Boundary conditions for applying argumentative diagrams

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Abstract: In this paper, we examine two factors that may influence the use of diagrams in computer-supported collaborative argumentation-based learning: students' preference for and ability to construct and read argumentative diagrams as opposed to argumentative texts, and the complexity level of presented information. Fifty-two high school students and 74 undergraduates completed a questionnaire on preference for argumentative texts or diagrams with different levels of difficulty. The high school students were also asked to construct texts and diagrams. Results show that preference for textual or diagrammatic representation depends on the level of difficulty of the represented information. The results suggest that learning with argumentative diagrams is only perceived to be beneficial with a medium level of information complexity. Sub optimal diagram construction in our previous studies on computer-supported collaborative learning may have been due to the complexity of the information.

Introduction

Computer-supported collaborative argumentation-based learning is described as an activity in which two or more people construct knowledge by discussing a topic in a computer-environment. People learn from argumentative interaction because it involves reasoning instead of merely retrieving information from memory (Andriessen, Baker & Suthers, 2003). They have to explicitate their thoughts, need to look at information from different sides, and search for causes and relations in the topic under discussion.

The broader and deeper learners' discussions, the more they can learn. However, good discussions do not automatically occur. Most people have difficulties with argumentation, especially with looking at a topic from different perspectives, and countering viewpoints (Chan, 2001: Felton & Kuhn, 2001). One reason for these difficulties is that argumentation is not linear, and consequently, it is hard to get a good grip on the space of debate through temporal linear discussion. Argumentative diagrams can be used to support argumentation-based learning. An argumentative diagram displays arguments in boxes, and relations between these arguments in arrows. There are various advantages to diagrams. For example, a diagram can represent the structure of the argument and the relations between different viewpoints and arguments, or be the basis for further discussion. However, less is known about the boundary conditions for applying diagrams. Students seem to not always exploit the benefits of argumentative diagrams (e.g., Munneke, Van Amelsvoort & Andriessen, 2003). They are very apt at understanding how to create a diagram, but they seem not to understand its possible added value of structure and relations for guiding discussions and learning.

We wanted to know if and when students consider argumentative diagrams useful for learning. We investigated two possible boundary conditions. First, we examined students' preference for and ability to work with diagrams as opposed to text. Research into visual and verbal learning is not new (e.g., Sternberg & Zhang, 2001; Mayer & Massa, 2003). However, two problems arise in applying these studies to argumentative diagrams. Firstly, the term 'visual' is not accurate for describing argumentative diagrams, since these kinds of diagrams are very 'texty'. Argumentative diagrams are both verbal and visual. To our knowledge, there is no questionnaire available that investigates students' preference and ability for argumentative diagrams as opposed to plain argumentative text. Therefore, we constructed one ourselves. Secondly, we believe that an important factor in students' preference and ability is complexity level of the information represented. Students may not consider argumentative diagrams beneficial when the information is very complex, because this impairs structure and overview. Therefore, we also investigated students' preference and ability while varying information complexity.

Study 1

Method

Fifty-two high school students (23 boys and 29 girls) participated in the study. They were asked to complete a questionnaire before engaging in a discussion task with chat and diagram. The questionnaire consisted of two parts. The first part asked about preference for either texts or diagrams and consisted of seven questions. The first question asked for students' general preference for information presented in text or diagram. In the other six questions, information was presented in both text and diagram (see Figure 1), with three different levels of information complexity. Students were asked to choose the representation they preferred, and to indicate level of difficulty of understanding the two representations on a 5-point Likertscale. The second part about ability consisted of three assignments in which students were asked to construct a diagram from text or write a text from a diagram.

I think she is suited for this job. She had the required education, has over five years of relevant work experience and has excellent communication skills. However, recruiting her is very expensive because she has been working for a long time.

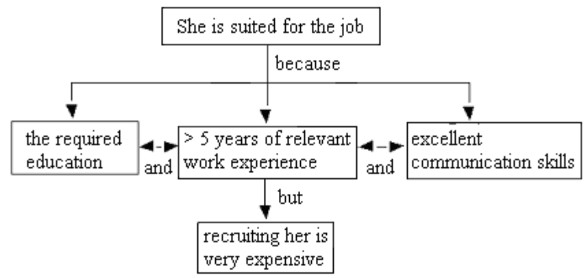

Figure 1. Example of a question (textual and diagrammatic representation).

Results

Reliability of the questionnaire was good, Crohnbach's alpha ranging from .72 to .82 when distinguishing between the questions on preference and complexity level. The interrater-reliability for the ability part of the questionnaire was .77 (Cohen's kappa).

On the first question, 64.7% of the students indicated a general preference for verbal information, and 35.3% for diagrammatic information. A score on general preference for verbal information correlated highly with perceiving the textual information as easier than the diagrammatic information. However, when the complexity level was low or high, students tended to prefer textual information, while when the complexity level was medium, they preferred diagrammatic information.

Students' ability to construct texts from diagrams and diagrams from texts also related to the information complexity. At the lowest level of information complexity, 51 out of 52 students scored the highest possible score. At the highest level of information complexity, 4% scored low, 71% scored medium, and 21% scored high. There was no correlation between preference and ability, nor between students' score on the questionnaire and their performance on the collaborative argumentation-based learning task.

Study 2

Method

Seventy-four undergraduate psychology students were asked to complete the first part of the questionnaire to investigate the question 'Do preferences for textual or diagrammatic information change with complexity level?' further. Part one was extended with two questions, to create four different complexity levels (easy – medium – complex – very complex).

Results

When asked what representation students preferred in general, 72.6% chose verbal information, and 27.4% chose graphical information. On the five-point Likertscales students indicated that textual information (M = 1.86, SD = .64) was easier than diagrammatic information (M = 2.56, SD = .84). Level of perceived difficulty of understanding ranged from 1.16 to 2.27 for the textual information, and 2.24 to 3.73 for the diagrammatic information.

Preference for textual or diagrammatic information was dependent on complexity level: while only 20.9% of the students preferred diagrammatic over textual information when information was at the extreme ends of complexity-level (easy or very complex), 55.5% preferred diagrammatic over textual information when it was medium or complex. Students who indicated a general preference for *verbal* information preferred the textual representation at the first and last two levels of difficulty, but the diagrammatic representation at the medium level of difficulty. They always considered the textual representations to be easier than the diagrammatic representations.

Students who indicated a general preference for *graphical* information preferred the diagrammatic representation at the medium and difficult level, but the textual representation at the extreme ends of difficulty-level. In addition, they indicated diagrammatic information as easier than textual information only at the two middle levels of difficulty. In short, we found a curvilinear relation between preference for verbal or visual information and complexity of the represented information (see Figure 2)

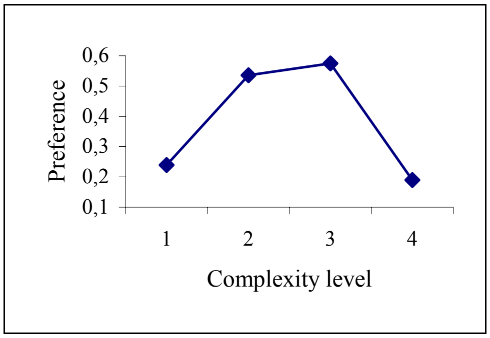

Figure 2. Preference for text (0) or diagram (1) related to complexity of information

Discussion

Reading and constructing argumentative diagrams is not easy. Although an argumentative diagram can be beneficial for collaborative argumentation-based learning, there are factors that can influence its beneficial effect. In this paper, we investigated students' preference for and ability to read and construct argumentative diagrams with different complexity levels. In general, most students prefer textual over graphic information. However, the complexity of information that is represented influences students' preferences. Argumentative diagrams are preferred over text when the represented information is of medium complexity. We also found that students' have more difficulty constructing diagrams from text when the information is complex. Our results imply that argumentative diagrams may only be useful for learning when the information (to be) represented is not too easy nor too complex. A very simple diagram does not have added value over text, because there is no need to see structure or relations. When a diagram is very complex, the benefits of showing structure and giving overview are not present anymore. Our studies investigated students' individual ideas on mostly presented diagrams. Further research is now needed to investigate whether this assertion stands when students construct diagrams in collaboration.

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