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Gijsbert Erkens[1], Jeroen Janssen[1], Paul A. Kirschner[1,2]

[1]Research Centre Learning in Interaction, Utrecht University, The Netherlands

[2]Netherlands Laboratory for Lifelong Learning / Psychology, Open University of the Netherlands

Abstract

The use of argumentation maps in CSCL does not always provide students with the intended support for their collaboration. In this chapter we compare two argumentation maps from two research projects, both meant to support the collaborative writing of argumentative essays based on external sources. In the COSAR-project, the Diagram-tool with which students could specify positions, pro-arguments, con-arguments, supports, refutations and conclusions in a free graphical format to write a social studies essay, was highly appreciated by students and teachers, but did not result in better essays. In the CRoCiCL-project, the Debate-tool with which students could specify positions, pro-arguments, con-arguments, supports and refutations in a structured graphical format, meant to visualize the argumentative strength of the positions, resulted in better history essays. The difference in representational guidance between both tools might explain these differences in effects, with the Debate-tool stimulating students to attend to the justification of positions and their strengths.

Introduction

Computer Supported Collaborative Learning (CSCL) systems are assumed to have the potential to enhance the effectiveness of peer learning interactions (Andriessen, Erkens, Overeem, & Jaspers, 1996; Dillenbourg, 1999). Groupware programs are used for CSCL as they generally support and integrate three functions: task support, communicative support, and group support. Computer tools in groupware programs are either task-oriented (information sharing, cooperation, and coordination), communication-oriented (interpersonal exchange) or group-oriented (Andriessen, 2003). They are meant to support collaborative group work by sharing tools and resources between group members, by supporting group dynamics, and by giving communication opportunities within the group and to the external world.

Shared argumentation maps are task-related tools that are often used in CSCL. They are constructed by the collaborating students and are designed to be helpful in completing the inquiry task at hand (e.g., CSILE: Scardamalia, Bereiter, & Lamon, 1994; Belvédère: Suthers, Weiner, Connelly, & Paolucci, 1995). The maps visually represent the argumentative structures the students agree upon. The aim of this chapter is to investigate the effects of argumentative maps or diagrams on students working on collaborative writing tasks. Often, inconsistent or disappointing results are found in the way argumentative diagrams support reasoning and discussion in CSCL (Van Drie, Van Boxtel, Jaspers, & Kanselaar, 2005). We will present two research projects that investigated the effects of two types of argumentative diagrams for supporting collaborative writing and inquiry. In both the COSAR- and the CRoCiCL-project, argumentative diagrams were used to support collaboration and argumentation on inquiry tasks. In the COSAR-project the effectiveness of the argumentative diagram for the quality of the students' group products was disappointing. For the CRoCiCL-project we redesigned the representational features of the argumentative diagram. Although the purpose of the two tools was similar, the effectiveness of the diagram for stimulating the quality of the students' group products improved. For the explanation of these differences in effectiveness, we offer some ideas but no definitive answers as the two projects differed in more aspects and the two tools were not compared directly. However, we hypothesize that the representational guidance (Suthers, 2003;

Suthers & Hundhausen, 2003) the two tools offer to collaborating students differ substantially. The differences in guidance may have resulted in differences in the effectiveness of the argumentative tools on the quality of students' group products.

Representational guidance of two argumentative maps

Representational guidance refers to the fact that different representations are capable of expressing different information, make different information salient, or stimulate different cognitive processes than others (Suthers & Hundhausen, 2003). Several studies investigating the effects of different argumentation tools showed representational guidance can influence students' behavior and learning process (e.g., Schwarz, Neuman, Gil, & Ilya, 2003; Suthers, 2001; Van Amelsvoort, Andriessen, & Kanselaar, 2007). Van Bruggen, Boshuizen and Kirschner (2003) distinguish five characteristics of representation tools that affect representational guidance: ontology (i.e., the type of representing elements), perspective (i.e., the view on the subject matter the representation allows), specificity (i.e., the categorical choice the representation forces, see also Suthers, 2001), precision (i.e., the accuracy of representation) and modality (i.e., form of expression; graph, text, list, matrix etc.).

In the COSAR-project, we examined the effects of the Diagram, a tool used for constructing argumentation maps (see Figure 1). The Diagram is a shared tool for generating, organizing and relating arguments in a graphical knowledge structure comparable to Belvédère (Suthers & Hundhausen, 2003; Suthers, Weiner, Connelly, & Paolucci, 1995). The tool was conceptualized to the students as a graphical summary of the arguments in an essay. Students were instructed that the information contained in the diagram had to faithfully represent the information in the final version of their essay. This requirement was meant to help students notice inconsistencies, gaps, and other imperfections in their texts, and encourage them to review and revise. In the Diagram, several types of text boxes can be used: information ("informatie"), position ("standpunt"), argument pro ("voorargument"), support ("onderbouwing"), argument contra ("tegenargument"), refutation ("weerlegging"), and conclusion ("conclusie").

In the CRoCiCL-project, we investigated the effects of the Graphical Debate-tool (GD-tool, see Figure 2). In this project, students were required to co-construct a representation of a historical debate. Comparable to the COSAR-project, this activity precedes a writing task where students have to co-author an essay. The GD-tool was designed after our experiences with the Diagram in the COSAR-project.

The boxes labeled Martyrs and Propaganda represent both positions of the debate. While working with the GD-tool, students can add arguments to either of the positions. These arguments can be found in the given sources. The sources also contain information that supports or refutes the arguments students add to the tool. Elements that represent supporting information have a white background, while elements that represent refuting information have a grey background.

The GD-tool visualizes how well positions are supported by arguments and supporting information. Each time an argument or a supporting piece of evidence is added to a position, it moves closer to the central flag. Conversely, when a refutation is added, the position moves away from the flag. Thus, when a position is located closer to the flag, it is better supported by arguments: the argumentation is more strongly in favor of the position. The embedded representational guidance of the GD-tool may help students draw a conclusion about the debate and thus may contribute to computational offloading (Ainsworth, 2006). The GD-tool also visualizes students' progress through the problem (Cox, 1999). For example, the boldness of the lines around the position and argument boxes serves as an indication for their elaborateness and complexity. Finally, in the GD-tool students have the option to rate the quality of arguments, supports, and refutations. Students can express this by giving ratings to arguments, positions, and refutations (indicated by the star in the corresponding boxes). A rating influences the distance of the position from the flag. When a rating is given to an argument, support or refutation, its corresponding position moves closer to or away from the flag. The rating functionality of the GD-tool stimulates students to think about and discuss the importance of arguments and may help them to see which arguments are more important than others.

[Insert Figures 1 and 2 about here]

Table 1 contains a comparison between the Diagram used in the COSAR-project and the GD-tool used in the CRoCiCL-project. From this Table important differences in the representational guidance offered by both tools become apparent. The most important differences concern the perspective, specificity, and precision of both tools. The Diagram offers a perspective on argumentation comparable to a concept map: Students can construct a map containing their own arguments and arguments found in the sources. The GD-tool offers a battle field perspective on argumentation: arguments advance or retract based on how well they are supported. It can be also be argued that the GD-tool gives more specific guidance than the Diagram does, because it gives feedback about the strength of argumentation and because it draws attention to the relative weight of arguments. On the other hand, it can be argued that the specificity of the Diagram is greater because students can use a larger number of different elements to construct their argumentation map.

It can be hypothesized that the differences in representational guidance offered by the Diagram and the GD-tool will affect their effects on students' collaborative process (Suthers, 2006; Van Drie et al., 2005). In the remainder of this chapter we will describe two studies that – separately – investigated the effects of the Diagram and GD-tool. Although both studies were in similar in certain aspects, other features of the studies differed (see Table 2). In spite of these differences, we offer tentative suggestions in the general discussion for why the effects of Diagram and GD-tool differed.

[Insert Tables 1 and 2 about here]

The COSAR-project

The COSAR-project (COmputer Support for collaborative and Argumentative wRiting) investigated the effects of using argumentative diagrams for argument generation and organization, compared to outlining tools for argument linearization in collaborative writing of source based argumentative texts. In argumentative writing (in contrast to narrative writing) the generation and organization of arguments and ideas and the linearization of the collected arguments in a linear text are the biggest problems for novice writers (Andriessen et al., 1996). A Diagram-tool and an Outline-tool were developed to support these specific writing processes.

A groupware environment called TC3 (Text Composer, Computer supported & Collaborative) was developed with which pairs of students collaboratively write argumentative essays (Erkens, Jaspers, Prangsma, & Kanselaar, 2005). This environment combines a shared word processor, a chat facility, and access to a private notepad and online information sources. Each partner works at his/her own computer, and wherever possible partners were assigned to different classrooms. The basic TC3-environment, shown in Figure 3, contains four main windows of which the upper two windows are private and the lower two are shared:

[Insert Figure 3 about here]

1. INFORMATION (upper right window): This private window contains tabs for the assignment ("i"), sources ("bron") and TC3 operating instructions. Sources are divided evenly between students. Each partner has three or five different sources plus one – fairly factual – common source.
2. NOTES (upper left window, "AANTEKENINGEN"): A private notepad where students can make non-shared notes.
3. CHAT (lower left, 3 small windows): The student adds his/her chat message in the bottom box. Every letter typed is immediately sent to the partner via the network, so that both boxes are WYSIWIS: What You See Is What I See. The middle box shows the incoming messages from the partner. The scrollable upper chat box contains the discussion history.
4. SHARED TEXT (lower right window, "GEMEENSCHAPPELIJKE TEKST"): A simple word processor (also WYSIWIS) in which the shared text is written while taking turns.

In addition, two representational tools and a supporting facility were developed for the experimental conditions: the Diagram (described above), the Outline, and the Advisor. The Outline (see Figure 1) is a shared tool for generating and organizing information units as an outline of consecutive arguments in the text. This tool was conceptualized to the students as producing a meaningful outline of the paper, and as is the case for the Diagram, the participants were required to have the information in the Outline faithfully represent the information of the final text. The Outline-tool was designed to support planning and organization of the linear structure of the texts. In addition, the Outline-tool has the pedagogic function of making the user aware of characteristics of good textual structure, thus allowing the user to learn to write better structured texts. The Outline has a maximum of four automatically indented, numbered levels. Both planning windows are WYSIWIS.

The Advisor is an extra help facility that provides advice on how to use the Diagram and/or Outline before and during task fulfillment. The Advisor consists of a tab sheet added to the information window with tips and instructions for optimum use of the representational tools: the Diagram or the Outline.

Method

Design

The experiment was executed in two phases. In the first year, a control group (39 dyads) fulfilled the collaborative writing task in the basic TC3-environment without Diagram, Outline, or Advisor. In the second year six experimental groups (106 dyads in total) fulfilled the same task in the basic TC3-environment in which the planning tools and/or advising facility added were varied (see Table 3).

[Insert Table 3 about here]

To control for school effects, classes from different schools were assigned to each condition. To control for differences in writing and argumentation skills, two pre-tests were administered individually before students worked on collaborative writing task. No systematic differences between students from different school classes were found in writing or argumentative competencies.

Participants

Participants were 290 Dutch students, aged 16 to 18, from six secondary schools in the Netherlands. The assignment was completed during four to six lessons. The analyzed sample included 151 girls and 139 boys. All students from a class were randomly assigned to pairs by the experimenter on the basis of the list of names provided by the teacher. As the writing task for the students were part of the school curriculum (the essays were graded), it was not possible to stratify the group formation on argumentative competence. Mixed gender dyads comprised 58 pairs of the total sample, 46 dyads were all female, and 41 were all male.

Task

The collaborative writing task was to write an argumentative essay of 600 to 1000 words in Dutch on cloning or organ donation. The assignment was to convince the Minister of Health, Welfare, and Sport of the position the students choose to defend. The arguments for or against the position had to be based upon facts and discussions about the issue presented in external information sources. The sources were taken from the Internet sites of Dutch newspapers. Each student had access to one common source and half of the remaining sources. By dividing the sources over the students, they were stimulated to discuss the relevance of the information for their common text. In all dyads, partners were seated in separate computer rooms to encourage them to only communicate through TC3. The students received grades for their texts from their teachers as part of their normal school work. These grades were separate from the scoring of the essays by two of the experimenters.

Analyses

Each of the 145 essays was coded on several dimensions. Before coding, the experimenters manually divided the texts into segments, largely based on the existing paragraph structure. The texts were scored on four variables on a scale of 1 to 10:

1. Textual structure: formally defined by introduction, body, and conclusion;
2. Segment argumentation: argumentative quality of the paragraphs;
3. Overall argumentation: quality of the main line of argumentation in the text, and
4. Audience focus: presentation towards the reader and level of formality of the text.

The interrater reliability for these measures was very high, with correlations between two independent raters for the four text scores on five texts ranging from .71 to 1.00 ($p < .01$).

Results

Quality of essays

First, the tool conditions in relation with the quality of the essays will be discussed. Table 4 shows the means and standard deviations of quality scores of the argumentative texts for all conditions separately and for the sample as a whole.

[Insert Table 4 about here]

The table shows that the scores were quite similar for all groups. Independent samples *t*-tests showed no differences between the two topics – organ donation and cloning – and there were no significant gender differences between female, male or mixed groups. The mean quality of the texts was 6.2 on a scale of 1-10. We only found a few differences in a multiple comparison analysis (Bonferroni) on the conditions: the Diagram-Advisor group had significantly lower scores on textual structure of the essays in comparison to the Control, the Diagram, and the Diagram-Outline-Advisor conditions (mean differences: -.73, -.68 and -1.12, all $p < .05$) and had a significantly lower score on segment argumentation in comparison to the Control condition (mean difference: .70, $p < .05$). In general, we can say that the representation tool conditions in themselves did not have a positive effect on the quality of the resulting texts.

However, the availability of a tool is no guarantee of adequate use. Comparing the frequency of use of the Diagram with the frequency of use of the Outline, the Outline-tool was more successful. Use of the Outline-tool was weakly positively related with text quality ($r = .13$, $p < .05$). The use of the Diagram was even negatively correlated with text quality ($r = -.25$, $p < .01$), except for the last phase of writing ($r = .17$, $p > .05$). These relations were even stronger when the use of the Advisor was correlated to text quality (Diagram-Advisor, $r = -.21$, $p < .05$ and Outline-Advisor, $r = .44$, $p < .01$). Correlation analyses showed that the frequency of using the Diagram to specify supports and refutations of positions tended to be weakly positively related to segment argumentation ($r = .21$, $p < .05$ and $r = .13$, $p < .07$). Furthermore, the more the Diagram was used for specifying arguments from the sources instead of self-generated arguments the less the overall argumentative quality of the texts proved to be ($r = -.21$, $p < .05$), ending up in an enumeration of arguments in the text. As for the Outline-tool, a positive effect was found of the proper use of the Outline (especially in outline-text congruence) and its Advisor on segment argumentation in the resulting argumentative text ($r = .26$, $p < .01$ & $r = .23$, $p < .01$)

Contrary to these findings, however, an evaluation survey of students and teachers showed that both groups evaluated both tools, but especially the Diagram, as useful and helpful.

Online collaboration

All utterances in the chat discussions were coded with a coding system consisting of three main levels: meta cognitive (planning and monitoring), cognitive (executive) and non task or social. In this Task Act coding system 34 different categories were distinguished in total. Reliability analyses showed Cohen's κ's of .57 and 64. Both Diagram and Outline affected the collaborative chat discussion of the students in a substantial way: 70% of the utterances versus only 47% in the control condition were on a meta cognitive level. That is, both the Diagram and Outline increased how often students deliberately planned and monitored the task completion.

In order to find an explanation of these findings a qualitative analysis of the discussion of the students while using the tools was undertaken. Analyses of the chat protocols showed that the Diagram often functioned as a visual representation for arguments mentioned but not as a basis for discussion or as a tool for idea generation. Thus, the Diagram only functioned as a visual summary, and not as a basis for discussion of the argumentative structure or as a tool for generating and organizing new ideas and arguments. When a diagram stimulates and reflects the discussion itself, it can be a valuable starting point for writing the text, and can benefit the textual structure. A more guiding function of the representation tool might encourage the students to use it as it was intended, and thus lead to different results.

Conclusions COSAR-project

In the COSAR-project a complex relationship between the use of representation tools, like the Diagram and Outline, and the argumentative quality of the texts was found. Inconsistent, small and even negative relations exist between using the argumentative Diagram and the final argumentative text. Positive relations, although small, were found between the use of the Outline linearization tool and text quality. However, both representation tools seemed to stimulate discussion and coordination on a planning level in the collaboration chat of the students. Furthermore, both students and teachers evaluated the Diagram-tool as very valuable and useful (more useful than the 'more effective' Outline-tool). The question therefore remains why the argumentative Diagram did not help students write better grounded texts. We assumed that the tool offered too little representational guidance to students. The free, unrestricted manner in which the arguments can be displayed in the Diagram by the students, prevents them from getting a systematic insight in the argumentative structure and organization of the debate they study. Furthermore, the loose graphical structure of an argumentative map gives no indication of the relative strength of the positions depicted. In the CRoCiCL-project we tried to develop an argumentative diagram tool that offers more representational guidance with regard to the argumentative structure of the debate and the argumentative strength of the positions.

The CRoCiCL-project

Aim of CRoCiCL was to examine how the representational guidance offered by an argumentative diagramming tool influenced the collaborative process. To answer this question the Graphical Debate-tool (described above) was compared to a Textual Debate-tool (TD-tool, see Figure 4). In this version of the tool, students also add arguments to the corresponding positions. No distinction is made however, between arguments, supports, and refutations. Instead, information is added to the TD-tool in a list wise manner (cf., Erkens et al., 2005; Van Drie et al., 2005). On the other hand, this makes the TD-tool somewhat comparable to the Outline-tool from the COSAR-project, because both tools stimulate students to organize arguments in a list. However, the TD-tool also differs from the Outline-tool because it uses – like the GD-tool – given positions. The process of co-constructing representations (i.e., reading and processing historical sources, extracting relevant information, placing this information in the appropriate place in the representation) is almost the same for both versions of the Debate-tool.

[INSERT FIGURE 4 ABOUT HERE]

The main difference between the GD-tool and the TD-tool concerns the representational guidance they offer (Suthers, 2001, 2003; Suthers & Hundhausen, 2003; Suthers, Hundhausen, & Girardeau, 2003). Compared to the TD-tool, the GD-tool uses several visualization techniques to make information salient and help students complete the representation more effectively and efficiently. For example, the GD-tool discerns between arguments, supports, and refutations. This feature may stimulate and guide students to find supporting and refuting information, and to formulate arguments since it is immediately clear to them if this information is present or not. Third, the GD-tool visualizes how well positions are supported by arguments and supporting information. It is more difficult to infer this from the TD-tool because no distinction is made between arguments, supports, and refutations. Finally, the option to rate the quality of arguments, supports, and refutations available in the GD-tool may stimulate students to think about and discuss the importance of arguments and may help them to see which arguments are more important than others.

Method

Design

We used a single-factor, between subjects design with two different groups defined by the type of representation used: GD- or TD-tool. We randomly assigned three classes to the GD condition, and two classes to the TD condition. In total, 79 students in 24 groups worked in the GD condition, and 45 students in 15 groups formed the TD condition. Before the start of the study, students completed a 15-item knowledge pretest. No differences were found between the two conditions with respect to their subject matter knowledge.

Participants

The participants were students from five different history classes from two secondary schools. The total sample consisted of 124 eleventh-grade students (55 male, 69 female), with an average age of 16.24 years of age (SD = 0.57). Their teachers randomly assigned them to different groups. Due to uneven class sizes and student drop-out, this resulted in one 2-person group, thirty 3-person groups, and eight 4-person groups.

CSCL-environment: VCRI

Students worked in a CSCL-environment named *Virtual Collaborative Research Institute (VCRI)*. VCRI is the successor of the TC3 used in the COSAR-project. Students use the *Chat* tool to synchronously communicate with other group members. To read the description of their group task or to search and read relevant information, students can use the *Sources* tool. This tool lists a number of sources which can be opened and read from the screen. Group members use the *Cowriter* as a shared word processor. Using the *Cowriter*, group members can simultaneously work on different parts of their texts. VCRI contains several other tools designed to support the inquiry process.

Task

Students collaborated on an inquiry group task in the domain of history. Students were given 14 historical and contemporary information sources and were asked to explore and discuss the different sources with respect to the debate. Students were required to co-construct a representation of this debate in either the GD- or TD-tool. After they had completed their representation, they had to co-author an argumentative essay based on their findings.

Analyses

To determine whether groups in the GD condition constructed argumentative diagrams of higher quality than groups in the TD condition, we rated all the items placed in the tool on a 5-point scale (ranging from 0 - 4). Interrater reliability of the rating process was assessed by two independent coders. Cohen's κ was .69.

To determine whether groups in the GD condition wrote better essays than groups in the TD condition, we analyzed the quality of these essays with respect to quality of grounds used for argumentation, and conceptual quality of the argumentation. The evidence provided by students to back up the claims and opinions in their texts formed the starting point for the analyses of grounds quality. Each text segment was judged on a 4-point scale, ranging from 0 to 3, in terms of how well and how elaborately it was supported by evidence or explanations (Clark, Sampson, Weinberger, & Erkens, 2007). The conceptual adequacy of the arguments given by the students, constituted the basis for the analyses of conceptual quality (Clark et al., 2007). Each segment was judged in terms of its conceptual correctness; thus segments containing, for example, flawed conclusions, misinterpretations or incorrect statements received lower scores for conceptual quality than segments containing no errors. Conceptual quality was also rated on a 4-point scale (0 - 3). Two independent judges assessed the quality of seven essays to establish the interrater reliability. Cohen's κ was .85 for grounds quality and .88 for conceptual quality.

To investigate whether students in the GD condition learned more than those in the TD condition, knowledge pre- and post-tests were developed. Both tests consisted of the same 15 multiple-choice items addressing topics covered in the inquiry group task.

Finally, to investigate the impact of representational guidance on the collaborative process, we used a coding scheme to analyze the online collaboration between group members (see Janssen, Erkens, & Kanselaar, 2007; Janssen, Erkens, Kanselaar, & Jaspers, 2007). The online collaboration process was captured in log files, containing all actions performed by the students. This coding scheme consists of four main categories: task-related activities, regulation of task-related activities, social activities, and regulation of social activities. Like the Task Act coding scheme for the COSAR-study, this coding scheme distinguished between meta-cognitive and task-related activities, but also focused on the social aspect of collaboration. Interrater reliability of this coding scheme was determined by two independent coders. Cohen's κ was found to be .90.

Results

Quality of constructed argumentative diagrams

Groups in the GD condition made argumentative diagrams of significantly higher quality than groups in the TD condition, $t(37) = 3.90$, $p < .01$, $d = 1.28$. Additionally, we correlated the number of items produced with the average quality of these items and found a significantly negative correlation, $r = -.66$, $p = .00$, meaning that when groups attempted to included a large number of items in their representations, this had a negative effect on the quality of their representations.

Quality of essays

Analyses show that GD groups wrote significantly better essays than TD groups in terms of grounds quality and conceptual quality, $F(1, 39) = 6.15$, $p < .01$, $\eta^2 = .15$, and $F(1,39) = 8.30$, $p < .01$,

$\eta^2 = .19$ respectively. Additional analyses showed that groups that received high scores for grounds quality also received high scores for conceptual quality ($r = .89$, $p < .01$).

Post-test performance

To determine the effect of condition, while controlling for prior knowledge, condition and pre-test score were added to a multilevel model. The first step in this analysis was to examine the results of a model without any independent variables, the so-called null model. This model contained two levels. Because students were nested in groups, the individual student constituted the lowest level, while the group constituted the highest level. Next, condition and pre-test score were added to the multilevel model. This model explained significantly more variance compared to the null model, $\chi^2 = 11.07$, $p < .01$. Both pre-test performance and condition had a significant effect on students' post-test performance. As expected, a higher pre-test score contributed to a better post-test performance, $\beta = 0.28$, $p < .01$. Furthermore, condition contributed significantly to post-test performance, indicating a positive effect of working with the GD-tool, $\beta = 0.42$, $p < .05$.

Online collaboration

When we examined the collaboration protocols, we expected to find that GD groups would be less busy coordinating, regulating, and monitoring their task performance. This, however, was not the case. Students that worked with the GD-tool were engaged in planning, monitoring, evaluating their task progress as much as students who worked with the TD-tool. In sum, we did not find evidence that the GD-tool facilitated the coordination of collaboration.

Conclusions CRoCiCL-project

Based on the results, we conclude that the representational guidance offered by the GD-tool has a positive effect on the quality of shared products students construct. First, the GD-tool helps students construct better argumentative diagrams. Furthermore, the GD-tool also helps group members write better essays. Finally, students that worked with the GD-tool performed better on a knowledge post-test. These findings contrast with other studies that found limited effects of representational guidance (e.g., Suthers & Hundhausen, 2003; Toth, Suthers, & Lesgold, 2002; Van Drie et al., 2005). An explanation may lie in the representational guidance offered by the GD-tool compared to the guidance offered by the tools in the work of other researchers. Our tool directs students' attention to the distinction between arguments, supports, and refutations, and this may stimulate students to incorporate these elements in their diagrams and essays. It has been argued that tools that support *linearization*, that is the ordering of content and arguments into an essay, may be better supported by tools specifically designed to support the planning of the linear structure of essays (e.g., the Outline-tool used in the COSAR-project). Although the GD-tool was not specifically designed to support the process of linearization, it may be the case that stimulating students to systematically address all arguments, supports, and refutations of a position also facilitates the process of converting a representation into an essay.

Interestingly, representational guidance has been found to affect students' collaborative process in previous research. In this study, this result was not replicated. Our study offers no support for the expectation that representational guidance decreases group members' need to coordinate and regulate their task performance in the online discussions. Students could use the representations in both the GD-tool and the TD-tool to exchange information (Van Drie et al., 2005). Because both tools were shared, adding an element to the representation equates to exchanging information with group members. Thus, there might be less need to engage in extensive information exchange in the chat discussions and the need to coordinate this process may also be diminished.

Although the GD-tool seems to help students write better texts, it is noteworthy that the students evaluated the GD-tool somewhat less positively than the TD-tool.

Conclusions and Discussion

In this chapter we compared two tools meant to help collaborating students understand and represent arguments and positions from different external sources within a societal or scientific debate. The Diagram in the COSAR-project provided students with a graphical mapping tool in which they could collaboratively specify positions, pro-arguments, con-arguments, supports, refutations and conclusions and could draw links or arrows between these elements. No restrictions on spatial structure and representation were made. Although the Diagram-tool was highly valued by the students and did effect their collaborative deliberation, no or negative effects were found on the quality of the argumentative essays they wrote. The Graphical Debate-tool in the CRoCiCL-project is also a tool for argument mapping in which students could collaboratively specify pro-arguments, con-arguments, supports and refutations with regard to two (given) positions. However, the spatial structure and representation of the connections between the elements were fixed and the relative argumentative strength of the positions was visualized. Furthermore, students could differentiate between the relative weights of supporting or refuting arguments. The Graphical Debate-tool resulted in better grounded and conceptually correct argumentative essays, and in learning effects on a knowledge post test, but did not significantly affect the collaborative deliberation between the students and was not valued very highly.

We assume that these differences can be – at least partly – explained by the representational guidance both tools offer. The specificity of the weighting of the arguments available in the GD-tool directs the students towards the relative strength of the arguments. The feedback given by the GD-tool about the relative strength of positions and arguments and the complexity of the representation further heightens the representational guidance. Furthermore, the perspective of the debate as a sort of battle field with advancing and retracting units supports the view of a debate as competing positions with justifications and supports for each side. In our view, the greater representational guidance offered by the GD-tool may partly explain why students in the CRoCiCL-project performed better than students working with the Diagram in the COSAR-project. Further research on whether these changes in specificity and perspective actually can be observed in the understanding and thinking of students working with the Graphical Debate-tool could support the representational guidance hypothesis.

It should be kept in mind that the Diagram and Graphical Debate-tool were not compared directly in an experiment. As Table 2 shows, there were differences and similarities between both studies. The question whether the differences between both studies can account for the difference in effectiveness is difficult to answer. Looking at Table 2, the most important differences concerned the size of the groups, the duration of the project, the subject of the task, and the operationalization of the dependent variables. It is of course possible that the difference in for example group size (dyads for COSAR, mostly triads for CRoCiCL) influenced the effectiveness of the tools. However, it is regularly found that smaller groups perform better than larger groups (e.g., Schellens & Valcke, 2006), possibly due to the fact that in larger groups coordination is more difficult . This would mean that the working condition in the COSAR-project would have been better – not worse.

In the COSAR-project the students had to use the Diagram-tool to organize positions and arguments found in internet and newspaper sources with regard to societal debates (organ donation and cloning). In contrast, in the CRoCiCL-project the students had to use the GD-tool to organize positions and arguments found in historical sources about a debate on early Christianity. Although the subject differed (social sciences and history), the task was similar (writing an argumentative essay) and meant for the same class level in secondary education. So it is not likely that differences in subject can explain the differences in effect.

Further research is needed however, to ascertain the precise impact of representational guidance on collaborative construction of argumentation maps.

WORDS: 6995

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Table 1. Features of the argumentation maps compared between the two studies.

	COSAR-project: Diagram	**CRoCiCL-project: Graphical Debate-tool**
Features of the argumentation map		
• Positioning of elements	Free – anywhere on screen	Constrained by tool
• Guidance - ontology	Elements of an argumentation (position, argument pro, argument contra, support, refutation, conclusion) and relations between them	Elements of a debate (position, argument, support, refutation)
• Guidance – perspective	Argumentation as concept map: Construction of own arguments and arguments found in sources	Argumentation as battle field: Reconstructing a debate from arguments found in sources
• Guidance – specificity	No feedback about strength of argumentation	Feedback about strength of argumentation, attention for weight of arguments
• Guidance – precision	Larger number of elements	Smaller number of elements
• Guidance – modality	Graphical and textual	Graphical and textual

Table 2. Comparison of the features of the COSAR- and CRoCiCL-study.

	COSAR-study: Diagram	**CRoCiCL-study: Graphical Debate-tool**
Features of the study		
• Assignment to groups	Random	Random
• Group size	Dyads	Mostly groups of three
• Task	Writing task based on sources	Writing task based on sources
• Duration	4 to 6 lessons	8 lessons
• Subject	Humanities: Social studies	Humanities: History
• Control condition(s)	Basic environment augmented with Outline and/or Advisor or basic environment only	Basic environment augmented with Textual Debate-tool
• Dependent variables	Quality of written texts, collaborative process focused on task-related and meta-cognitive activities	Quality of written texts, collaborative process focused on task-related, meta-cognitive, social, and meta-social activities, quality of representation, post-test performance
• Control variables	Pre-test of writing and argumentation skills	Pre-test on subject matter knowledge

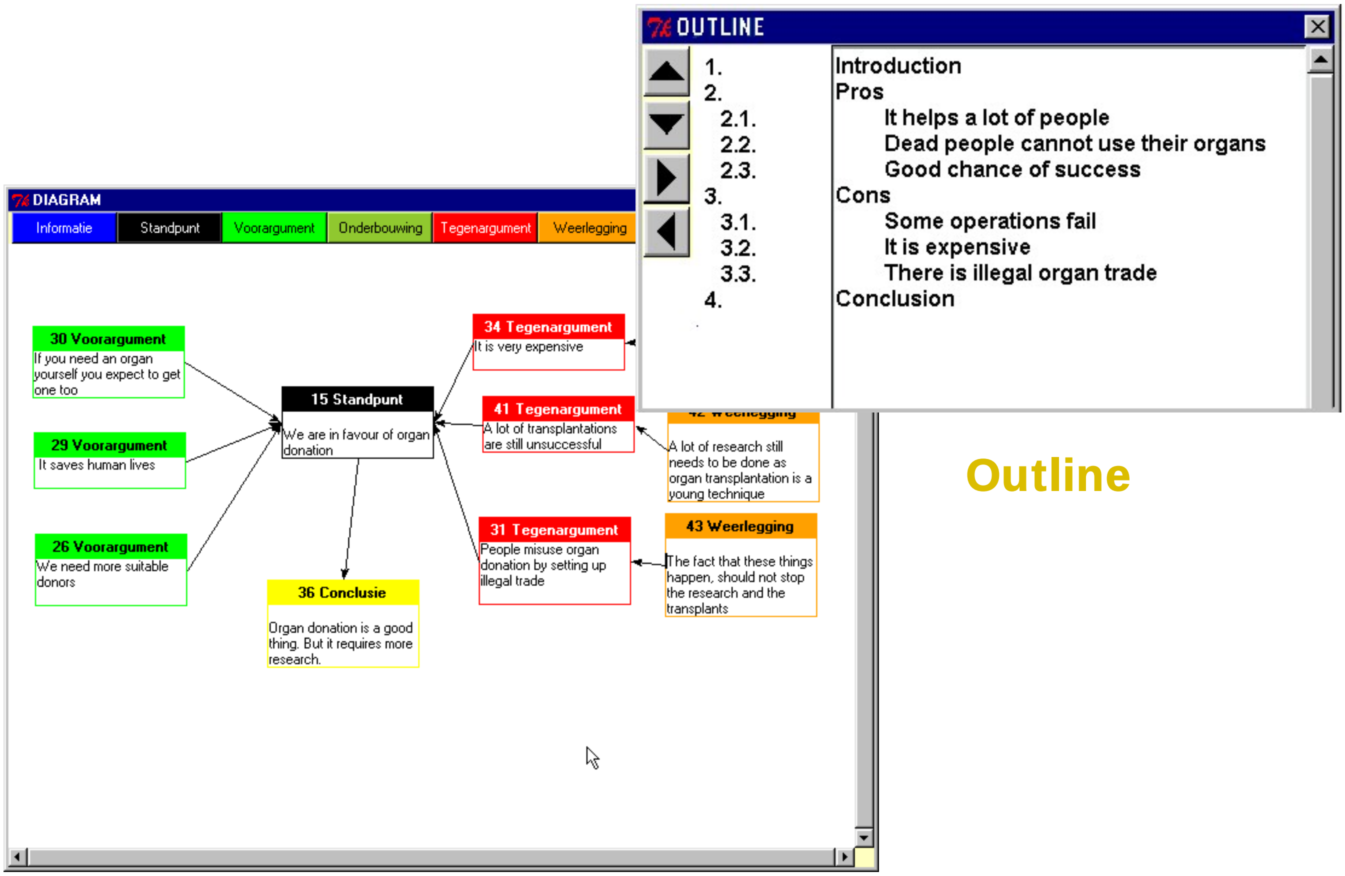
Table 3. Experimental Design.

Abbreviation	Condition	Tools & facilities	No. dyads	Year
C	Control	Basic TC3	39	1
D	Diagram	Basic TC3 + Diagram	17	2
DA	Diagram Advisor	Basic TC3 + Diagram + Advisor	26	2
DO	Diagram Outline	Basic TC3 + Diagram + Outline	23	2
DOA	Diagram Outline Advisor	Basic TC3 + Diagram + Outline + Advisor	11	2
O	Outline	Basic TC3 + Outline	18	2
OA	Outline Advisor	Basic TC3 + Outline + Advisor	11	2

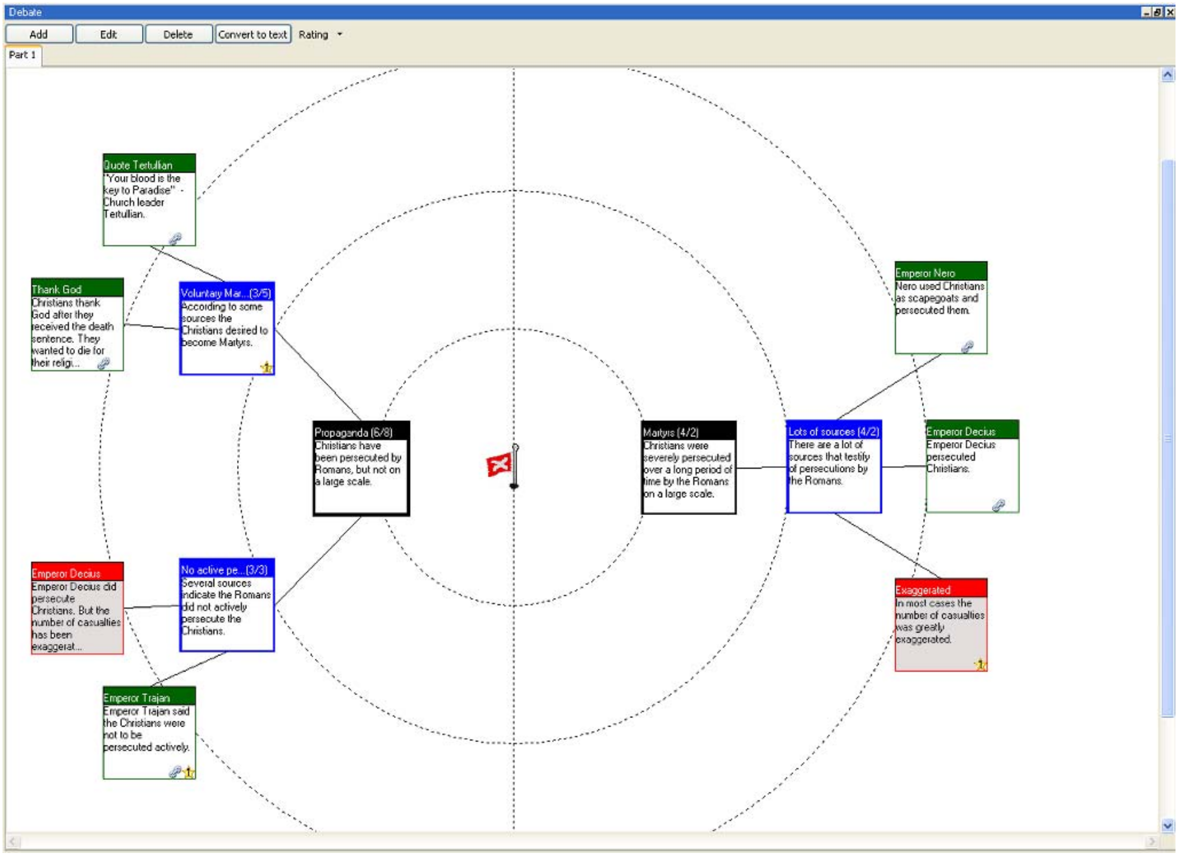
Table 4. Descriptive Statistics for Text Quality per Condition.

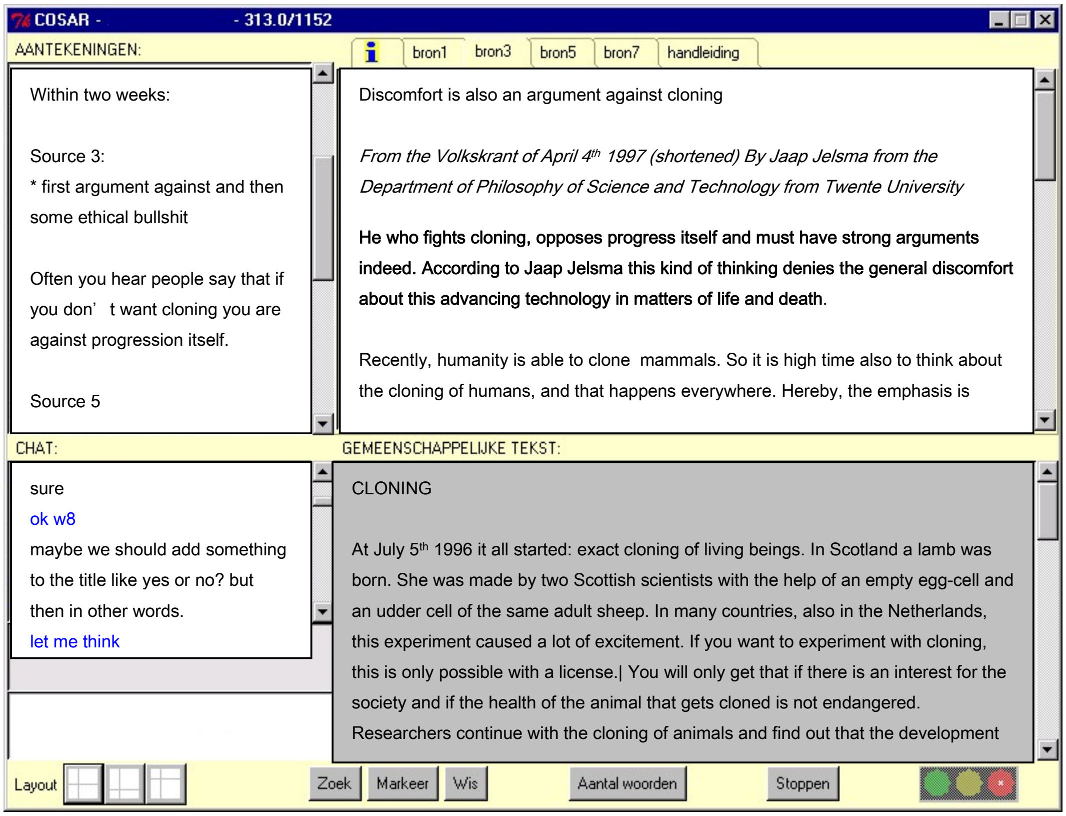
Condition	*n*	Textual structure		Segment argumentation		Overall argumentation		Audience focus	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Control	39	6.76	1.13	6.19	1.36	5.75	2.37	6.20	2.10
Diagram	17	6.71	.97	5.63	1.34	6.81	2.29	5.81	1.84
Diagram + Advisor	26	6.03	.82	5.49	1.34	6.41	2.07	6.01	1.64
Diagram + Outline	23	6.44	.83	5.64	1.32	6.16	2.25	6.20	1.60
Diagram + Outline + Advisor	11	7.15	.88	5.42	.84	5.76	1.69	5.57	1.00
Outline	18	6.59	1.00	5.90	1.06	5.74	1.80	6.04	1.95
Outline + Advisor	11	6.49	.83	6.34	.94	5.76	1.52	6.59	1.90
Total	145	6.56	1.00	5.83	1.28	6.06	2.13	6.08	1.81

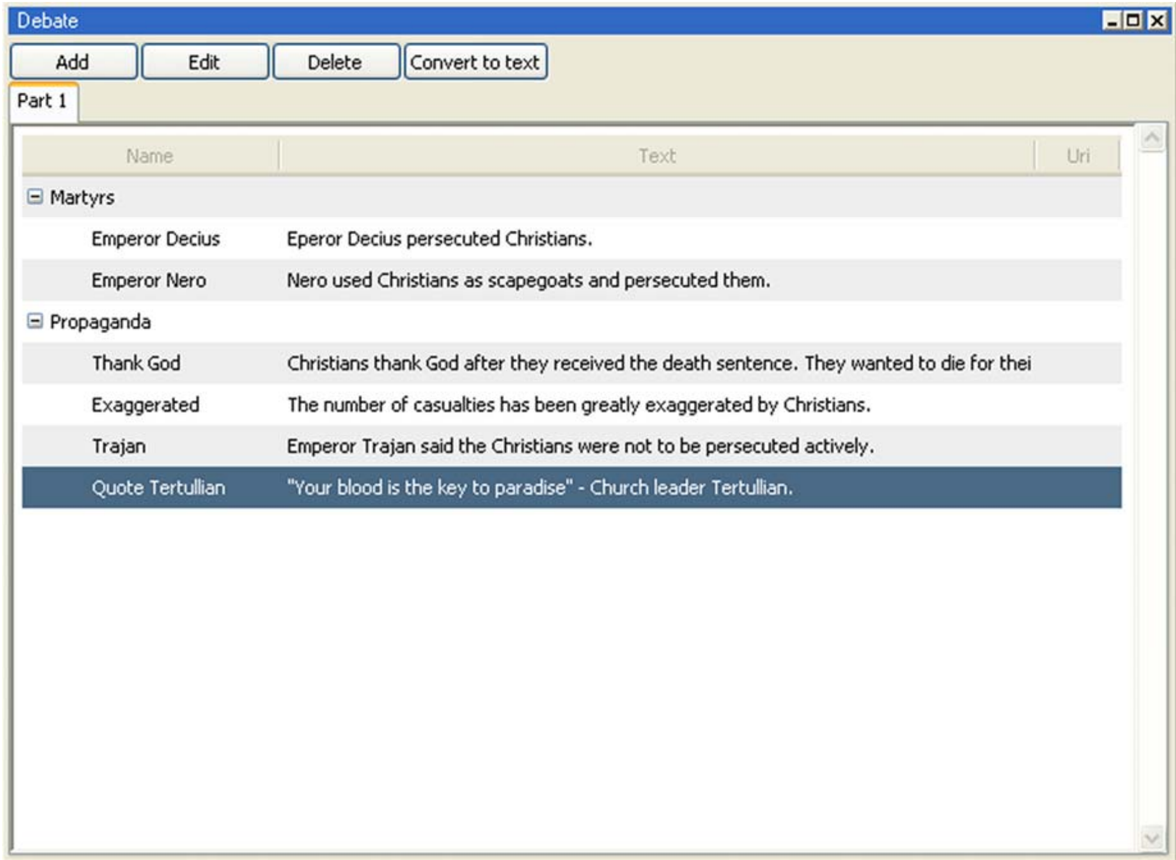
Figure captions


OUTLINE
1. Introduction
2. Pros
2.1. It helps a lot of people
2.2. Dead people cannot use their organs
2.3. Good chance of success
3. Cons
3.1. Some operations fail
3.2. It is expensive
3.3. There is illegal organ trade
4. Conclusion
DIAGRAM
Informatie
Standpunt
Voorargument
Onderbouwing
Tegenargument
Weerlegging
30 Voorargument
If you need an organ yourself you expect to get one too
29 Voorargument
It saves human lives
26 Voorargument
We need more suitable donors
15 Standpunt
We are in favour of organ donation
36 Conclusie
Organ donation is a good thing. But it requires more research.
34 Tegenargument
It is very expensive
41 Tegenargument
A lot of transplantations are still unsuccessful
A lot of research still needs to be done as organ transplantation is a young technique
31 Tegenargument
People misuse organ donation by setting up illegal trade
43 Weerlegging
The fact that these things happen, should not stop the research and the transplants

Outline


Debate
Add
Edit
Delete
Convert to text
Rating
Part 1
Quote Tertullian
"Your blood is the key to Paradise" - Church leader Tertullian.
Thank God
Christians thank God after they received the death sentence. They wanted to die for their religi...
Voluntary Mar...(3/5)
According to some sources the Christians desired to become Martyrs.
Propaganda (6/8)
Christians have been persecuted by Romans, but not on a large scale.
Emperor Decius
Emperor Decius did persecute Christians. But the number of casualties has been exaggerat...
No active pe...(3/3)
Several sources indicate the Romans did not actively persecute the Christians.
Emperor Trajan
Emperor Trajan said the Christians were not to be persecuted actively.
Martyrs (4/2)
Christians were severely persecuted over a long period of time by the Romans on a large scale.
Lots of sources (4/2)
There are a lot of sources that testify of persecutions by the Romans.
Emperor Nero
Nero used Christians as scapegoats and persecuted them.
Emperor Decius
Emperor Decius persecuted Christians.
Exaggerated
In most cases the number of casualties was greatly exaggerated.


COSAR - - 313.0/1152
AANTEKENINGEN:
bron1
bron3
bron5
bron7
handleiding
Within two weeks:
Source 3:
* first argument against and then some ethical bullshit
Often you hear people say that if you don' t want cloning you are against progression itself.
Source 5
Discomfort is also an argument against cloning
From the Volkskrant of April 4th 1997 (shortened) By Jaap Jelsma from the Department of Philosophy of Science and Technology from Twente University
He who fights cloning, opposes progress itself and must have strong arguments indeed. According to Jaap Jelsma this kind of thinking denies the general discomfort about this advancing technology in matters of life and death.
Recently, humanity is able to clone mammals. So it is high time also to think about the cloning of humans, and that happens everywhere. Hereby, the emphasis is
CHAT:
sure
ok w8
maybe we should add something to the title like yes or no? but then in other words.
let me think
GEMEENSCHAPPELIJKE TEKST:
CLONING
At July 5th 1996 it all started: exact cloning of living beings. In Scotland a lamb was born. She was made by two Scottish scientists with the help of an empty egg-cell and an udder cell of the same adult sheep. In many countries, also in the Netherlands, this experiment caused a lot of excitement. If you want to experiment with cloning, this is only possible with a license.| You will only get that if there is an interest for the society and if the health of the animal that gets cloned is not endangered.
Researchers continue with the cloning of animals and find out that the development
Layout
Zoek
Markeer
Wis
Aantal woorden
Stoppen


Debate
Add
Edit
Delete
Convert to text
Part 1
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Text
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Martyrs
Emperor Decius
Eperor Decius persecuted Christians.
Emperor Nero
Nero used Christians as scapegoats and persecuted them.
Propaganda
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"Your blood is the key to paradise" - Church leader Tertullian.