holidays	No class	
	C2. Collaborative 1	Messenger chatting: Discussion on other groups' writing (20 min.) Feedback: Using Daedalus Respond (10 min.) Messenger chatting about peer feedback (15 min.) Revising: Using Daedalus Write to revise and edit (30 min.)	Messenger chatting: Discussion on other groups' writing (20 min.) Feedback: Using Wiki to post reviews or feedback (10 min.) Messenger chatting about peer feedback (15 min.) Revising: Using Wiki to revise and edit (30 min.)
7	C2. Collaborative 2	Procedures are the same as collaborative writing task 1 except for topic (Should any information acquired by illegal bugging be revealed and be investigated to satisfy people's right to know?)	
8	C1. Midterm exam	Exam	
	C2. Post-test	Essay writing test Questionnaires	

With respect to data collection, the students were asked to read a writing test prompt and write their responses at the beginning of the semester. It took 30 minutes to conduct the essay writing test. In addition to the test, the students were asked to respond to the questionnaires specially designed to measure learner attitudes toward writing.

After taking the pre-test, the students completed their writing tasks using one of the two computer-assisted writing tools: Wiki or Daedalus. The students in one class completed four writing tasks (two individual and two collaborative) using *Owiki*, a type of Wiki that allowed learners to read, write, and rewrite their drafts; the students in the other class performed the same tasks with Daedalus, a program that supported writing in the network-based learning environment.

When the students finished the tasks, they were asked to take the same test as the one conducted at the outset of the project. The students' performance on the post-test as well as their reponses to the questionnaires were then compared between the two groups.

5. Data Analysis

For data analysis, the students' writing tests were rated by two native speakers of English. The raters used an analytic scoring rubric from Jacobs, Zingraf, Wormuth, Hartfield, and Hughey (1981) to grade the student papers. In rating the student papers, they considered five different dimensions of writing: content (30 points), organization (20 points), vocabulary (20 points), language use (25 points), and mechanics (5 points). The inter-rater reliability index obtained for both the pre-test and the post-test was .83.

IV. FINDINGS AND DISCUSSION

1. Effects of CSCW Tools on Students' Writing Proficiency

To examine whether the different writing tools had differential effects on the students' writing proficiency, the Daedalus group was compared with the Wiki group. Before running a *t*-test for a group comparison in terms of the students' post-test measures, pre-test measures were compared to discover if the groups were initially identical. From the descriptive statistics in Table 3, the students in the Wiki group seemed to have scored higher on the pre-test than the Daedalus group. This, however, did not lead to a significant difference between the two groups in the pre-test [$t(24)= -.79$, $p=.437$]. The independent sample *t*-test for the post-test measures also yielded nonsignificant differences between the Daedalus group and the Wiki group [$t(24)=-1.34$, $p=.192$].

〔Table 3〕 Writing Test Scores According to Groups

	N	Pre-test		Post-test	
		M	S.D.	M	S.D.
Daedalus	11	76.45	11.18	77.18	10.74
Wiki	15	79.60	9.11	82.17	8.23

An analysis of covariance (ANCOVA) also confirmed the findings from the *t*-test. For the ANCOVA, the group (Daedalus vs. Wiki) was entered as an independent variable, post-test measures as a dependent variable, and pre-test measures as a covariate so that the effects of pre-test measures were partialled out. The analysis again resulted in nonsignificant differences between the two groups [$F(1, 23) = 1.13$, $p=.298$]. The findings indicate that the different computer tools did not have differential effects on the learners' writing proficiency development. This result may be due to the fact that these two tools had many things in common. Daedalus supports the creation of a computer-aided writing environment, and it contains useful writing modules such as Invent, Write, and Respond. Like Daedalus, Wiki also allows users to add, remove, and edit the posted text, thus facilitating process-oriented writing. Wiki was similar to Daedalus in many aspects except that it did not have the Invent module that supports the process of brainstorming or idea generation. These features shared between the two tools seem to account for the nonsignificant differences in their effects on the learners' writing proficiency.

〔Table 4〕 ANCOVA for Post-test Writing Scores

Source	SS	df	MS	F	p
Pre-test	445.12	1	445.12	6.18	.021
Group	81.67	1	81.67	1.13	.298
Error	1656.85	23	72.04		
Total	168899.75	26			

2. Students' Writing Apprehension

Descriptive statistics for the students' writing apprehension were compared across the two contexts. For most of the items, the students in the two groups showed similar responses. For instance, regardless of the groups the students displayed negative responses to the items describing anxiety (Item 11, 13, 16, and 19). With regard to Item 11 ("I feel nervous when I write English compositions on a computer"), 36 percent of the students in the Daedalus group and 43 percent of the students in the Wiki group disagreed.

Although slight differences were observed between the two groups, many students reported that they did not tremble or perspire when writing English (55% for Daedalus and 73% for Wiki) nor freeze up when unexpectedly asked to write English compositions (46% for Daedalus and 67% for Wiki). The students also did not seem to avoid writing in English. Specifically, 64 percent of the students in the Daedalus group and 73 percent of the students in the Wiki group disagreed with the item about avoidance of L2 writing. In the same vein, many students actually responded that they would use English to write compositions whenever possible (40% for Daedalus and 47% for Wiki).

〔Table 5〕 Students' Writing Apprehension According to Context

Items	1 (not at all true)		2		3		4		5		6 (very true)	
	D	W	D	W	D	W	D	W	D	W	D	W
3. I feel afraid when I have to write in English under time constraints.			1 (9.1)	1 (6.7)	1 (9.1)	2 (13.3)	4 (36.4)	5 (33.3)	2 (18.2)	5 (33.3)	3 (27.3)	2 (13.3)
4. I feel worried about what other people would think of my English composition.		2 (13.3)	2 (18.2)	5 (33.3)	1 (9.1)	2 (13.3)	2 (18.2)	3 (20.0)	4 (36.4)	3 (20.0)	2 (18.2)	
5. Whenever possible, I would use English to write a composition.	1 (10.0)			1 (6.7)	1 (10.0)	2 (13.3)	4 (40.0)	5 (33.3)	3 (30.0)	4 (26.7)	1 (10.0)	3 (20.0)
6. I feel confused and absentminded when I write English compositions on a computer.		2 (13.3)	3 (27.3)	3 (20.0)	2 (18.2)	7 (46.7)	5 (45.5)	3 (20.0)	1 (9.1)			

Items	1 (not at all true)		2		3		4		5		6 (very true)	
	D	W	D	W	D	W	D	W	D	W	D	W
8. I feel my heart pounding when I write English compositions under time constraints.	2 (18.2)	1 (6.7)	2 (18.2)	3 (20.0)	2 (18.2)	5 (33.3)	1 (9.1)	5 (33.3)	2 (18.2)		2 (18.2)	1 (6.7)
9. I feel worried that my English composition would be rated as very poor.		1 (6.7)	1 (9.1)	2 (13.3)	2 (18.2)	5 (33.3)	2 (18.2)	3 (20.0)	5 (45.5)	4 (26.7)	1 (9.1)	
10. I try to write English compositions outside of class.			3 (27.3)	5 (33.3)	1 (9.1)	4 (26.7)	3 (27.3)	4 (26.7)	3 (27.3)	1 (6.7)	1 (9.1)	1 (6.7)
11. I feel nervous and anxious when I write English compositions on a computer.		2 (14.3)	4 (36.4)	4 (28.6)	3 (27.3)	7 (50.0)	1 (9.1)		3 (27.3)	1 (7.1)		
13. I tremble or perspire when I write English compositions.	1 (9.1)	6 (40.0)	5 (45.5)	5 (33.3)	3 (27.3)	2 (13.3)	2 (18.2)	2 (13.3)				
15. While writing in English, I often worry that I would use expressions and words improperly.	1 (9.1)	1 (6.7)	1 (9.1)	2 (13.3)	3 (27.3)	5 (33.3)	2 (18.2)	3 (20.0)	4 (36.4)	4 (26.7)		
16. I do my best to avoid situations in which I have to write in English.	1 (9.1)	4 (26.7)	6 (54.5)	7 (46.7)	1 (9.1)	1 (6.7)	1 (9.1)	1 (6.7)	2 (18.2)	2 (13.3)		
17. My mind often goes blank when I start to write English compositions on a computer.		2 (13.3)	3 (27.3)	3 (20.0)	3 (27.3)	5 (33.3)	3 (27.3)	5 (33.3)	2 (18.2)			
19. I freeze up when unexpectedly asked to write English compositions.	1 (9.1)	4 (26.7)	4 (36.4)	6 (40.0)	3 (27.3)	3 (20.0)	3 (27.3)	1 (6.7)		1 (6.7)		
20. While writing in English, I feel anxious that I would make grammatical errors.	1 (9.1)		2 (18.2)	5 (33.3)	2 (18.2)	5 (33.3)	3 (27.3)	2 (13.3)	2 (18.2)	3 (20.0)	1 (9.1)	
21. I feel afraid when I write English compositions on a computer under time constraints because I'm not good at typing.	3 (27.3)	5 (32.3)	3 (27.3)	3 (20.0)		3 (20.0)	1 (9.1)	2 (13.3)	1 (9.1)	1 (6.7)	3 (27.3)	1 (6.7)
23. My mind often goes blank when I start to work on an English composition.		2 (13.3)	2 (18.2)	3 (20.0)	3 (27.3)	5 (33.3)	5 (45.5)	4 (26.7)	1 (9.1)	1 (6.7)		
24. I feel afraid that other students would deride my English composition if they read it.	1 (9.1)	3 (20.0)	2 (18.2)	4 (26.7)	1 (9.1)	3 (20.0)	5 (45.5)	3 (20.0)	2 (18.2)	2 (13.3)		
26. While writing English compositions, I feel worried and uneasy if I know that they will be evaluated.		1 (6.7)		3 (20.0)	4 (36.4)	3 (20.0)	2 (18.2)	4 (26.7)	4 (36.4)	3 (20.0)	1 (9.1)	1 (6.7)

Note: 1. D= Daedalus W= Wiki
2. For items with missing data, valid percentage was reported.

For some of the items the students showed positive responses irrespective of the group. For instance, the students did not enjoy writing English compositions under time constraints. As shown in Table 5, 46 percent of the students in the Daedalus group and 47 percent of the students in the Wiki group agreed with Item 3. In addition, regardless of group, the students (36% for Daedalus and 27% for Wiki) showed a tendency to worry about using appropriate expressions and words.

Particularly noticeable was that the group reaction was found to be different in Item 4 and 9. As summarized in the table, only 20 percent of the students in the Wiki group were worried about what others would think of their composition whereas 55 percent of the respondents in the Daedalus group were. This finding may be due to the difference in the nature of the computer tools. Wiki is a Web-based system that shares everything and updates new postings; thus the students might have become used to the open, multidirectional interaction and evaluation. Unlike Wiki, Daedalus' Respond module was available only to class members; for that reason, the students' might have become more conscious of their classmates' evaluation. Special concerns about others' evaluation might have led the students in the Daedalus group (55%) to become more sensitive to their performance than those in the Wiki group (27%) as shown in Item 9.

To examine if the students differed in their writing apprehension between the two groups, independent sample *t*-tests were run for pre- and post-tests. The group differences were found to be significant for both the pre-test [$t(24)=3.374$, p=.003] and the post-test [$t(24)=2.663$, p=.014]. Thus, an ANCOVA was performed to control for the effects of the initial differences; the group differences in the post-test anxiety scores were found to be nonsignificant [$F(1, 23) = .04$, $p=.84$].

3. Students' Attitudes Toward Writing with Computers

In a comparison of student attitudes toward writing with computers, 55 percent of the students in the Daedalus group responded that they felt more comfortable when writing on the computer than when writing on paper (See Table 6). In contrast, about one fourth of the students (27%) in the Wiki group reported so. Despite the difference, the frequency ranges (25-50%) are notable in that many students reported that they felt at home when writing on the computer.

With respect to Item 14 ("I start writing on a computer without writing on paper"), the students in the Wiki group (57%) showed higher levels of agreement than those in the Daedalus group (36%). This may be because Wiki, as a Web-based platform, was easier to access and use

compared to Daedalus. Interestingly, as shown in Table 6, more than one third of the students in the two groups showed similar reactions to Item 27 ("I write my composition on a computer after I plan it on paper.") both on the positive and the negative side. In contrast, more students from the Daedalus group responded that they revised their composition on a computer (46% compared to 20%). This may have to do with the process-oriented writing feature that Daedalus offers, i.e., the Respond module.

〔Table 6〕 Students' Attitudes Toward Writing With Computers (Daedalus versus Wiki)

Items	1 (not at all true)		2		3		4		5		6 (very true)	
	D	W	D	W	D	W	D	W	D	W	D	W
7. I feel more comfortable when writing on a computer than when writing on paper.	1 (9.1)	2 (13.3)	3 (27.3)	3 (20.0)		5 (33.3)	1 (9.1)	1 (6.7)	5 (45.5)	3 (20.0)	1 (9.1)	1 (6.7)
12. I work on a computer when reviewing and revising my composition.			2 (18.2)	1 (6.7)		1 (6.7)	2 (18.2)	4 (26.7)	3 (27.3)	6 (40.0)	4 (36.4)	3 (20.0)
14. I start writing on a computer without writing on paper.	1 (9.1)	1 (7.1)	2 (18.2)		4 (36.4)	2 (14.3)		3 (21.4)	4 (36.4)	5 (35.7)		3 (21.4)
18. I correct my composition on a computer after editing it on paper.	3 (27.3)	5 (33.3)	4 (36.4)	5 (33.3)		3 (20.0)	1 (9.1)	1 (6.7)	3 (27.3)	1 (6.7)		
22. I type and revise my composition on a computer after I write a draft on paper.		3 (20.0)	5 (45.5)	6 (40.0)		2 (13.3)	1 (9.1)	1 (6.7)	4 (36.4)	3 (20.0)	1 (9.1)	
25. I just type my revised composition on a computer after I finish writing and reviewing my composition on paper.		7 (46.7)	6 (54.5)	5 (33.3)	3 (27.3)	1 (6.7)	1 (9.1)	1 (6.7)		1 (6.7)	1 (9.1)	
27. I write my composition on a computer after I plan it on paper.		1 (6.7)	4 (36.4)	5 (33.3)	3 (27.3)	3 (20.0)		3 (20.0)	4 (36.4)	3 (20.0)		

Note: 1. D= Daedalus W= Wiki
2. For items with missing data, valid percentage was reported.

Regarding Item 18 ("I correct my composition on a computer after editing it on paper") and Item 25 ("I just type my revised composition on a computer after I finish writing and reviewing my composition on paper"), the students tended to be more negative. With respect to Item 18, their negative responses were similar across the groups, whereas in Item 25, the Wiki group's endorsement rate for disagreement (80%) was greater than that of the Daedalus group (55%). The findings indicate that few students edited their composition on paper before correcting it on a computer.

4. Student Reaction to Daedalus vs. Wiki

In addition to the students' attitudes toward writing with computers and their writing apprehension, their reaction to different writing tools was examined. Table 7 summarizes how the students in the Daedalus group evaluated the Daedalus integrated writing experience after use.

As shown in Item 1 and 3, the students were not so positive about the beneficial effects of Daedalus. Only 9 percent of the respondents reported that they improved English writing skills thanks to Daedalus, whereas a majority of students (73%) stood in the middle position. About 46 percent of the students disagreed with Item 3 describing the beneficial effects of Daedalus on individual writing.

〔Table 7〕 Students' Reactions to Daedalus After Use

Items	1 (not at all true)	2	3	4	5	6 (very true)
1. My English composition ability has improved after I practiced writing on Daedalus.		2 (18.2)	3 (27.3)	5 (45.5)	1 (9.1)	
2. It was convenient to compose on Daedalus.		2 (18.2)	2 (18.2)	5 (45.5)	2 (18.2)	
3. It was beneficial to compose on Daedalus when writing individually.		5 (45.5)	1 (9.1)	2 (18.2)	3 (27.3)	
4. I have become more confident in English compositions after I practicing writing on Daedalus.		2 (18.2)	5 (45.5)	4 (36.4)		
5. I hated the fact that other people could read my composition when I worked on Daedalus.	3 (27.3)	2 (18.2)	2 (18.2)	4 (36.4)		
6. It was beneficial to compose on Daedalus when writing collaboratively.		2 (18.2)	1 (9.1)	4 (36.4)	4 (36.4)	
7. It was fun to write English compositions using Daedalus.		5 (45.5)	2 (18.2)	1 (9.1)	3 (27.3)	
8. I hated the fact that other people could modify my composition when I worked on Daedalus.		3 (27.3)		5 (45.5)	3 (27.3)	
9. It was easy to learn how to use Daedalus.	1 (9.1)		2 (18.2)	2 (18.2)	5 (45.5)	1 (9.1)
10. My English writing anxiety has decreased since I practiced writing on Daedalus.	1 (9.1)	1 (9.1)	5 (45.5)	3 (27.3)	1 (9.1)	
11. I felt more nervous and anxious to compose on Daedalus because other people could read my composition.	2 (18.2)	2 (18.2)	2 (18.2)	5 (45.5)		

Items	1 (not at all true)	2	3	4	5	6 (very true)
11. I felt more nervous and anxious to compose on Daedalus because other people could read my composition.	2 (18.2)	2 (18.2)	2 (18.2)	5 (45.5)		
12. I want to continue to use Daedalus to practice English compositions.	1 (9.1)		5 (45.5)	3 (27.3)	2 (18.2)	
13. I became motivated to write more English compositions after I practiced writing on Daedalus.			1 (9.1)	3 (27.3)	3 (27.3)	4 (36.4)
14. At first, I felt worried about writing on Daedalus because I was not familiar with how to use it.		4 (36.4)	1 (9.1)	2 (18.2)	1 (9.1)	3 (27.3)
15. I want to recommend that other people use Daedalus for practicing English compositions.		1 (9.1)	2 (18.2)	4 (36.4)	1 (9.1)	3 (27.3)
16. It was helpful to use Daedalus for practicing compositions because other people could read my composition.		1 (9.1)	2 (18.2)	4 (36.4)	2 (18.2)	2 (18.2)
17. It was helpful to use Daedalus for practicing compositions because it was easy to check when and how my composition had changed.		1 (9.1)	1 (9.1)	5 (45.5)	1 (9.1)	3 (27.3)

Particularly interesting was that, although 46 percent of the students did not find Daedalus fun to use for writing practice (Item 7), 64 percent of the respondents acknowledged its motivating power (Item 13). Slightly more than half of the students also reported that it was easy to learn how to use Daedalus (Item 9). Moreover, about one third of the students recommended Daedalus for writing practice (Item 15) and agreed that the review features of Daedalus for sharing and revising were useful for practicing English composition (Item 16 and 17).

Similar patterns were observed for Wiki. Table 8 shows the students' reactions.

First, the students seemed to have enjoyed the features of Wiki that allowed them to share and revise their written work. About one third of the students were positive about the sharing function of Wiki (Item 16), and 60 percent of the students disagreed with Item 5 ("I hated that other people could read my composition when I worked on Wiki."). In addition, 40 percent of the respondents showed negative reactions to Item 8 ("I hated that other people could modify my composition when I worked on Wiki."). Interestingly, over half of the students reported that they were not bothered and pressured by others' reading their written work (Item 11).

Despite the acknowledgment of the benefits of Wiki, 40 percent of the students did not find Wiki convenient to use (Item 2). More than a third of the respondents denied the effectiveness of Wiki for individual writing. Interestingly, 80 percent of the students admitted that Wiki was

〔Table 8〕 Students' Reactions to Wiki After Use

Items	1 (not at all true)	2	3	4	5	6 (very true)
1. My English composition ability has improved after I practiced writing on Wiki.	1 (6.7)		1 (6.7)	11 (73.3)	1 (6.7)	1 (6.7)
2. It was convenient to compose on Wiki.	1 (6.7)	5 (33.3)	3 (20.0)	5 (33.3)	1 (6.7)	
3. It was beneficial to compose on Wiki when writing individually rather than when writing collaboratively.	2 (13.3)	4 (26.7)	2 (13.3)	4 (26.7)	3 (20.0)	
4. I have become more confident with English compositions since I practiced writing on Wiki.	1 (6.7)		5 (33.3)	9 (60.0)		
5. I hated that other people could read my composition when I worked on Wiki.		9 (60.0)	2 (13.3)	4 (26.7)		
6. It was beneficial to compose on Wiki when writing collaboratively.				3 (20.0)	10 (66.7)	2 (13.3)
7. It was fun to write English compositions on Wiki.			2 (13.3)	9 (60.0)	3 (20.0)	1 (6.7)
8. I hated that other people could modify my composition when I worked on Wiki.	2 (13.3)	4 (26.7)	6 (40.0)	3 (20.0)		
9. It was easy to learn how to use Wiki.			5 (33.3)	4 (26.7)	4 (26.7)	2 (13.3)
10. My English writing anxiety has decreased since I practiced writing on Wiki.		3 (20.0)	5 (33.3)	7 (46.7)		
11. I felt more nervous and anxious to compose on Wiki because other people could read my composition.	2 (13.3)	6 (40.0)	3 (20.0)	2 (13.3)	1 (6.7)	1 (6.7)
12. I want to continue to use Wiki to practice English compositions.		3 (20.0)	5 (33.3)	5 (33.3)	2 (13.3)	
13. I became motivated to write more English compositions after I practiced writing on Wiki.			2 (13.3)	7 (46.7)	5 (33.3)	1 (6.7)
14. At first, I felt worried about writing on Wiki because I was not familiar with how to use it.		4 (26.7)	2 (13.3)	5 (33.3)	4 (26.7)	
15. I want to recommend that other people use Wiki for practicing English compositions.		1 (6.7)	4 (26.7)	8 (53.3)	2 (13.3)	
16. It was helpful to use Wiki for practicing compositions because other people could read my composition.		1 (6.7)	1 (6.7)	8 (53.3)	4 (26.7)	1 (6.7)
17. It was helpful to use Wiki for practicing compositions because it was easy to check when and how my composition had changed.			6 (40.0)	5 (33.3)	4 (26.7)	

effective for collaborative writing. Although the degree of agreement was not as strong for Wiki as for Daedalus, about 40 percent of the students agreed that Wiki was easy to learn (Item 9) and

that it helped to boost their motivation for L2 writing (Item 13).

V. CONCLUSION

The present study compared the effects of two different computer writing tools (Daedalus and Wiki) on students' writing proficiency and their writing attitudes. Daedalus and Wiki are computer programs that are commonly used for writing practice. Daedalus is an intranet-based writing program that supports process-oriented writing with such modules as Invent, Write, and Respond. Wiki is a Web 2.0 communication tool that can be used for group learning processes since it facilitates multiuser participation. It allows users to construct and enhance knowledge and revise and manage versions of writing in the thread mode and the document mode (Cole, 2009).

The participants of the study were 26 college students (11 students in the Daedalus group and 15 students in the Wiki group) in two multimedia English courses. The participants were asked to complete a writing test and attitude questionnaires twice in Week 2 and Week 8. Between the two tests, the students in both classes performed a total of four writing tasks: two individual and two collaborative. The students in one class performed writing tasks via Wiki, whereas the students in the other class performed the same tasks with Daedalus.

To examine the effects of Daedalus and Wiki on the students' writing proficiency and attitudes, their pre- and post-test measures on the writing test and the attitude questionnaire were compared. The results indicated that although the two groups differed in terms of writing proficiency and writing apprehension, the differences were not statistically significant. In addition to the students' writing proficiency and writing apprehension, their reactions to the different writing tools was examined. With regard to Daedalus, many students reported that it was easy to use, but not so much fun to work with. They also answered that they became motivated to write more English compositions; they also wanted to recommend that other people use Daedalus for practicing English writing.

Similar patterns were observed for Wiki. The students seemed to have enjoyed the features of Wiki that allowed them to share and revise their written work. Despite the acknowledgment of the advantages of Wiki, 40 percent of the students did not find Wiki convenient to use. More than a third of the respondents denied the effectiveness of Wiki for individual writing, whereas almost 80 percent of the students endorsed the beneficial effects of Wiki for collaborative writing.

These findings seem to suggest the pedagogical value of Daedalus and Wiki for writing classrooms. First, these computer-assisted writing tools facilitate those practices the proponents of process-oriented writing have emphasized, namely, a cyclical writing process ranging from idea generation to rewriting. Second, these tools seem to alleviate affective pressures writers often feel in writing. The accessibility to those tools for easy revision and feedback helps writers understand that what they write can be easily changed and improved. The prospect of a better outcome can prompt and thus motivate students to engage more in their writing process. This in turn helps writers become more open to peer feedback and criticism. Third, the findings suggest that these tools are particularly effective for collaborative writing, rather than for solitary and individual writing.

Although many researchers assert the benefits of collaborative learning, it has not been easy to apply collaborative writing in classrooms because many writing classrooms still rely on paper-and-pencil writing tasks. It is not easy even with word-processing programs because collaborative writing requires more than one writer to work on the same document. Although word-processing programs may be adequate for facilitating process-oriented writing, they are not the best tool for collaborative writing. Fortunately, the two tools investigated in this study, Wiki and Daedalus, seem to have many benefits. Considering these benefits, it seems safe to say that these tools can be incorporated into writing instruction, particularly with respect to the collaborative and interactive components of writing.

While the findings of the study offer pedagogical implications, they are limited and thus carefully interpreted. The study was conducted with a small number of students and with college level students only. This makes it difficult to generalize the findings of the study to other groups. In addition, the amount of time allocated for students to experience the tools may not have been sufficient. For these reasons, follow-up research studies should be conducted for a prolonged period of time and with a greater number of participants.

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