

Using Tools and Resources in Computer Supported Collaborative Writing

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ABSTRACT

The relationship between collaboration processes, task strategies and the use of the tools and resources that the computer environment offers, may be crucial for the effects of computer supported collaborative learning. We are interested to find out how, within a computer environment, students collaborate, how they use the different tools we offer and how this influences the quality of the final product. A custom-made computer-supported environment (TC3) was implemented that enables pairs of high school students to collaborate in writing an argumentative essay. The essay had to be convincing and based on authentic information sources. TC3, a *groupware* program, offers the students as task related and communicative tools: a shared text editor, a chat facility, access to relevant sources of information and a private notepad. Furthermore, some facilities or tools were offered that might promote collaboration on the task: access to the chat history, adaptability of the display layout, marking and searching in information sources and counting the number of words in the shared text. From our analyses we may conclude that the tools and resources the students use during collaborative writing seem to reflect the writing strategies they adhere to and that the use of these tools and resources in the different phases of the collaborative writing process is related to the argumentative quality of the final product. Future research will focus on the effects of adding tools for text planning and linearization to the TC3 environment on the coordination processes of collaborative writing.

Keywords

Computer supported collaborative writing, tools, resources, argumentative writing

INTRODUCTION

A recent Dutch educational law has transformed the curriculum in the last three years of college preparatory high school. Among the changes, schools are required to provide support for students to do increasingly independent research, in order to prepare them better for college studies. Working and learning actively, constructively and collaboratively are seen as important parts of this program. The computer-supported, collaborative writing environment that we are developing is meant to fit within this new program. Through its active and interactive nature, the Information and Communication Technology (ICT) involved can emphasize both the constructivist and collaborative aspects of the curriculum.

Computer and telematics-based environments seem especially suited for collaborative learning by the variety of possibilities they possess: they integrate multimedia information sources, data processing tools and communication systems (time and place independent) in a single working environment (Bannon, 1995, Van der Linden, Erkens, Schmidt & Renshaw, 2000). Computer Supported Collaborative Learning systems (CSCL) are assumed to have the potential to enhance the effectiveness of peer learning interactions (Dillenbourg, 1999). As for the role of computers in education, the focus is on the construction of computer-based, multimedia environments: open learning environments that may give rise to multiple authentic learning experiences (Cognition and Technology Group at Vanderbilt, 1994). The cooperative aspect is mainly realized by offering computerized tools, that can be helpful for collaborating students in solving the task at hand (e.g., the CSILE-program of Scardamalia, Bereiter & Lamon, 1994; the Belvedere program of Suthers, Weiner, Connelly & Paolucci, 1995). These tools are generally one of two kinds: task content related or communicative. Task related tools support the performance of the task and the problem solving process (Teasley & Rochelle, 1993). Communicative tools give access to collaborating partners, but also to other resources like external experts or information sources on the Internet. In this respect, the program functions as a communication medium (Henri, 1995). Programs that integrate both functions are generally known as *groupware*: they are meant to support collaborative work by sharing tools and resources between group members and by providing communication opportunities within the group and with the external world. In complex, open problem solving tasks students will have to decide when and where to use the task related and communicative tools and resources during the process of collaboration within the groupware environment. Furthermore, they will have to coordinate the use of shared tools and discuss their application.

COLLABORATIVE ARGUMENTATIVE WRITING

Writing clearly is an open task. Writing texts of any length has been shown to be a complex process in which several interrelated sub-processes can be distinguished, each with its own dynamics and constraints (Rijlaarsdam & Van den Bergh, 1996). We conceptualize writing argumentative texts mainly as a knowledge-construction (Galbraith, 1999) and problem-

solving task. In this task, several informational units from internal or external sources must be generated, selected, collected, related to each other, and organized in a consistent knowledge structure. Furthermore the problem of convincing the reader by finding a persuasive ordering of arguments and contra arguments must be solved. This entails quite a few skills, among which social, cognitive, rhetorical, and cultural.

The main advantage of collaborative writing, compared to individual writing, is the presence of a workspace where the writers can receive immediate feedback. Argumentation by itself, according to Stein, Caliches & Bernas (1997), facilitated learning because it necessitates searching for relevant information and using each other as a source of knowledge. Furthermore, the discussions generated by the activity make the collaborators verbalize and negotiate many things: representations, purpose, plans, doubts, etc. Collaborating writers have to test their hypotheses, justify their propositions, and make their goals explicit. This may lead to progressively more conscious control and increased awareness of the processes (Giroud, 1999).

Planning argumentative texts

Theories of writing (Hayes & Nash, 1996) generally distinguish three types of activities in the writing process: planning (generating, organizing and linearizing content), formulating or translating (writing the text) and revising. Planning an argumentative text is a type of task whereby arguments need to be generated and ordered based on one's position and the audience's needs. Unlike in storytelling, the order of the content of an argumentative text does not inherently follow from the order in which events take place. During planning activities, ideas will probably be conceived and organized in a very different manner than in time – for instance, in argument clusters. Hence, linearization of the contents is needed before the ideas can be expanded into text, and again when a text is re-organized. Linearization, therefore, is an important part of argumentative writing (Levett, 1989). Research at our department showed that an explicit parting of the idea organization and linearization phases during planning leads to an improvement of the quality of an argumentative text (Coirier, Andriessen & Chanquoy, 1999). It was apparent that converting the conceptual representation of ideas into linear text is a crucial problem for the writer who is producing argumentative texts. The proposed environment will endeavor to support students during these two phases with an ICT environment in which tools for conceptual organizing and linearization are integrated.

Much previous research has concerned itself with examining *preplanning*. Preplanning refers to planning activities that occur before the actual writing of the text. Such research has shown that preplanning can have a favorable effect on the quality of the text (Andriessen, Coirier, Roos, Passerault & Bert-Erboul, 1996). It is known that inexperienced writers seldom do preplanning (Alarmargot, 1997). Moreover, because of a lack of knowledge of the issues involved, when preplanning does occur in novices it is more likely to be a superficial sort of brainstorming, which is actually not much more than simple content-activation based on the terms used in the assignment. Bereiter & Scardamalia (1987) found this to be true for children. Torrance, Thomas, & Robinson (1996), likewise, found little idea generation based on rhetorical demands during preplanning for adult undergraduates (relative novices). Rather, their idea generation made a better match with a simple content-activation model. Also, the number and originality of ideas in the draft were not correlated with time spent preplanning. Preplanning for writing informational or argumentative texts, however, largely consists of searching, reading and annotating external information sources.

Lacking preplanning skills, supporting *online planning* becomes especially important for inexperienced writers. By online planning we mean the monitoring activities that occur during writing based on goals set, ideas, expectations and strategies (Van der Pool, 1995). These activities direct the process of knowledge construction during writing. Online planning activities, unlike preplanning, are generally linked more strongly to the local organization of the text. Preplanning, at least in experts, is more concerned with global issues like setting goals and determining overall organization and genre. In earlier research, the transition between preplanning processes and writing the actual text was found to be a stumbling block. Kozma (1991), Scardamalia & Bereiter (1985, 1987), and Schriver (1988) all found positive effects of teaching preplanning on the amount and/or the quality of preplanning, but not on the quality of the written text. The problem can lie in the linearization or the translation processes, both transitional processes.

In collaborative writing the partners will have to agree on both the content and the ordering of the text. Thus, reflecting on transitions becomes a natural process. Furthermore, the use of resources will have to be coordinated and discussed. In previous research, in which college undergraduates selected arguments and produced an argumentative text while collaborating in a groupware environment, differences in the argumentative discussion were found to correlate with the representation of the source material. It was found that in a task where the arguments appeared as pictures, more inferences were needed to deduce the usefulness of the information. The students discussed more new arguments in the chat discussion and more new arguments in their common argumentative text (Andriessen, Erkens, Overeem & Jaspers, 1996). Having to put the pictures into words must have helped. Thus, the constructive activities of organizing, linearizing as well as translating to the common text will have to take place in mutual deliberation, necessitating verbalization and reification of ideas. This negotiation, arriving at a shared knowledge construction and common task strategy, takes place in the collaboration dialogue between the partners (Erkens, Andriessen & Peters, submitted). The expectation is that more mutual

coordinating activities in the dialogue result in a more consistent, shared knowledge structure and in a better mutual problem solution, that is a better argumentative text (also see Baker, 1999). Furthermore, computer support for content generation, organizing and linearization will help to make these planning activities explicit and negotiable. We are currently examining these two expectations in the COSAR project. This paper will focus on the question how students use and coordinate their use of tools and resources in the process of collaborative writing, and how the use of these tools and resources relates to the quality of the final written product.

COSAR PROJECT

In the COSAR project (COmputer Supported ARgumentative writing) we study electronic collaborative text production with respect to the relationship between characteristics of interaction on the one hand and learning and problem solving on the other (<http://eduweb.fss.uu.nl/cosar>). A groupware program (TC3: Text Composer, Computer Supported & Collaborative) was developed that combines a shared text editor, a chat facility and private access to internal and external information resources to foster the collaborative distance writing of texts. The project was meant for pairs of students (16-18 years old) working together in writing argumentative essays in the context of the Dutch language curriculum. The assignment was to choose a position pro or contra a current topic (cloning or organ donation) and to write a convincing argumentative text addressed to the Department of Public Health. The texts had to be based on recent articles from well-known newspapers published on the Internet. Each partner worked at his/her own computer.

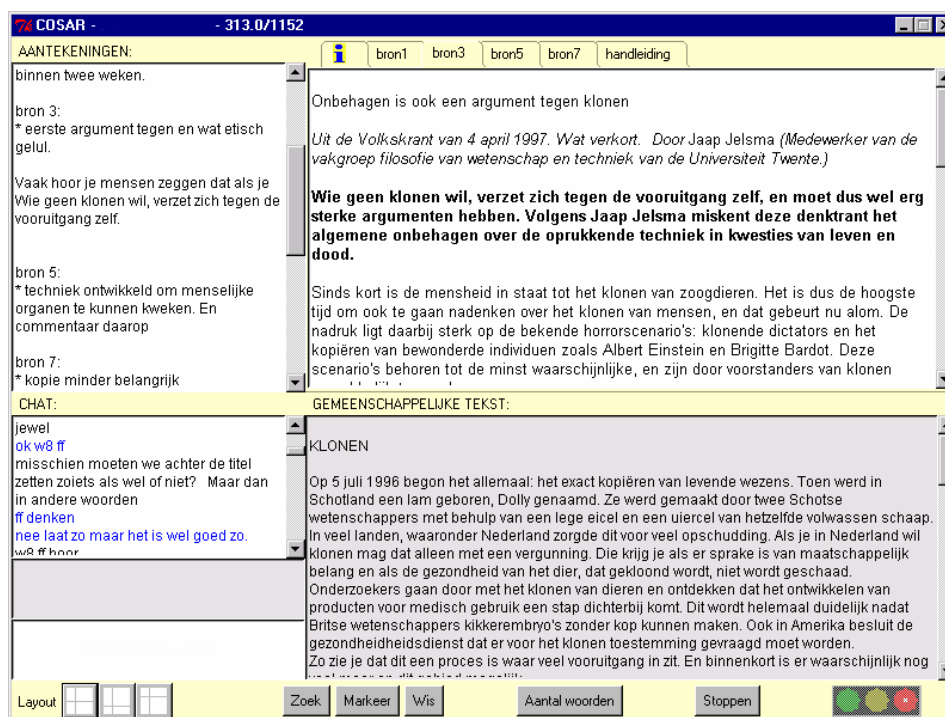
The basic environment consists of four main windows (see Figure 1):

INFORMATION (upper right): This private window contains tabs for the task assignment and the information sources. Each student has different sources. Relevant parts of the sources can be highlighted, and the search button (bottom toolbar) allows students to cycle through the marked parts. On request of the teachers, copying and pasting from the information sources was disabled.

NOTES (upper left): A private notepad in which the student can make personal notes. Copying and pasting from the notes to the shared text is possible.

CHAT (lower left): The chat window is shared and *WYSIWIS* ('*What you see is what I see*'). The lower chat box is for the student's current contribution; the other shows the incoming messages of his partner. The scrollable window holds their past dialogue: the chat history. Copying and pasting from the chat is disabled.

SHARED TEXT (lower right): A text editor (also *WYSIWIS*) in which the shared text can be composed by taking turns with a turn-taking device. Turn taking is regulated by a traffic light (bottom toolbar). One student has the green sign and can write in the text, the other has a red sign. The student with the green sign can pass on his turn by clicking on the traffic light. The partner will get the green light and can then write in the text. A student with the red light who wants to write, can ask for the turn by clicking the traffic light. Both lights will turn to yellow and flash, signaling that the turn has been asked for. A word count button (bottom toolbar) can be used to count the number of words the text contains. It is possible to copy and paste from the shared text into the notes.



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Furthermore, the students can change the layout, that is, resize the windows, of the basic TC3 environment by layout buttons (bottom toolbar). For reading information sources and making private notes the information window and the notes window can be enlarged. Another layout button will enlarge the lower windows (chat and shared text) for emphasis on the communicative and shared tools. The layout buttons change the layout of the TC3 environment individually. The last button in the bottom toolbar is the stop button. With the stop button the students can stop their collaborative work and continue at a later time. The students work on a text for about 6 hours, in most cases in 3-4 sessions on separate days. Clicking the stop button automatically saves all work in progress that is, all text, notes, highlights and chat history.

The program keeps a log file in which all actions in the separate windows and the chat discussion history are saved. This log file may be used to literally replay all keystrokes and thus the full collaboration between the students. The log file is also used to construct an activity and chat dialogue protocol for data analysis.

RESEARCH QUESTIONS

In a first study 40 pairs of students from two College Preparatory High schools (*VWO*) have written one or two argumentative texts on the topics cloning and organ donation in the basic TC3 environment. The evaluation of the students showed that, although criticizing technical flaws and drawbacks of the program (mainly in the first session), they were rather satisfied with this way of computer-supported collaborative learning.

In a second study, we have experimentally added two planning tools (a diagram visualizing the argumentative structure and an outliner function for the text) in order to determine the effect of sharing these tools on the argumentation in the discussion and on the resulting argumentative text. In this study 120 pairs of students from six schools participated. We are currently analyzing the results from the second study.

In this paper we will discuss results on three research questions in the context of the first study in the COSAR project:

- How do students use the tools and resources in order to coordinate their collaborative writing?
- How does the use of tools and resources relate to the argumentative quality and structure of the resulting text?
- Does the use of tools and resources differ in different phases of the writing processes, i.e. before and during the actual writing of the text?

In the next section we will discuss the method of analysis we are using to study the coordination of the collaborating students of the use of tools and resources during planning and writing the argumentative texts. In the following section we will present quantitative results on the three research questions. In the last section we will discuss some conclusions and further analyses we are planning to do.

METHOD OF ANALYSIS

Chat and activity protocol

Process oriented research in general is very laborious and consists of two consecutive analyses: a) single case analyses of protocols of the processes, and b) comparison of quantitative or qualitative characteristic features of the processes in the protocols that have been analyzed. If several protocols are to be compared, this can be an enormous task. We try to reduce the effort of protocol analysis by using the computer program MEPA (Multiple Episode Protocol Analysis), developed in our department at the University of Utrecht. The use of tools and resources is recorded by TC3 in a full action, keystroke based protocol. These protocols are automatically compressed into basic actions and converted into a MEPA data file. The actions with regard to tools and resources that are logged in the protocols are shown in Table 1.

Table 1. Actions categories for use of tools and resources

Actions	Description	Actions	Description
Chat	Chatting	To-manual	Opening the TC3 manual information
Layout	Using a layout button	To-notes	Activating the notes window
Mark-source	Marking in an information source	To-source	Opening a information source
Stop	Clicking on the stop button	To-text	Activating the shared text window
To-assignment	Opening the assignment information	Turn-ask	Asking for a turn shift by clicking the traffic light
To-chat	Activating the chat window	Turn-give	Giving the turn by clicking the traffic light
To-chat history	Activating the chat history window	Word count	Clicking on the shared text word count button

Argumentative quality and structure of the texts

We measured text quality with four measures and their mean score. Textual structure refers to the absence or presence of the formal units – introduction, body, and conclusion – and their composition. Segment score measures the quality of the argumentation at segment level – segments roughly coinciding with paragraphs. The argumentation score concerns the argumentative quality of the text as a whole, including introduction and conclusion. The audience score consists of three parts: presentation, level of formality, and empathy. Finally, the mean score of these four measures was computed for each text. Interrater agreement on five papers by two raters varied between 74-87% on these scores, resulting in satisfying Cohen's kappa's between .69 and .79. This grading of argumentative quality was accomplished separately and blind to the grades the teachers gave the papers following their own criteria.

Phases of collaborative writing

There are two points in the writing process that can be clearly distinguished: the first draft and the final draft. In between, one or more drafts are written. We have used these two drafts as anchors. The first phase refers to the period in the chat and activity protocol before writing the first draft, and so reflects the preplanning phase. The rest of the protocol is divided into two phases of equal duration. We expect the second phase to be characterized by more writing activities and the third phase by more revising activities. However, we view the three phases as units of time, not as specific activity periods.

RESULTS

Using tools and resources for coordinating collaborative argumentative writing

Our first question was: How do students use the tools and resources in order to coordinate their activities in writing an argumentative text? Table 2 shows the mean percentages and standard deviations for activation of the different tools and resources in the protocol. On average, the collaborative writing protocols contained 994 actions. Almost two thirds of these actions refer to the chat tool. It shows the crucial role that task oriented chat plays in coordinating the collaboration process. The next highest percentages are as we expected: using the shared text tool (11%) and reading the sources (6%). Counting the number of words in the shared text (5%), giving and asking for turns (4%) and marking in the information sources (2%) occur rather regularly if we take the total number of actions into account. The students seldom use the layout buttons, work in the notes or read the program manual.

Table 2. Total number of actions, mean percentages and standard deviations in the protocols

Actions	Mean	SD	Actions	Mean	SD
Chat	62.47%	9.70	To-manual	.25%	.31
Layout	.82%	.93	To-notes	.98%	1.12
Mark-source	2.30%	2.98	To-source	6.37%	2.98
Stop	.34%	.41	To-text	11.18%	2.59
To-assignment	1.18%	.69	Turn-ask	1.42%	.86
To-chat	3.46%	1.89	Turn-give	3.06%	1.58
To-chat history	1.32%	.84	Word count	4.85%	2.08
			Total number of actions	993.75	349.09

Is the use of tools and resources related to the quality of argumentative texts?

In this section we will describe the relations we found between tool and resource use frequencies and the scores for the argumentative quality of the texts. Table 3 shows the correlations between the action categories and each of the argumentative text scores.

We did not find significant correlations for textual structure, nor for overall argumentation. However, we found several significant correlations for each of the other text scores. The quality of the segments correlates negatively with the *total number of actions* (-.38). This seems to be an overall tendency, as this category also shows negative correlations for audience score (-.20) and the resulting mean score (-.24). This could mean that long chat and activity protocols result in lower quality texts. In other words, switching between tools and criss-crossing the computer environment might be detriment to the production of a high quality text, possibly because the students do not focus efficiently on the task at hand. In line with this possibility, we found that paragraph argumentation (segment score) correlates positively with *to-text* (.28). This strengthens the theory that paying closer attention to the text may lead to a better text, in this case at the segment level. However, we did not find correlations for *to-text* with any of the other text scores. Note that a high frequency of *to-text* does not imply that students also write in the shared text. It seems plausible that focusing on the shared text is an important influencing factor.

Table 3: Correlations between action percentages and text scores for all phases.

	Textual Structure	Segment score	Argumentation score	Audience score	Mean score
Chat	.01	-.07	.03	.17	.05
Layout	-.08	-.09	-.16	-.25*	-.19°
Mark-source	.01	-.01	-.05	.05	-.00
Stop	.16	-.01	.03	-.06	.02
To assignment	-.02	.06	.05	-.05	.03
To chat	-.01	.03	-.02	-.17	-.05
To chat history	.10	.05	.07	-.07	.04
To manual	-.02	.12	-.05	-.01	.00
To notes	.14	-.00	.09	.08	.09
To source	-.09	.07	-.09	-.19°	-.10
To text	.13	.28*	.03	.03	.12
Turn ask	.07	-.11	-.05	-.17	-.09
Turn give	-.07	-.06	-.02	-.26*	-.12
Word count	-.11	-.10	.05	-.09	-.05
Total no. of actions	-.08	-.38**	-.14	-.20°	-.24*

** Pearson correlation is significant at the 0.01 level (2-tailed); * significant at the 0.05 level (2-tailed); ° significant at the 0.10 level (2-tailed).

The audience score correlates negatively with *layout* (-.25), *to-source* (-.19), *turn-give* (-.26), and *total number of actions* (-.20). Somehow, focusing on these activities seems to draw the students' attention away from their readers. Finally, the mean score – which is the mean of the other four scores – correlates negatively with *layout* (-.19) and the *total number of actions* (-.24). Again, text quality seems to be influenced by the length of the protocol and by focusing on the program rather than the writing task.

Differences in the use of tools and resources in different phases of the writing processes

The differences in use of tools and resources in the three phases of the collaborative writing process are visualized in two graphs in Figure 2 and Figure 3. Figure 2 shows the mean percentages of all actions in the three phases. The mean number of actions for each of the phases is 163.0 (sd.=103.1), 402.1 (sd.=206.8), and 428.6 (sd. =174.0), respectively.

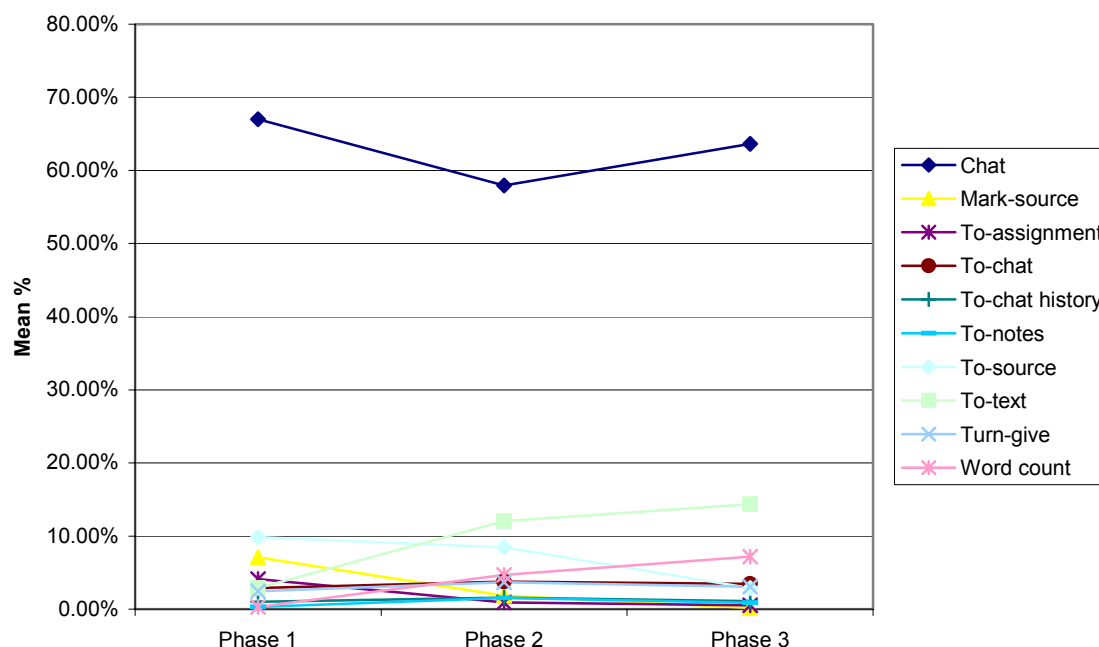


Figure 2. Trend graph including all action categories.

As can be seen in Figure 2, the *chat* activity relatively dominates in all three phases. The chat percentage clearly decreases (from 67% to 58%) and then increases again (from 58% to 64%): during preplanning and the final phase the students spend more time deliberating than during the highly productive middle phase. This is consistent with the findings by Kraut, Galegher, Fish and Chalfonte (1992), who found that subjects sought more frequent and richer communication during planning and revision phases than during the more solitary activity of drafting the text.

For better readability the chat action is excluded from the graph in Figure 3. As can be seen in this chart several action categories show a constant declining tendency, and often for obvious reasons. The categories *mark-source* and *to-assignment* are both activities naturally performed during the initial stages of the writing process. After all, when students leave marking sources and reading the assignment to the final phase, it will be too late to change the text. On the other hand, some categories show a rising tendency: *to-text*, and *word-count*. Again, this is hardly surprising, as these are activities naturally performed when the actual writing and revising are in full progress and the goal – that is, finishing the text – draws nearer. The mean differences for *total number of actions* show that the preplanning phase is a lot shorter than the other two phases that differ only slightly.

We found four categories showing a rising-then-falling tendency: *to-chat*, *to-chat-history*, *to-notes*, *turn-ask*, and *turn-give*. The latter might be explained by a change in co-operation between the students. At first, there is no reason to ask for turns, because there is nothing in the shared text yet. Later on, as they grow more familiar with the program and each other, the students start asking for turns in the chat window instead of using the *turn-ask* button for this purpose. From our observations we can confirm that most students seem to prefer this verbal communication to the flashing yellow screen caused by a *turn-ask*. However, the student evaluation showed that on average the students liked the turn taking system. For obvious reasons, virtually no *to-chat-history* is logged in the first phase. As the chat history grows, it can be used as a source: all arguments and viewpoints discussed earlier can be reviewed there. This explains the increased use of this window in the second phase. However, during the last phase there is less need for consulting the chat history, as the outline of the text has been clearly laid out by that time.

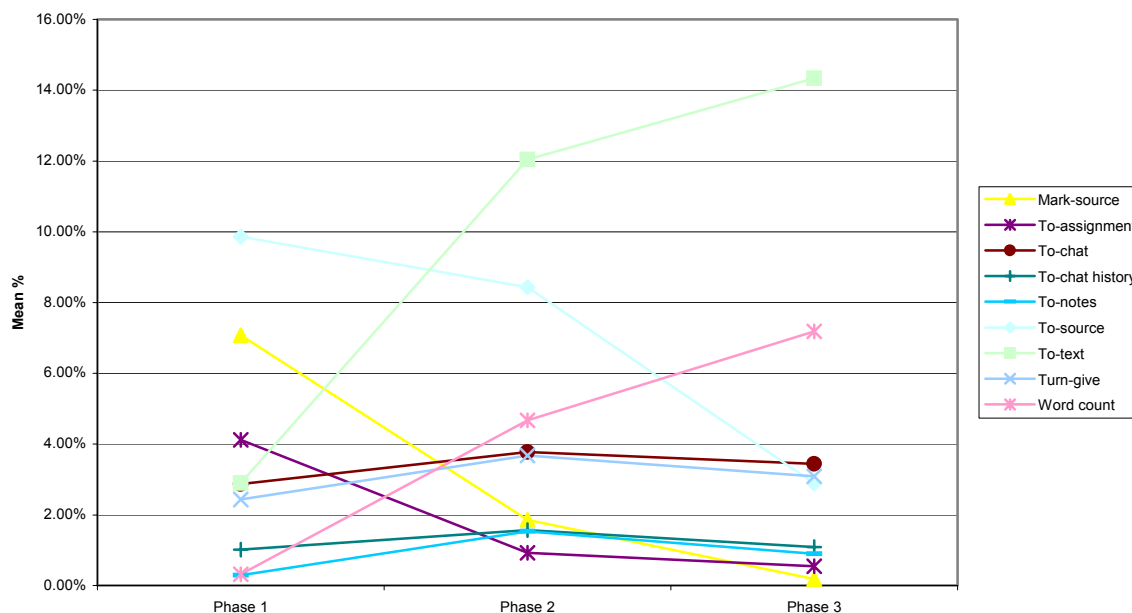


Figure 3. Trend graph excluding chat category

The tendency for *to-notes* can be explained with very similar reasons: the students read the sources first, before they start taking notes on them. The decrease between the second and third phases is caused by the fact that towards the end of the assignment all sources will have been read and annotated. The students know what is in their notes by then, and so they do not need to refer to them very often anymore during revision. However, reading – writing – taking notes – writing – revising does not seem to be the logical approach to planning and writing texts. It makes sense to take notes *before starting* to write the text, because you need to know about the content of the sources before you write about them. The students in this control group, however, only started to take notes extensively after they had already started writing the first draft.

Finally, *to-chat* was logged most frequently during the middle phase, and less frequently during the other two phases. This category was logged whenever a student clicked in the chat window without actually entering chat before moving on to a different window. The tendency for *to-chat* is in line with the tendency for *chat*: during the second phase, relatively fewer *to-chats* resulted in *chat*, thus resulting in a falling-then-rising tendency for *chat*.

DISCUSSION

This study posed research questions with regard to: a) the use of tools and resources by students in the TC3 groupware environment to coordinate their collaborative writing process, b) the relationship between the use of tools and resources and the quality of the written text, and c) the differences in the use of tools and resources during different phases (i.e. preplanning, writing and revising) of the writing process. So what is the relationship between the frequencies of tool use in the three phases of the writing process and the quality of the resulting text?

As we can see in the charts above, there are clear differences between the phases. However, the use of the chat facility is most frequent in all three phases. In a further analysis of the topics the students chat about, we found that 47% of the chat is about planning of the writing task on a meta-cognitive level, 36% of the topics are content related and 17% of the topics is not task related, social chat. Planning activities on a meta-level occur equally in all three phases of the collaborative writing process for low, medium and high quality texts. Discussion of specific content clearly occurs more often in the high quality text groups. Furthermore, we find that the higher the performance, the lower the occurrence of non-task, social chats.

In the pre-writing phase the students clearly make more use of the information sources, marking them and taking notes. Further analysis showed that *to-source* and *to-notes* frequencies in the first phase are, in fact, positively correlated to respectively the segment score ($r = .36$) and the textual structure ($r = .22$) scores. In the second phase of actual writing of the text the students show more activity in the shared text window and in the turn-giving device. Further correlation analysis showed a significant positive correlation between *to-text* frequency and the textual structure score ($r = .33$), the segment score ($r = .45$) and the argumentation score ($r = .21$). The third phase of writing shows an increase of chat activity, of text activity and of *word-count*. In the correlation analysis for the third phase only a small correlation is found between chat activity and the audience score (.19).

In our further analyses we will focus on the way the students explicitly discuss their use of tools and resources in the chat discussion. Furthermore, we will investigate the effects of adding tools for text planning and linearization to the TC3 environment on the coordination processes in collaborative writing.

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