

# The Effects of Computer-Supported Collaborative Learning on Students' Writing Performance

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**Abstract:** Using mixed research methods, this study investigated the effect of a computer-supported collaborative learning (CSCL) environment in improving the fifth graders' writing performance and outcomes. Thirty-four students participated in a real-world writing project, taking on alternative roles of journalists and editors in creating a school newspaper. While both groups were engaged in the task of collaborative writing, the CSCL group was supported by a web-based software *Knowledge Forum* whereas the control group created their articles via paper and pencil. During the research, observation notes were taken and students were interviewed. The results showed that students who worked with *Knowledge Forum* had significant gains in their writing performance compared with the control group. In addition, the students in *Knowledge Forum* were more motivated to write than the other group. The study demonstrates that CSCL augments collaborative learning and makes individuals' thinking visible via its technological affordances.

## Introduction

Writing, which is often noted as one of the three "R"s (reading, writing, and arithmetic) of education, has been observed as an important curriculum area in one's academic life. Writing is valued by society as one of the key tools for thinking (Bereiter & Scardamalia, 1987). Despite the fact that writing is regarded as the foundation of many other areas of education and success in life, only 23 percent of the public agree that schools in their own community are already doing a good job in teaching writing (Belden, Russonello, & Stewart, 2005). This disturbing statistic, along with testing requirements and stringent accountability systems for schools required by the No Child Left Behind Act (NCLB) in the United States, leaves educators concerned about their current practice of writing instruction in schools.

In the U.S., students from the fifth to the eighth grade must participate in some kind of state criterion reference test for writing. In order to receive a satisfactory score on the writing test, it is pertinent that the students receive instruction on how to properly develop their writing skills. Students must be able to select a focus in the form of expository, persuasive, descriptive, or narrative writing and create an organizational structure based on the purpose, audience, length, and required format. Although the fifth grade is often the first time that students are held accountable for writing, skills that develop students' quality of writing are designated as learning objectives as early as kindergarten by many states.

While teachers of the fifth-eighth grades feel the push to develop quality writers by the time students take the state test, students are often faced with rushed lessons and writing practice that do not apply to real world situations. Often students are instructed to organize, compose, and edit their own writing selections, with feedback provided solely from the teacher. Students feel unmotivated to write, merely going through the motions of regurgitating what they have learned prior to the writing test and creating samples that lack quality. This kind of writing instruction ultimately leaves students with virtually the same writing ability as they started with.

Therefore, the main purpose of this research was focused on effective instructional strategies aiming at improving students' writing performance. Based on a critical review of the research and our experience on writing instruction, we switched to a more process-based and audience-centered approach in the hope of motivating students to write and deepening their understanding of writing principles. Computer-Supported Collaborative Learning Environment (CSCL) is such an approach that has been proved to be effective in supporting authentic learning and process-based writing activities (Goldberg, Russell, & Cook, 2003; Scardamalia & Bereiter, 1994) and in motivating students to write (Bar-Natan and Hertz-Lazarowitz, 2000; Goldberg, Russell, & Cook, 2003).

## Computer-Supported Collaborative Writing

A Computer-Supported Collaborative Learning Environment (CSCL) is a way to create a learning community that assists students in learning the writing processes and purposes through collaboration with peers via networked computers. CSCL, which has its instructional underlying in collaborative learning (Koschmann, 1996), provides opportunities for students to solve problems in one of the most common and natural situations of the society (Nelson, 1999). Collaborative learning or cooperative learning, which is sometimes used interchangeably in the literature, has shown to be an effective method of instruction when teaching writing

(Aiex, 1998; Bar-Natan & Herts-Lazarowitz, 2000, Herrmann, 1989; & Lingnau, Hoppe, & Mannhaupt, 2003). Neuwirth and Wojahn (1996) emphasized the likelihood that students, regardless of their educational level, will encounter numerous cooperative learning activities in writing courses. These opportunities allow students to discuss writing goals, generate ideas, discuss vocabulary selection and language usage, and engage in peer review and cooperative revision process (Aiex, 1998; Neuwirth & Wojahn, 1996). Students can communicate their ideas in the form of writing and receiving meaningful feedback in the form of revisions, suggestions and editions from their peers. Hence, learning is a joint process (Wessner, Holmer, and Pfister, 2001) with peer students involved in learning how to improve their writing.

Although this whole cooperative writing process can be carried out via pencil and paper, the literature shows that a CSCL environment can be a more effective approach in writing instruction. CSCL supports writing activities through not only the writing and editing tools, but more importantly, a technological platform for students to articulate their knowledge of revisions and their decisions behind changes in their texts, and for teachers to coach students more effectively during students' writing processes (Neuwirth & Wojahn, 1996). Scardamalia and Bereiter's (1994) Computer Supported Inquiry Learning Environment (CSILE), opened the door for collaborative learning through a model that: a) facilitates and encourages peers to comment on each others notes; b) eliminates turn-taking problems; and c) opportunities for all to participate regardless of academic level or age. Another computer tool, which is called PREP Editor (Neuwirth & Wojahn, 1996), can also facilitate and encourage peer feedback and comments through various collaborative writing activities, including prewriting, drafting, revising, editing, and polishing final draft.

Some researchers also found a positive effect of computer-supported writing on motivation. Goldberg, Russell, and Cook (2003) concluded in their meta-analyses that using computers to learn to write increases student engagement and motivation. They found that students writing was of better quality and were longer than pencil paper written work. In a study conducted by Bar-Natan and Hertz-Lazarowitz (2000), cooperative learning in conjunction with computer-mediated communication had a positive impact on student writing development and perception of writing. However, larger questions have remained unanswered as to why computer-supported collaborative writing would be more effective than just classroom-based collaborative writing.

## **Purpose of the Study**

This was a pilot study focusing on investigating technology affordances in the context of computer-supported collaborative learning in writing instruction and their effects on students' writing achievement, rather than comparing instructional effectiveness of different media. Although CSCL has been researched for over ten years, mostly focusing on science or mathematics education as far as K-12 is concerned, we have not found much research specifically assessing the writing outcomes of students who have participated in CSCL, particularly among elementary school students with lower socio-economic status and special education needs. Besides, there have not been sufficient empirical studies done on the effectiveness of CSCL. Some researchers suggested conducting controlled, experimental hypothesis-testing studies to evaluate the effectiveness of various CSCL technologies in improving writing performance and to understand how CSCL technology can be shaped to improve writing performance (Neuwirth & Wojahn, 1996). As argued by some researchers, it is important to demonstrate empirically that participation in collaborative undertakings leads to knowledge building, and additionally to understand why it works (Koschmann, Hall, & Miyake, 2002; Neuwirth & Wojahn, 1996). With these research issues in mind, we investigated the following questions, using a mixed research method including an experimental study and a qualitative study:

1. Does CSCL enhance collaborative writing process and improve writing performance among the 5th grade students in a real-world writing task in terms of the writing processes (e.g., sentence structure, paragraph structure, organizations, and grammar)?
2. How do students collaborate and perform on their writing task in different conditions, that is, the CSCL condition and the non-CSCL condition?

## **Research Method**

For this study, the *Knowledge Forum* software (<http://www.knowledgetforum.com>) was used to create the CSCL environment, which provided a support system for students to create writing artifacts that tie the skills they have learned to the real world. The students participating in this study used *Knowledge Forum* to create, review, and edit their writing. The outcome of this collaborative writing activity would lead to a school newspaper to be distributed to the entire school.

## **Participants**

Thirty-four fifth grade students (15 male students and 19 female students), ranging in age from 10 to 13, at an urban rural elementary school in the southwest of the United States participated in the study. Of the 34 students, nine students were identified as having a learning disability with deficits in the areas of written

expression, reading, and mathematics. All students, except those identified as having a learning disability, received writing, reading, and math instruction from their homeroom teacher. The students who were identified as having a learning disability received small group instruction for the content areas of writing, reading, and math in the special education classroom and additional instruction in the regular classroom setting from their homeroom teacher. For the purpose of this study, all the students received writing instruction in their homeroom classroom, but special education students also received instruction in both the special education classroom and the regular education classroom.

## Design

The research design for this study was a mixed method, including both quantitative and qualitative studies. A quasi-experimental study was conducted to investigate the first research question over a period of 4 weeks through the comparison of the student writing performance between the two groups: the treatment group (i.e., the CSCL learning environment using *Knowledge Forum*), which consisted of 18 students, and the control group (i.e., the peer learning environment using paper and pencil), which consisted of 16 students. Two classes were randomly assigned to either the CSCL condition or the non-CSCL condition. A writing task was designed for the study, which required students to work collaboratively with a peer student, taking either the role of a journalist or of an editor to create a school newspaper. The assessment of students' writing performance was carried out towards the end of the study session, two days after the completion of their writing projects, by asking students to write an essay, which was graded using a scoring rubric. This writing assessment was a practice state test taken from the past state test sets.

Meanwhile, the qualitative study was also carried out to investigate the process of students' collaboration in their writing tasks in the two groups. Everyday observations were conducted to gather data on peer interactions, particularly their dialogues, by the first researcher and the two fifth grade teachers whose students were participating in the study. Students were assigned seats so that the observations were only recorded for students with parental permissions. Although this precaution was taken, it was not necessary since every participant had parental permission. Students' reflections were collected as additional data sources, including what they liked and disliked, what they had learned from the study, and so on. After completing the writing test at the end of the research session, the students also participated in a 10-15 minute interview conducted by the first researcher, which was intended to determine how effective and enjoyable students perceived the writing project was.

## Procedure

Students were divided into two groups, editors and journalists, in each of the conditions (CSCL or non-CSCL). One editor was paired with one journalist, forming eight peer groups in the non-CSCL group and nine peer groups in the CSCL group. The pair assignments were randomly made by the first researcher. As a result, some special education students paired up with a regular education student or another special education student.

The first three days of the study involved only the CSCL group (treatment), designed to allow sufficient time for the participants to become familiar with the CSCL environment and tools that they would be using to create their newspaper articles.

After the training was completed, the students of both groups went through a review on the topics of writing purposes and writing processes, which lasted approximately 5 days. On the eighth day, with the facilitation of the first researcher, the students brainstormed the topics they would write about, most of which were related to the real life, people or events they were familiar with. From all the topics that had been generated, each pair of students was asked to select a topic and create a title for their article. Over the next six days students worked in peer groups going around the school to interview their characters and developing their storylines. The CSCL group worked in the computer lab while the paper pencil group worked in their own classroom using paper and pencil to complete all the writing activities.

The CSCL group created their school newspaper articles with the support of *Knowledge Forum*, providing and receiving feedback to each other through the use of the communication tools in *Knowledge Forum*. Carefully designed question prompts by the researchers were posted in *Knowledge Forum* to facilitate students' communications and scaffold students' writing process in each of the writing stages, such as prewriting, selecting a structure, revising, editing, and publishing. Examples of the question prompts included: *Where should I begin when creating a story? Does my writing make sense? Which focus of writing should I choose?* Within each of the prompts, the students could select a label, such as "graphic organizer", "What would you do after this?" or "brainstorm" for the prompt *Where should I begin when creating a story?* After the journalists finished and posted their drafts, the editors would edit and comment on each other's writing. Students in the non-CSCL group also received the same writing prompts as the CSCL group except in paper format, which students were asked to keep in a 3 ring binder. The non-CSCL students used paper and pencil to practice writing and create newspaper articles.

After the peer editing process, both the journalists and the editors of the article were asked to work together on the final draft. After 15 school days of the writing activities, all the students who participated in the study in either condition took an approximately 1 and 1/2 hours of practice writing test, which mimicked the state writing test the students were going to take in the subsequent semester.

Every day over the entire research process, the first researcher was on site facilitating the two teachers with writing instruction and the students with writing activities while taking observation notes as a participatory researcher. She also interviewed the participants on the 16<sup>th</sup> day during the class hours, which was the day before the participants took the writing test.

## Results

### Experimental Results

The first researcher and another teacher graded every student's writing test using the writing rubrics published by the State Department to ensure the inter-rater reliability. Prior to their grading, the two raters had discussed the rubric and reviewed some writing samples at each score level: *idea development*, *organization*, *word choice*, *sentence development*, and *grammar*. A composite score of 15 maximal points was calculated for each of the participants by adding up the five sub-scores, each of which was worth 3 points. The two raters reached 100% agreement on all the scoring.

Due to the high correlations among the five sub-scores, which ranged from .75 to .88, a decision was made that it would be inappropriate to run a multivariate analysis of variance (MANOVA) for the statistical analysis of the test scores because of the possible overlaps between those five sub-scores. Instead, the data of the test scores were analyzed by one way analysis of variance (ANOVA) for the comparison of the mean composite scores between the CSCL group and the non-CSCL group. The ANOVA result showed that the CSCL group performed significantly better than the non-CSCL group in the writing test,  $F(1, 32) = 5.943$ ,  $p = 0.02$ , Eta Square = 0.16. The CSCL group ( $M = 13.44$ ,  $SD = 3.55$ ) had statistically higher mean composite scores than the non-CSCL group ( $M = 10.25$ ,  $SD = 4.09$ ).

The descriptive statistics presented in Table 1 revealed detailed information of the students' performance for each of sub-scores: the students in the CSCL had higher mean scores than the students in the non-CSCL group at each score level.

Therefore, in response to Question 1, the use of a CSCL tool enhances collaborative writing process and improves the quality of writing among the 5th grade students in a real-world writing task in terms of the writing processes (e.g., sentence structure, paragraph structure, organizations, and grammar).

**Table 1: Mean scores of student writing test between CSCL group and non-CSCL group**

	<b>Group</b>	<b>Mean</b>	<b>SD</b>	<b>Sample Size</b>
Idea Development	CSCL	3.28	.75	18
	Non-CSCL	2.44	1.09	16
Organization	CSCL	2.72	.75	18
	Non-CSCL	2.19	.83	16
Word Choice	CSCL	2.56	.71	18
	Non-CSCL	1.88	.96	16
Sentence	CSCL	2.5	.86	18
	Non-CSCL	1.81	.75	16
Grammar	CSCL	2.39	.92	18
	Non-CSCL	1.94	.77	16
<b>Composite</b>	CSCL	13.44	3.55	18
	Non-CSCL	10.25	4.09	16

### Qualitative Findings

The qualitative data analysis began as soon as the study started. Different sources of data from observation notes, interview transcripts, students' reflective journals, and the newspaper articles the students created were triangulated for data analysis. The two researchers went through an iterative process of data reduction, data display and conclusion drawing and verification in order to draw themes and provide answers or explanations to the research questions (Miles & Huberman, 1996). Below are the themes we generated on peer interactions, the role of technology and students' engagement in students' writing activities.

### Collaborative Writing

Both groups of students enjoyed the collaborative process in their writing project. From both interviews and reflective journals, most of the participants indicated that the peer help allowed them to generate new ideas

that they might not have on their own. The response such as, “I liked working with a peer, partner, or friend” was given repeatedly in the interviews. Several students replied by saying something like, “... my peer was there to help me come up with different ideas”. Many students pointed out that their peers provided great assistance when writing, editing, and revising. They felt that working with a peer helped improve the quality of their writing because they had someone to specifically work with when completing different tasks throughout the study. One student said: “I have someone to help me if I need help. And if I get stuck on a question, then I’ll have someone to help me. I feel like that like I learn more like that than on my own.” This data also seemed to indicate that working with peers increase students’ confidence and interest in writing.

The data analysis suggested several advantages of peer interactions for improving students’ writing performance: (a) working with peers made writing an enjoyable process, which motivated students to write; (b) the peer interactions were most helpful for them to generate or develop ideas, (c) the peer interactions helped students to improve writing through peer writing, editing, and revisions; and (d) the peer interactions also encouraged students to write and increased their confidence to write.

### Technology Affordances: Visualization and Organization

With all the advantages of peer interactions discussed above, however, some students in the control group suggested that coming up with different ideas made the task at hand more challenging. One student stated, “...when my peer had a different idea then we could not put our ideas together it became a dispute”. We hypothesized that this kind of challenges might be an issue that CSCL could address as the collaborative tools provided in a CSCL system could help students to visualize their thinking and make it easier to negotiate meanings with peers and reach a consensus. Our hypothesis was supported by students’ responses from the CSCL group, “you could see what you were thinking” when working with *Knowledge Forum*, which occurred more than once in the interviews and the reflection journals. The students in the CSCL group found the ability to look through various threads a meaningful component to improving their writing. The data suggested that the CSCL technology provided a collaborative workspace for students to work together. The CSCL technology had not only helped students to make their own thinking visible, but also their peers’ thinking visible for meaning negotiation and knowledge construction.

The students in the CSCL group also expressed the usefulness of the scaffolds provided in *Knowledge Forum* pertaining to the purposes and stages of writing, were most helpful for their understanding and development of writing; for example, “It (Knowledge Forum) helps us get better at writing, like the sentence structure we use, punctuation, misspelled words, and such...” “It (Knowledge Forum) helps because of the different information provided on the different purposes or forms...” This type of scaffolds “helped me with my writing skills and preparing me for the test in February.” One student stated, “The computer teaches you more stuff, even more than the teacher”. Although these students might not be aware that it was the teacher or researcher who designed the scaffolds in *Knowledge Forum*, this data did indicate that such a CSCL support system could play the role of a tutor or a coach, readily providing assistance to learners through various scaffolds and tools. This finding was further supported by other students’ responses in their interviews, for instance, they could find assistance, answer questions about their writing, or reread their thoughts about an assignment by looking at the discussion threads in *Knowledge Forum*.

In addition to designing and providing scaffolds, the organization of information and the visualization of students’ own thinking through threaded discussion were some other features of technological affordances. The scaffolds and the build-ons automatically organized the students’ thoughts and discussions, which allowed students to see the steps of their writing in order and provided them with such information as who had reviewed and provided feedback on each discussion. Visually seeing the discussion in an organized fashion was hardly obtainable in a traditional learning environment, which made it difficult for a teacher to meet various learning needs of different students in a classroom.

Therefore, the data suggested that CSCL could serve as a support system to augment students’ ability to collaborate, to make their thinking visible for self-reflection and peer reviews, and to make teachers better facilitate students’ learning process, which would not have been possible within the non-CSCL condition.

### Motivation, Engagement and Confidence

The data also indicated that the use of technology had an impact on students’ motivation. It was observed that the CSCL students seemed extremely excited and motivated in using *Knowledge Forum*. Each day they would beat the first researcher to the computer lab, and already be logged in ready to work on the day’s assignment. The students, according to their teacher, behaved well overall throughout the day as if they were worried they might not be able to participate in the activities for this study if they failed to behave well. The students’ excitement for using *Knowledge Forum* was evident not only in their behavior in the lab, but also in their conversations with the first researcher and their homeroom teacher. For example, one group of students was so engaged in their story development that they asked if they could go into the lab early and continue working on their story on their own time during the day.

One pair of CSCL students, which consisted of two students in special education, exhibited a higher confidence level and better writing ability. Although the students still had some errors in their writing, they displayed a sense of enjoyment and confidence in their work, paying very close attention to their writing, quietly but diligently working together to make revisions to their story. This particular group of students, who were normally rather withdrawn and occasionally disengaged, were completely engaged in their work and produced a rather organized and developed story.

One particular student standing out in this study was one who was identified as needing special services. She was a couple of grade levels behind and was often daydreaming or disengaged in her normal school days. However, during this study her overall presence changed greatly. She was engaged throughout the study and always seemed excited about working on her writing with her group member and on *Knowledge Forum*. At one point she even said, "This is easy! I understand how I am supposed to write." She was very engaged when working on her story (she was the journalist) and took every comment and bit of feedback from her peer (the editor) seriously, making sure she made corrections and revisions to her work in order to make it better. This student, who normally had to be redirected to her assignments, was now very focused on her work with minimal to no daydreaming. Although at times it was evident that she may have some difficulties with writing (grammatical, punctuation, capitalization, etc...) she worked very confidently when writing and revising her story.

Overall, according to the first researchers' observations, the CSCL group seemed to be more engaged than the non-CSCL group probably because of the technological features provided by the CSCL technology, such as organization, visualization, and convenience, allowed little reason or time for students to stray from their task at hand. Although they received the same instructions and daily activities and question prompts as the CSCL Group in a paper form, the non-CSCL students very seldom referred back to their notebook to address questions they may have had in developing their writing.

## Conclusion

Although the benefits of collaborative learning are well known already to educational researchers, the advantages of computer-supported, over non-computer supported, collaborative learning have not been sufficiently demonstrated through empirical studies. In this study, while recognizing the important role of the teacher or facilitator in supporting the collaborative learning process, we particularly investigated the role and the specific features of technology in supporting students' collaborative writing process. The statistical results answered our hypothesis, that is, CSCL improves students' writing performance in a real-world writing task. Furthermore, the qualitative data suggested that CSCL enhanced collaborative writing process by making thinking visible for individual and peer reflections, meaning negotiation, and knowledge building through technological affordances, such as the capability of designing scaffolds and the features of the visualization and organization of the CSCL technology. In addition, this study also led us to see the underlying reasons for the success of CSCL and provided us explanations for students' engagement, motivation, and confidence in a CSCL environment. Above all, this study was an attempt to evaluate the effectiveness of CSCL in the context of writing instruction and with a group including students of special education. Hence, this proposal has important contributions to the learning science community.

This study also has a number of implications for instructional designers, developers, and teachers. First, it revealed what technological features or functions were particularly important and useful to students in the context of writing, and how a CSCL system could be adapted for use for different subject areas, which have specific implications for instructional designers or developers to consider when designing CSCL tools. Second, this study also suggested the important role of a teacher in designing the scaffolds, scaffolding the collaborative learning process, and making CSCL a success. Third, it is important that a meaningful, real-world task is designed for CSCL in order to engage students in authentic learning activities of knowledge construction.

In conclusion, the researchers recognized the limitations of this study. Due to the time constraint, we were not able to conduct a pre-test, although we believe that the randomization of the group assignment could address the concern in that regard. In our future studies, we plan to include a pre-test and increase the sample size. In addition, we also plan to add a control group to the CSCL group and paper-and-pencil group to help us understand more insights about the collaborative learning process. Despite its limitations, we believe that this study has yielded important findings regarding computer-supported collaborative learning.

## References

- Aiex, N.K. (1998). *Collaborating on a newspaper in the elementary classroom*. ED414580.
- Belden, Russonello, & Stewart (2005). Learning to write, writing to learn: Americans' views of writing in our schools. *A Report of a National Public Opinion Survey conducted for The National Writing Project*.
- Bar-Natan, I & Herts-Lazarowitz, R. (2000). *Using cooperative learning (CL) and computer mediated communication (CMC)*. ED444191

- Bereiter, C. & Scardamalia, M. (1987). *The psychology of written composition*. Hillsdale, NJ: Lawrence Erlbaum.
- Goldberg, A., Russell, M., & Cook, A. (2003). The effect of computers on student writing: A meta-analysis of studies from 1992 to 2002. *The Journal of Technology, Learning, and Assessment*, 2(1).
- Hermann, A. W. (1989). *Teaching writing with peer response groups. Encouraging revisions*. ED307616
- Koschmann, T. (1996) Paradigm shifts and instructional technology: An introduction. In T. Koschmann (Ed.) *CSCL: Theory and Practice of an Emerging Paradigm* (pp.1-23). Mahwah, NJ: Lawrence Erlbaum Associates.
- Koschmann, T., Hall, R., Miyake, N. (Eds.). (2002). *CSCL 2: Carrying forward the conversation*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Lingnau, A., Hoppe, H.U., & Mannhaupt, G. (2003). Computer supported collaborative writing in an early learning classroom. *Journal of Computer Assisted Learning*, 19, 186-194.
- Miles, M.B. & Huberman, A.M. (2<sup>nd</sup> ed.). (1994). *Qualitative data analysis*. Newbury Park, CA: Sage.
- Nelson, L. (1999). Collaborative problem solving. In C. M. Reigeluth (Ed.), *Instructional-Design Theories and Models* (pp.241-292). Mahwah, NJ: Lawrence Erlbaum Associates.
- Neuwirth, C.M. & Wojhan, P. (1996). Learning to write: Computer support for a cooperative process. In T. Koschmann (Ed.), *CSCL: Theory and practice of an emerging paradigm* (pp. 147-170). Mahwah, NJ: Lawrence Erlbaum Associates.
- Scardamalia, M. & Bereiter, C. (1994). Computer support for knowledge-building communities. *The Journal of the Learning Sciences*, 3(3), 265-283.
- Wessner, M., Holmer, T., & Pfister, H. (2001). *The learning net: An interactive representative of shared knowledge*. ED 466229.