Learning to Write Together Using Groupware

Ilona Posner , Alex Mitchell and Ronald Baecker
Dynamic Graphics Project, University of Toronto
10 Kings College Road
Toronto, ON M5S 1A1, CANADA
Tel: 1-416-978-5473
E-mail: ilona@dgp.toronto.edu

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ABSTRACT

Most studies of collaborative writing have focused on mature writers who have extensive experience with collaborative writing. Typically, these studies also deal with short, somewhat artificial tasks carried out in a laboratory, and thus do not extend over a period of time as real writing usually does.

This paper describes an ethnographic study of collaborative writing by two groups of 4 grade six students using synchronous collaborative writing software for one hour per week over a 12 week period. Despite initially having no idea of what it means to write together, and no experience in doing so, both groups produced nearly one dozen short collaboratively conceived, written, and edited documents by the end of the study.

A careful analysis of video tape records, written documents, questionnaires, and interviews provided insight into the way in which novices learn to write together, and the role groupware technology can play in the process. It also demonstrated the importance of concepts such as awareness, ownership, and control in the writing process, and highlighted many examples of strengths and weaknesses in the writing software.

INTRODUCTION

Writing together, while often necessary, is never easy. We have seen this repeatedly in our research into the ways in which people write together, how people learn to write together, and how computer-based tools can help with the learning and writing processes [1, 13, 17, 22]. Other investigators have studied collaborative writing among mature writers [3, 6, 11, 23]. A number of theories of collaborative writing have been developed [6, 23, 26] to characterize the writing process. There have also been a number of tools designed to support collaborative writing [1, 7, 12, 18, 20].

We learned that experienced writers have biases towards groupware based on the way they write using conventional non-groupware tools, and they often resist the new paradigms introduced by groupware technology. In order to learn more about the process of collaborative writing, we decided to focus this study on novice writers learning to use groupware to write collaboratively. We chose to observe extended usage of groupware technology in the realistic setting of a classroom in order to observe the effects of groupware tools on the collaborative writing process and to learn how to design better software.

In our study, two groups of grade six students worked together for twelve weeks to produce a magazine on prejudice (see Figure 1). The students learned how to use Aspects[2], a commercial synchronous collaborative editor, and developed the skills necessary to work as a group and to successfully write together. Although collaborative writing is a common practice among mature writers, our experience with the SASSE [1] group editor suggests that novice writers are uncertain as to how to proceed, and often have difficulty even understanding what is meant by collaborative writing. Other researchers have dealt with group writing in the classroom [4, 8], identifying the difficulties facing novice writers in collaborative situations, without the added complexity of using groupware tools. Our early trials using naive collaborative writers highlighted the importance of demonstrating to novices a variety of approaches to group writing. Because of this, we began our study by providing the students with training in collaborative writing, and concluded by observing their attempts to write together using groupware.

[1] This paper combines materials presented in the paper appearing at CHI'95 [16] and CSCL'95 [24].

[2] Aspects was developed by Group Logic Inc., formerly Group Technologies Inc.

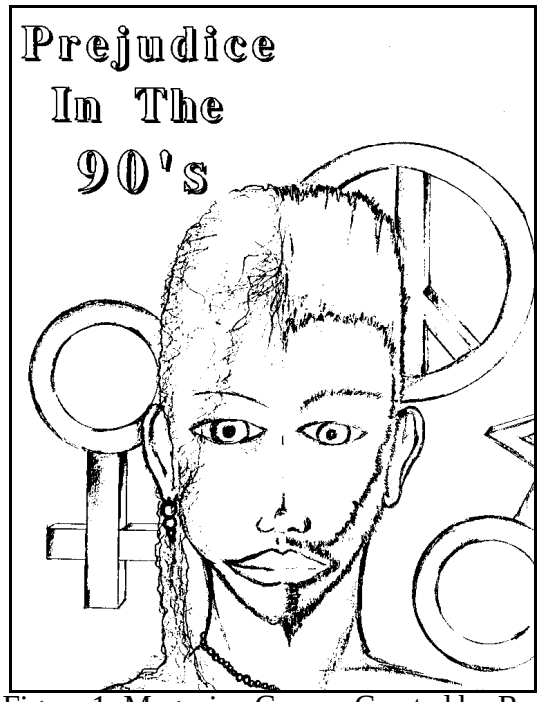

Figure 1: Magazine Cover. Created by Ryan Field, age 12.

This paper presents the results of this study. We will begin with an overview of the study itself, and describe the methods used to observe the sessions and analyze the collected data. We then discuss the process of learning to write together by describing the writing approaches and activities employed by the students, and the ways in which these approaches and activities developed over the twelve hours of the study. We continue with a brief look at the effects of these writing approaches and activities on the resulting documents. We also discuss the impact of the project on the participants. A detailed section examines the effects of the technology on the process of learning to write together; it describes the students' experiences and how our observations can inform the design of future collaborative writing tools. We conclude the paper with implications for future studies.

THE PREJUDICE PROJECT

The Prejudice Project took place at the Huron Street Public School in Toronto between February and May 1994. The goal of this project was for grade six students to learn about prejudice while collaboratively writing and producing a magazine on that topic.

We conducted an ethnographic study of two groups of four grade six students preparing the written material for this magazine. Eight students were selected, with the assistance of their teachers, from 14 volunteers out of two grade 5/6 classes. The students were familiar with the Computer Supported Intentional Learning Environment (CSILE), a shared knowledge building system [25], but had never used synchronous collaborative software.

Through the course of the study the students learned to write together using Aspects on networked Macintosh computers. Aspects is a synchronous text editor, which allows multiple users to work concurrently on a document, entering text at the same time in different paragraphs, with changes immediately visible on all users' screens. Aspects also provides telepointers, individual cursors which can be made visible on all users' screens.

The Study

Each group met once a week for one hour after school over a period of twelve weeks. The students worked in one classroom, sitting at four adjacent Macintosh computers (see Figure 2). The computers were connected by a local area network, and all ran Aspects, allowing the sharing of documents among different machines. Seating arrangements were rotated weekly to reduce the likelihood of subgroup formation and to assign the preferred seats equally among the students. During the study they were given training in the use of Aspects, introduced to collaborative writing techniques, and given the freedom to use their new skills.

Figure 2: Physical setup of the study.

The first five weeks were highly structured in order to allow us to cover a variety of topics related to prejudice and to introduce a number of collaborative writing techniques. Students were shown the mechanisms provided by Aspects which were required to perform the assigned writing tasks. These tasks included working as a group to write a poem and a story. The tasks were designed to expose the students to a variety of writing approaches [22, 23], which were introduced by the instructor to show them the various different ways of writing together.

The following schedule outlines the breakdown of the first five weeks of the study:

1 Introduction to the project: goals, rules, responsibilities — Feb 1
Exercise: Differences: Interview a partner, getting to know each other better & tell the group
Exercise: Similarities: As a group find what makes you all happy & sad
Exercise: Perception: Look at a picture write down 3 things you find most interesting
Goal of Excercises: Get students talking, expressing their opinions, more comfortable with each other. See that they are all unique and have different opinions but that they agree about other things.
Technical Goals: Start writing on-line using CSILE. Writing approaches: independent & scribe

2 Ex: Perception: Advantages and disadvantages of differences in perception — Feb 8
Goal of Excercise: To show that people have different perceptions of the same things, people, events.
Technical Goals: Introduction to groupware and group writing exercise, introduce consept of revising their work. Writing approaches: scribe, parallel, joint.

3 Exercise: Minority Poem: When I'm in the Minority I feel ... — Feb 15
Goal of Excercise: To introduce concept of minority and how it might feel to be a member of a minority.
Technical Goals: Introduction to groupware. Use both CSILE and Aspects, learn how to Cut/Paste between two applications. Writing approach: parallel & joint.
Exercise: Develop Orientation Plan: How to Welcome a New Student to Your Class.
Technical Goals: More practice with software and collaborative writing. Writing approach: joint/parallel.

4 Exercise: Generalizations: Need to qualify what we say, "Basketball players are tall" better "most…"Feb 22
Exercise: Stereotypes: Discussion how stereotypes are created & group writing exercise.
Goal of Excercises: To introduce concept of generalization, stereotype, and prejudice. Make them aware that all generalizations, particularly those about people, need to be qualified.
Technical Goals: More practice using software and doing collaborative writing. Writing approach: parallel.

5 Exercise: Prejudice: Define concepts, read a sample story, group writing exercise (story). Mar 1
Technical Goals: More practice in collaborative writing. Writing approaches: scribe & joint.

In the remaining weeks the students were free to choose what they wanted to work on and how they would work together. The students' work during the second half of the study included doing research, writing articles, creating artwork, and editing materials created in the first five weeks which they had chosen to include in the magazine. After the initial training in the uses of technology and the group writing approaches, we minimized our guidance so that we could observe the choices the students would make.

Data Collection and Analysis

During each weekly session all of the groups' interactions were videotaped (see Figure 3). Two cameras covered the students working on the computers, and two cameras captured screen images. In addition, time-indexed notes were made using the Timelines [9] sequential data analysis and video annotation software while the sessions were in progress. Exploratory analysis was conducted on the video records of the sessions by two people using Timelines. This analysis focused on identifying common problems, incidents and trends in the data.

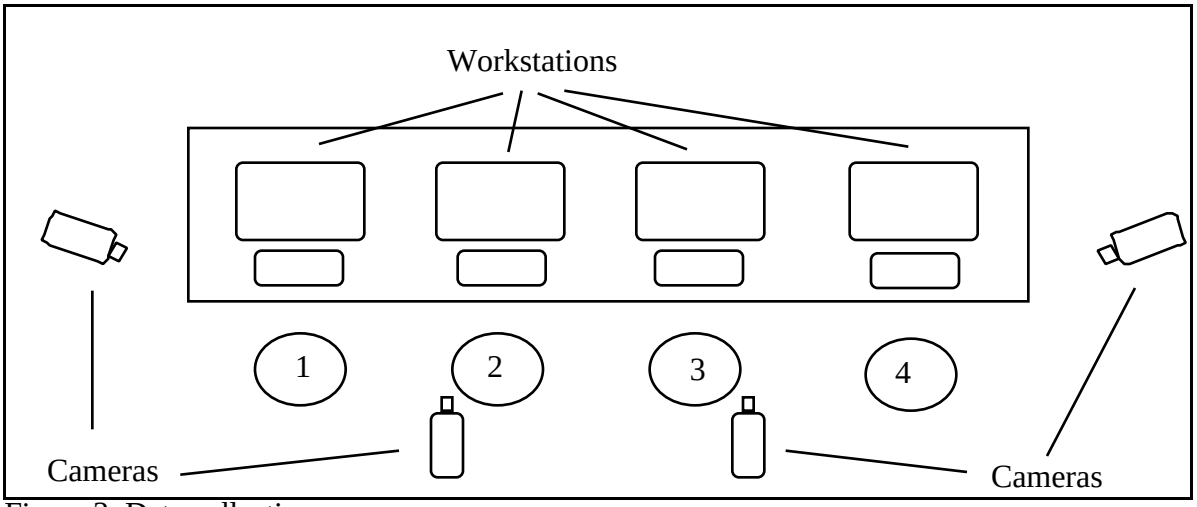

Figure 3: Data collection.

A number of other measures were used to provide a rich view of the sessions. The students' teachers were asked to evaluate the students' writing skills and ability to work together. Each individual's writing skills were rated using a seven point scale according to vocabulary, spelling, grammar, ideas and creativity, and writing style. The teachers also provided blind evaluations of a selection of work, both individual and group, using these categories. These scores were then averaged for each individual, and across each group, to give an indication of general writing level. Each student's ability to work in a group was also rated according to interpersonal skills, communication skills, leadership skills, maturity, and task focus.

We also conducted two questionnaires, one at the halfway point and one at the end of the project, and a final individual interview with each student. A few weeks after the end of the project,

we came back and conducted a group discussion about the project, which gave additional insight into the students' experiences.

THE PROCESS OF LEARNING TO WRITE TOGETHER

By *writing together* or *collaborative writing* we mean the creation of documents with the participation of several individuals. There may be numerous stages in the creation process, including brainstorming, planning, choosing a writing approach, assigning activities, combining ideas, resolving conflicting ideas, entering text, editing, and reaching consensus about the final text.

Given this complexity, it was not surprising that when the students were asked to write together early in the project they did not understand what this meant. They gradually developed an understanding of group writing as they were coached about different writing approaches, experimented with different writing activities, and gained experience over the 12 week period.

We will now look at the different writing approaches and activities used by the students, examining how these approaches and activities changed over the course of the study. We will focus specifically on three texts: a poem written during the third week, a story written during the fifth week, and the introduction to the magazine written during the eleventh week. These documents were selected from among the documents that the students chose for inclusion in their magazine. The writing of these documents spanned the duration of the project and involved the use of a variety of writing approaches.

Writing Approaches

When a group project is assigned during their everyday classroom work, the students generally use the ***independent*** writing approach — dividing the task into distinct components and working on those sections individually, with minimal feedback between group members. We started by using this approach to minimize the transition from the students' everyday writing, since they already had to contend with many changes due to the physical setup of our study. This early writing also provided us with samples of individual work that we could evaluate and compare to the students' individual in-class writing and to their group work.

Since all of our students enjoyed typing on the computers, they found the synchronous access provided by Aspects to be fun. However, introducing a shared workspace did not spontaneously lead to close collaborative work. The students tended to use the ***parallel*** writing approach, working on different parts of one document, and seldom examined each others' entries. This approach was used by both groups when writing the poem. When segments were written in parallel by different individuals, information was often duplicated. The students also noticed that this parallel writing approach often resulted in a fragmented writing style. Here Sue[3] discusses how to improve the poem that the group had written in parallel:

Sue	I think we should write the whole thing over because it sounds like 3 poems stuck together.
Hope	Yeah, I think one person has to rewrite it.
Liz	Yeah.

The ***scribe*** writing approach, where one person enters the text at the keyboard while the rest of the group suggest ideas, was also familiar to the students. This approach is often used by individuals working simultaneously on one document using traditional writing software. By making the group document available to different writers on several different computers, Aspects subtly alters the dynamics of the scribe approach. Even though a document was accessible on several computers, in the early stages of the project the group would still gather around one machine with the scribe controlling the document and making all the final decisions. This is the way the scribe approach is normally used with a single-user word processor.

[3] Note that the names of the students have been changed, but their gender preserved.

However, Aspects makes the shared document visible on all users' computers, letting all the participants have an equal opportunity to view the text. After a few weeks, when the students had become used to the idea of a shared document, they would follow the text being typed by the scribe on their own computers, suggest changes to the scribe, and use telepointers to indicate where the changes should be made. Despite the fact that the scribe still had control of the document, other group members provided input that led to very fine grain changes in the text, including spelling, wording, and grammar.

Later in the project, individuals were seen correcting the text which was just typed by the scribe as soon as it was accessible to them[4]; we call this the ***joint*** writing approach. Joint writing involves all participants taking an active role in the actual manipulation of the emerging document, a role not possible in traditional single-user word processors.

These approaches should be viewed as four points in the space of collaborative writing possibilities. Real collaborations may include a combination of several approaches. For example, while writing the story, both groups used primarily the scribe writing approach, but there were some instances of joint writing; we'll call this *scribe/joint* writing.

As they gained experience with the technology and the group writing approaches, the students in the first group expanded their repertoire, using a *parallel/joint* writing approach. While writing the magazine's introduction on the eleventh day, each member of the group worked inside the shared document, writing quietly and making changes to his/her entries based on each others contributions but without much discussion. At times students would glance at other parts of the document or discuss ideas, assuming that everyone was aware of the entire document's contents.

As they became more experienced with collaborative writing, the students also became more selective in their use of writing approaches, to the point of switching strategies in the middle of composing a document. For example, when working on the magazine's introduction, the second group shifted between scribe/joint and parallel writing to solve a consensus problem. During the scribe/joint writing component, the group couldn't agree on the best wording for one section of the document. To solve this, three members worked in parallel to enter their own ideas. Once the ideas had been entered, they all read these entries and combined them into a single paragraph. The group then shifted back to scribe/joint writing to complete the document.

By the end of the study, both groups had progressed from the simple use of an independent writing approach to an understanding and use of a variety of collaborative writing approaches. They where able to select an approach appropriate to a given task, and to adapt their writing approach to suit the demands of each stage of writing. After twelve hours of training and practice, they had clearly developed significant proficiency and sophistication in collaborative writing.

Writing Activities

Among writing activities [23] we include planning, typing, dictating, correcting mistakes, and editing, where editing implies clarifying the language, ideas, spelling, vocabulary, and grammar. The notion of different writing activities was familiar to the students. Each student participated in various activities throughout the project. We will now discuss how the students perceived these activities and how the activities were assigned to individuals in the groups.

In the final questionnaire the students were asked to rate the importance of the various activities that are involved in group writing. At the same time they were asked to rate each activity according to how much they enjoyed it. The students felt that correcting mistakes was the most important activity, followed by planning and making changes. However, the most enjoyed activity was typing the words, followed by planning and dictating. All the students were willing to perform activities they did not necessarily enjoy since they recognized their importance.

The students used a variety of methods to assign activities to individuals. The easiest method was to have someone volunteer for an activity and have their suggestion remain

[4] During the project we set Aspects' locking at the paragraph level, so paragraphs could be controlled by only one individual at a time.

unchallenged by the rest of the group. Another method was to have someone assign an activity to a willing individual. The remaining assignment methods involved negotiation, compromises, and at times even power struggles to attain a desired activity.

The most preferred and contested activity was typing. Both groups witnessed lengthy and intense debates over who should type the story, which was to be jointly written by the group:

Hope	I'll type
Liz	I'll type
Sue	I'm the fastest
Dan	I'm typing
Sue	We can all type
Liz	Its not fair
Instructor	Wait wait wait! The point here is not the typing. The point here is the story!
Dan	They always get to do everything! They're being sexist[5] and its no fair! [punches table]
Liz	[typing already]
Hope	[also typing]
Dan	Okay I'm starting

The group went along with this, everyone dictating while Dan typed. Ideas were passed around and negotiated, but the final decisions were made by Dan.

The assignment of activities was often informal, and people frequently shifted between activities during the writing process. Which activity an individual chose was guided by the activity's perceived enjoyment as well as the individual's skill at each activity. Rob typed the group's story, but delegated the corrections to other group members after admitting that he is a bad speller. The ideas for the story originated mostly with the other group members. Carol fixed the grammar, which is her strength, and Kim corrected the spelling. Thus, unlike individual work, where one person performs all writing related activities, participants on group projects are able to pick and choose among activities based on their strengths and their preferences.

Which activities to perform and in what sequence these are to occur are decisions that must be made explicit in group work. The resulting patterns evolve out of the writing habits of the individual participants. Rob tried to guide the second group into following his favorite writing scheme, of first producing a rough draft of the text then later going back to make changes. Some of his collaborators were not as comfortable with this scheme, and preferred to correct the spelling and grammar mistakes as soon as these occurred. While writing the story, the group compromised and corrected some mistakes right away, with minimal interruption to the creative process, and made a separate pass correcting the remaining mistakes. During the various passes, different people took control of the document performing different activities: Rob typed the text; Carol fixed the grammar, and Kim corrected the spelling. Throughout the entire writing process, the group remained extremely goal oriented and task focused with only a few distractions. This had a positive impact on the final product.

IMPACT OF GROUP WORK ON THE PRODUCT

There is some disagreement in the literature about whether group work has a positive or negative effect on the quality of the product [4, 8]. We will now examine how, in this study, the quality of the group document relates to the writing ability of the individual writers and to the quality of their individual work, and how the writing process seems to affect the product quality.

As mentioned earlier, the two teachers were asked to evaluate the students' writing created while working on our project. Each teacher also produced a score to estimate his students' *in-class writing average*; we used this score as a baseline measure of the students' writing ability. During this project, each group produced eleven writing samples including both individual and group work.

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[5] The groups consisted of three girls and one boy. This imbalance led to some subgroup formations and some disputes where gender differences became an issue. Dan complained that "Group writing was very stressful ... they all ganged up on me, every time, because I'm a boy." He did, however, obtain control of the group's document at critical moments.

We will focus our discussion on the students' independent work done during the project (*on-project average*) and on three jointly written documents (*poem*, *story*, and *introduction*). Table 1 summarizes our results.

	Writing Samples	Average Score	Week #	Lines #	**Writing Approach** Plan	Write	Edit
GROUP 1							
Individual Work	in-class avg.	6				I	
	on-proj avg.	4.4	2,4			I	
Group Work	poem	5.1	3	35	—	P[5mins]	J[7]
	story	6.1	5	26	J[6]	Sj[19]	Sj[10]
	introduction	4.5	11	11	J[1]	Pj*[23]	while writing
GROUP 2							
Individual Work	in-class avg.	4				I	
	on-proj avg.	3.2	2,4			I	
Group Work	poem	3.4	3	18	—	P[7]	Pj[9], J[6]
	story	4.1	5	18	J[5]	Sj[20]	J[11], I[2], J[3]
	introduction	4.7	11	7	J[3]	Sj[11], P[3], Sj*[11]	while writing

Table 1: Teachers rating of students' individual and group work. The *average scores* are evaluated on a 7 point scale and each value averages ratings in these categories: vocabulary, spelling, grammar, ideas, and writing style. The first initials of the *writing approaches* are used as follows: I independent, P parallel, J joint, S scribe, Sj scribe/joint, Pj parallel/joint. Time estimates in minutes are displayed in [ ], for each writing approach. * indicates that students were very distracted while working.

When examining the students individual work, we note that their in-class writing is rated higher than their on-project writing. Some of this difference may be due to the fact that the on-project work was evaluated blind — the teachers did not know the identity of the writer. We found that, in all but one case, the teachers' rating of students' in-class work was higher than their blind evaluations of the same person's on-project work. Another possible explanation is that the individual on-project writing was done in the early weeks while the students were getting used to the distractions of the foreign surroundings and the project setup.

Next, we note that the students' group work shows an improvement over their individual on-project work. Since the individual work was done mostly earlier than the group writing, perhaps the students' performance was hindered by the fact that they were still becoming accustomed to our setup and to the new software. Another possible explanation for this improvement is that during group work each document is available for scrutiny to all the group members, thus increasing the number of potential criticisms and new ideas which, combined, produce an improved final product.

Let us now examine the group work segments of the table. In both groups the story is rated higher than the poem. First, the story is written two weeks later than the poem and the groups' writing may be improving with experience. Second, both poems were written using the parallel writing approach — segments were written separately by the students in different documents, and later combined into one document, with minimal feedback between participants. The stories were written using the scribe/joint writing approach — the scribe typed the document produced by the group working together from conception and initial ideas through the final editing changes. If we consider these two writing approaches it becomes clear that in scribe/joint writing there is significantly more task related interaction among group members; the products are scrutinized by the whole group at every stage of the writing process. In addition, the poems were written with no planning prior to writing, whereas before writing the stories each group spent at least five minutes

discussing their tasks away from the computers[6]. Note also that the story is rated slightly higher than even the baseline in-class individual writing.

The reader will have noticed that group one has higher overall ratings than group two. This occurred because we unintentionally formed two groups whose abilities differed in both writing skills and group work skills. However, despite this, the introduction written by group two is rated slightly higher than that of group one. Both groups spent minimal time (less than 3 minutes) planning prior to writing and spent a long time working on this relatively short document. The main difference lies in the writing approaches they used. Group one wrote using the parallel/joint writing approach, each member of the group worked inside the shared document, making changes to his/her entries based on each others contributions but without much discussion related to their task; this group was very distracted during this task. Group two, on the other hand, remained more focused, using the scribe/joint approach with everyone contributing ideas and comments to the scribe throughout the writing. At one point they switched to parallel writing for three minutes but later returned to their original approach. By increasing the scrutiny of the document during the writing process, scribe/joint writing enabled all participants to apply their talents, to the benefit of the final product.

IMPACT OF TECHNOLOGY ON LEARNING AND WRITING

In addition to learning about the task of writing together, the students had to learn to use the tools provided. The students had no problem working with the computers. All had extensive experience with computers both in the classroom and at home. In fact, the students were so comfortable with the computers that they took a cruel pleasure in causing the software to crash.

Collaborative writing is a very difficult task. To support it successfully, the tools provided must not add to that complexity. Experienced writers often get distracted from the content of their writing when composing on a computer [10]. The vast number of fonts and styles available tend to encourage a focus on format and layout. This is especially true for novice writers. The students found it hard enough to stay on task without technological distractions. Tools such as chat boxes and cute telepointer shapes were often more distracting than useful. An interface that supports gradual disclosure of features would allow users to be comfortable with the system at all stages of learning (a)[7].

The feedback provided by the system was often obscure and confusing, leading the students to ignore it. When the messages were critical, such as when document consistency was lost, this led to later problems (b). The fact that documents are shared, yet replicated, caused continuous confusion to both the students and the experimenters. A number of documents were lost and had to be reentered because the various contributors all assumed that someone else had saved the document. The location of the document was not at all obvious from the interface (c).

However, as the students became more familiar with the concept of shared access to a common document, they developed working patterns that took advantage of the technology. As will be discussed below, the students came to realize how the technology could be used in different situations.

Having described the process through which the students learned to use Aspects to write together, we will now focus on the various aspects of the collaborative writing experience, discuss how the tools provided influenced this experience, and suggest how these observations can inform the design of future collaborative writing tools.

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[6] The students found the computers extremely enticing; given the opportunity they usually wanted to explore or play with telepointers and Chat boxes. On several occasions we had to resort to "hands on the heads" and "turn the machines off" techniques, in order to reduce chaos and regain the groups' focus.

[7] Throughout our discussion of the study we will use letters such as (a) to link our observations to the list of design recommendations appearing near the end of this paper.

Collaboration and Awareness

The first major difference encountered by any user when moving from single-user to multi-user software is the notion of a shared space in which other people are working. The importance of collaborator awareness mechanisms has been well recognized [1, 5, 17]. When dealing with novice writers, this is especially important.

Self-Awareness

Even after becoming familiar with the notion of a shared workspace and having worked on the system for six weeks, the students still had difficulty determining where they were and what they were doing.

Where Am I? There are several things that the students were asking when they asked "Where am I?" The simplest is location in the shared document. However, it is also important to provide some feedback as to whether the user is in a conference or working alone, and whether the current document is private or shared with others (d).

It was common for people to become confused as to whether their work would be seen by others or not, and whether they would be able to see others' work. This was especially true when someone stopped working closely with the group, and then later returned. In one case, it turned out that the students who had been working together to edit a document had in fact been working in separate copies of the document (e).

Sue [moving her mouse and looking at Hope's screen] Why doesn't it [her pointer] show up?
Instructor Why don't I have a copy of that?
Dan [moves mouse, looks at Sue's]

This situation wasn't discovered until Sue happened to glance at Hope's screen and notice that her telepointer was not showing up.

What Am I Doing? Similarly, in a multi-user conference with multiple documents it isn't always obvious what you are doing at a given moment. This can range from confusion as to whether you are telepointing or not, a simple interface problem, to more subtle concerns, such as whether you are interfering with someone else's attempts to edit text. The system needs to make the information about your relative location and influence on others readily available (e).

Collaborator Awareness

Collaborator awareness is always important, but even more than usual when dealing with users who are learning to work together. Awareness not only includes awareness of where people are within a document, but who is present for collaboration and who is potentially present.

Where Are You? Lack of any reminder of where others are makes it easy to forget that there is a shared workspace (f):

Group [they start to divide the task up by questions - each group member tells the others what they wrote as if the others can't see it]
Instructor Everyone can see the same thing. [goes over and scrolls Sally's to show them]

What Are You Doing? When working individually, it is easy to lose track of what others are doing. This problem is often overcome by resorting to physical pointing and glancing at each other's screens (g):

Sally I'm getting confused. Rob, what are we changing here?
Rob [makes changes, points to screen to indicate what he is doing]
Carol [watches what Rob is doing]
Sally [doesn't notice Rob's gesture] Rob what are we doing here?
Rob Its gonna look like a poem.
Sally [sees gesture and looks over] Okay

Who Did That? With synchronous shared access to the document, it is possible to enter text or to delete someone else's text without that person's knowledge. This can lead to confusion:

Dan [deleting something]
Liz No no don't erase it DON'T! who erased that?
Hope Not me I just got in.

Liz [looks over at Sue] Sue?!?
Dan [looks around, says nothing]

Tracking of where other people are and what they are doing can come in many forms. Aspects provides bars alone the side of the document indicating that someone has control of a region of text. This tells you that someone is there, but not who it is.

Pointing and Gesturing

Users may also want to explicitly provide information to others about their actions. Aspects provides a simple telepointing mechanism, allowing each user to gesture with a remote cursor of a user-selected shape. However, the students often found it easier to use physical pointing and gestures:

Sally Rob, can you show me what you're trying to do?
Rob Take a look here. [points to her screen]

Telepointers were too limiting because they were both unable to draw collaborators' attention and lacked information about the person who was pointing. All this information is available in a simple hand gesture (g).

The telepointers also tended to be rather distracting; the students often ended up chasing each others' pointers around the screen. However, one group did learn to use them effectively when proofreading and editing:

Liz Meant is spelled M-E-A-N-T [points at her screen]
Dan Where is it?
Liz Its, I'll mark it, there I've marked it. See? That's where it is [uses telepointer] where my little annoying thingy is.

Having discovered this function, Liz explains it to the others:

Liz Say he spelt birth wrong [points with finger, Sue looks] you go to that [moves telepointer there] and go like that. [wiggles it]
Sue OHHH.

The shared workspace encourages this type of consulting and collaborative learning.

Effect of Physical Placement

The students tended to take advantage of the physical placement of the computers to aid in their awareness of group activities. The computers were placed in a row, allowing each student to glance around at the other students and at their screens. From the start, they tended to glance around a lot, anxious to stay aware of what the rest of the group is doing. This ability to look at each other's computers also led to shifts between working independently or together on separate computers and working huddled around one machine.

The physical placement of the machines also allowed people to notice when someone is looking at their work; this is useful for encouraging and facilitating collaboration and consultation:

Group [they start entering comments]
Liz [glances at Hope's screen for confirmation she's doing it right]
Hope [notices, gives her advice]

However, the physical placement can also lead to formation of subgroups and exclusion of peripheral group members. To minimize this, we rearranged seating patterns each session.

Document Ownership

The perception of who has a claim to ownership of a section of text, or over the entire document, was independent of how ownership was represented by the technology. Aspects doesn't provide any explicit indication of who wrote a section of text. However, the students would often assume, especially in the early parts of the study, that the person who typed a section was the only person who could change it.

Similarly, there was a connection between who typed in a section of text and who got credit for the ideas contained in the text. We observed that the scribe usually provided fewer ideas than the rest of the group. Despite this, the scribe occasionally took credit for the content of the

document. For example, in the first group, the person who typed a story claimed the next day that it was his story:

Dan	I wrote the story.
Sue	No I did.
Liz	I did.
Hope	We all did.
Dan	The one about the...
Hope	I made up Tiger Lily.
Instructor	I thought everybody wrote it.
Dan	I wrote it most cause I typed everything.

Although the system did not provide explicit ownership information, the students tended to continue to identify text with the person who typed it. This showed up most clearly when the second group was editing one of the documents. In this case, the sections of the document were all written in parallel, with each section easily identifiable as belonging to a different person. Two of the group members were suggesting changes, but refused to make the final alterations until the entire group gave permission.

However, when the group was working together on a document that had already been edited, the group members had no reservations about arbitrarily deleting someone else's text without telling them (h). This suggests that at this point the group members had come to regard the text as shared, rather than just owned by the person who typed it.

Document Control

The system's assumptions about control over the document, both in terms of the ability of group members to edit sections of text and to access documents, had several effects on the collaborative writing process

The students in the study used Aspects in paragraph locking mode. This allows each user to gain control of a paragraph of text and make changes within that paragraph. As long as the user doesn't move the selection point out of the paragraph, other users are locked out. This granularity of locking led to some interesting behaviour.

When working with physical documents, the students were able to gain control over a paper by grabbing it if necessary. In Aspects there was no way to force a shift in control. One student understood the technology to the extent that he deliberately kept an entire document as one paragraph to keep control of the changes being made to the text, even when encouraged to add paragraph breaks:

Instructor	Can I suggest you put some more returns in there? [gets up and puts returns in so Dan isn't locking the whole document]
Liz	[starts typing like mad as Instructor puts in spaces]
Sue	[starts typing like mad as Instructor puts in spaces]
Dan	I didn't want to or else they'll start doing funny things with it.

However, the group soon learned to overcome the limitations of the locking mechanism by simply using the other person's computer rather than trying to get control of the document from within the system.

Dan	[takes Sue's mouse when she's not looking, moves her out of a paragraph]
Sue	[looks back, sees Dan]
Dan	One sec... stop, let me work on this part.

Control over the text also had an effect on the roles taken on by the group members. When deciding who would be the scribe, the group would either take a vote or argue until someone managed to get control of the text. For example, when the first group was composing a story, Dan ended up gaining control of the text. The group went along with this, everyone dictating while he types; ideas were passed around, negotiated, and the final decision was made by the scribe.

Although the system gave the scribe explicit control of the document, the other members of the group were still able to make significant contributions and provide feedback which affected the contents of the document. In the above example, where Dan had control of the document, there

were several occasions where other students tried to make changes. Kim would attempt to alter a sentence, and failing that would ask Dan to make the change, using the telepointer to indicate the change. So, in spite of the control mechanisms provided by the technology, the entire group was able to influence the document (i).

Synchronous Access and Collaboration

The fact that everyone could access the workspace influenced the style of collaboration. Initially, everyone wanted to type just because they could. However, as they gained experience with the technology and with group writing, the students became more selective in their choice of writing style. For example, when working on the last day on the magazine's introduction, the second group shifted between scribe and independent parallel writing to solve a consensus problem. Sally was acting as scribe, but the group couldn't decide on the wording of one section of the document. To solve this, they all entered their own ideas, then all read them and selected the best. They then shifted back to scribe mode, and continued (h).

Working synchronously but on separate sections of the document worked well in a task that lends itself to division. On the tenth day, the two members of the first group were preparing the questions for an interview – they discussed the content, then split the task up, but talked back and forth while entering the text. Then, after the interview, they worked in a scribe fashion, one student dictating the answers while the other typed.

However, it was not always clear who had been given the role of scribe. In fact, the assignment of roles tended to change dynamically, since the technology lets anyone take control as long as the previous scribe is willing to relinquish control. In general the groups were able to adapt to this shifting of control. If someone's ideas were not being accepted or they were being ignored, that person would sometimes go off and start entering the ideas independently in a different section of the document.

The students were able to adapt their use of the system to suit their working patterns, and to take in to consideration the social and group interactions taking place as they worked. It was possible because the system did not attempt to impose strict roles and patterns of usage on the students (j).

Design Recommendations

The above observations stress the importance of maintaining an awareness of both the shared space in which you are working, and the fact that there are other people working in that shared space. Dourish and Bellotti [5] indicate that the use of shared feedback, the notion of providing implicit, peripheral information about everyone in a shared space, is a promising approach. Examples of this approach can be seen in ShrEdit [14] and SASSE [13, 17]. ShrEdit allows you to request that the system find and track movements of others; SASSE provides peripheral information in the form of colour-coded, shared scrollbars, audio cues, a document overview (or gestalt), and a tracking mode.

Another important problem introduced by collaborative tools is the need to keep track of changes in a shared document. One way to provide the necessary information about changes in the document is through the display of differences in the document, often called "diffs", either as change bars [18], through the use of annotations [17], or through more active notification [15].

Ownership of and access to the shared workspace are also important considerations. As we have seen, the way in which both of these are handled by the system have an influence on the behaviour of the group. While some systems such as Grove [7] and PREP [19] assign roles to collaborators, most systems leave this up to the group. This, along with flexible access and floor control mechanisms, allows social interactions, not the system, to determine working patterns and group behaviour.

The above discussion suggests a number of design recommendations, which we will summarize below:

(a) provide tools appropriate to the users' level of expertise; avoid distracting tools; use gradual disclosure

(b) make sure the system's feedback is simple and concise
(c) provide a clear and accurate mental model of the system
(d) provide self-awareness in terms of location in the shared workspace, and potential actions in that location
(e) provide awareness of the user's effects on others
(f) provide awareness of the presence of others in the shared workspace to encourage discussion and negotiation
(g) provide collaborator awareness in terms of shared feedback and explicit information such as gestures
(h) provide flexibility in terms of the representation of ownership information to allow for changes over time
(i) allow flexibility in terms of document control to allow for shifting roles at different stages of the writing process
(j) avoid imposing patterns on natural social interactions.

IMPACT OF THE PROJECT ON PARTICIPANTS

After a total of twelve hours of working on this project, the students felt that they had learned a lot about the topic of prejudice. They quickly became extremely conscious and sensitive about these topics in their everyday lives. They even enjoyed the learning process:

Liz I liked learning everything … like prejudice, minorities, stereotypes, perception

Aside from the structured exercises, the students learned many important things from the extra projects that some of them elected to do. Sue and Liz conducted a survey around the school; they collected 37 responses, and compiled and tabulated the results. After the survey Sue discussed one surprising discovery:

Sue I didn't think that it would have happened so much, people getting insulted racially. I didn't know that there were actually so many people, that did and remembered.

In the group discussion, conducted several weeks following the project, the students expressed some insightful opinions that demonstrated a deep and mature understanding of these complex issues.

The product of their work, the magazine "Prejudice in the 1990's", was well received by their classmates and teachers. The students had differing ideas about the possible impact of their magazine, and about who would benefit the most from reading it. Sue felt that the people who wrote the magazine would benefit the most; others disagreed about its impact:

Carol Bad people [prejudiced people] will understand what they are doing is bad and they will become friends [with their victims].

Kim People who discriminate against people for their difference, they may learn how a person might feel and won't do that.

Dan Someone who doesn't understand about racism [will benefit from the magazine] ... I don't think that a racist person would benefit very much, cause they are ignorant and they'd ignore the magazine.

By working so closely together on this project, the students learned many things from each other. They learned new words and the correct spelling of other words. They also learned new concepts from group discussions. Rob described the most important thing that he learned from this whole project:

Rob Everybody is different period. I didn't know it that much. We looked at the topic a lot and learned how and why. I knew that people were different but not by how much.

Aside from these topics, the students learned about working and writing together. Rob reflected on the learning process:

Rob When I first came I didn't think it would work out, but the computer helped, talking to the group helped, planning helped. I've never did this [collaborative writing] before.

With time, the students also began to appreciate the complexity of collaborative writing. Carol expressed what she learned about group writing:

> Carol It's important to hear other people's opinions. Important to talk before we write. [The result is] sometimes worse [than individual writing] because there are so many different opinions the story comes out messed up.

The groups experienced the frustrations and stress that accompany conflict resolution and consensus forming. The girls in particular felt that the worst part of their experience was arguing with their collaborators. The boys felt outnumbered and excluded (each group consisted of three girls and one boy), one boy complaining that "they did not listen to me!" We have already seen that, despite these complaints, the boys were able to gain control of the group document at key moments during the writing.

In the final questionnaire all the students agreed that they enjoyed writing in a group. Several students stated that they felt more comfortable now about working in a group, writing in a group, and about writing in general. In these few weeks the group developed a sense of identity. In the eyes of their peers they became known as "the after school group" and were viewed with some respect and envy, since they got to work on computers and be surrounded with a lot of special video equipment. The groups even developed a common language; group two coined a phrase "prejudice matters" which then became transformed into "minority matters" and other such expressions. The gender differences were put aside when the two groups joined together to produce a single magazine and do a presentation in front of two classes of their peers.

The students' feeling of ownership of the magazine increased towards the end of the project. In the early weeks, they would continuously ask the instructor for feedback about their ideas and writing. When this happened, they were instructed to consult with their group and sometimes minimal feedback was provided. In the later weeks of the project they requested much less feedback. In the final week, when Sally went to ask for help, Rob interrupted her saying "No! Don't ask. This is our magazine!"

All the participants expressed a sense of pride about the finished product. From the final questionnaire we discovered that every student was happy to have their name on the magazine because "it shows that I contributed" and because "it is a good magazine and I like my name being on something my friends and I worked on!" This pride was also expressed in their decision to make a class presentation, explaining what they learned, and recounting their experiences from this project.

Despite never having previously worked with synchronous collaborative writing software, both groups managed to produce coherent documents which they felt reflected the work of the entire group. They testified to having written a magazine "together", something that they did not even know the meaning of at the start of the study. Perhaps this in itself is the best definition of group writing - the perception that the results of your work are the results of the group's work, rather than the work of the individual members of the group.

SUMMARY AND CONCLUSIONS

The observations we have made of the students working together using Aspects are very encouraging. Over the 12 hours they were working with Aspects, they developed distinct, mature strategies for working together. Between them the two groups successfully produced a 32 page magazine which will be on display starting in early 1996 as part of an exhibit at the Ontario Science Centre. This achievement validates the concept of a synchronous shared text editor, and provides promise for the use of such technology in education, and for writing in general.

The group jointly learned about an important topic, prejudice. As one student said in the final group discussion:

> Liz Everyone is different, we all have different beliefs, and we should respect that; this is what we learned.

They had become comfortable with the idea of writing together, and confident with the technology. From not knowing what it means to write together, they had progressed to feeling that they were

able to succeed at, and enjoy, group writing. During the final group discussion, one student volunteered the following:

Rob The best thing was learning how to work with everybody, we weren't too good at that before.

By observing this learning process, we have been able to gain an insight into the nature of group writing, and identify some of the effects of the use of collaborative writing tools on this process.

We have seen that the technology has a distinct effect on the way in which novice writers approach the collaborative writing task. However, at the same time we have seen that writers, as they become familiar with both the task and the technology, are able to exploit the features of the system and use it to their advantage in creative ways. The observations we have made of the problems students have learning to write together are very similar to those seen among adult writers. From these observations we have drawn a series of recommendations for future design.

To summarize, we would like to briefly present a number of important insights.

- Groups of novice collaborators can learn to write together relatively quickly. The new skills required include flexibility in choosing the writing approach appropriate to the situation and task, and the ability to divide up writing activities to take advantage of each individual's strengths.

- Novice collaborators require some instruction. We helped the students learn to write together by guiding them through different writing approaches and activities. Many of these activities were already familiar to the students, but needed to be made explicit and become part of the groups' experience before the students felt comfortable using them in group writing.

- Groupware technology can be both a powerful tool and a compelling distraction. We had to carefully balance the students' need to experiment with the technology against their desire to play with the computers and forget about their tasks.

- The task had to be selected with great care in order to encourage interest and debate and thus lead the group towards a motivating and rewarding experience.

- When forming groups one must consider the following variables: gender, different ages, different writing levels, different maturity levels, and whether the group members were friends or just acquaintances.

During the project we observed fluctuations in the groups' power structures, changes in their attitudes towards the task, and changes in their utilization of the technology. This highlights the importance of studying real groups, in real situations, performing real tasks, over extended periods of time to observe interactions that typically cannot be seen in artificially constructed scenarios, experiments, and usability laboratories. This allows usage patterns to develop naturally, and provides the time needed for the participants to learn about the task and the technology. Although this type of ethnographic study is harder to run and much more time-consuming to analyze than a traditional lab study, the type of real usage that we have observed could never be seen in a usability laboratory.

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