Scaffolding Computer Supported Argumentation Processes through Mini Map Based Interaction Techniques

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Abstract. Recent prior studies with argumentation systems have shown that, unfortunately, with larger learner groups using argumentation software over longer periods of time, argument maps inevitably increase greatly in size and complexity, often leading to learner confusion. To help users understand and navigate within large and complex argument maps, we implemented an initial version of mini maps within an existing tested argumentation system. This is an implementation of the general usability pattern “overview + detail”. In addition, in order to facilitate the interaction with larger argument maps, the “anchor principle” has been implemented to define an anchor area in a workspace. Evaluation studies showed that, using mini-maps and anchors, the orientation of students could be improved.

Keywords: usability patterns, argumentation systems, mini-maps.

1 Introduction

The successful application of argumentation skills is important in many aspects of life. Even though this importance has been widely recognized, many people have problems as they engage in argumentation activities (Kuhn, 1991). In addition, educating students in their argumentation abilities is often not explicitly done in schools (Osborne, 2010) or at least problematic, caused (among other factors) by teacher’s time: face-to-face tutoring is still the favored argumentation teaching method, but does not scale up well for larger groups.

One approach to deal with these issues is the use of argumentation systems (cf. Scheuer et al., 2010, for an overview). These tools engage (groups of) students in argumentation by representing the argument in a graphical fashion (e.g., using a graph, table/matrix, thread/tree) and allowing students to interact with this representation. By means of making explicit and sharing the representation of an argument (an argument map), which is typically only an abstract entity in people’s minds otherwise, these systems support discussions and are therefore helpful for learning how to argue.

However, recent prior studies with argumentation systems have shown that, unfortunately, with larger learner groups using argumentation software over longer periods of time, argument maps inevitably increase greatly in size and complexity,

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often leading to learner confusion (Niebuhr & Pinkwart, 2012). Especially if learners collaborate or join existing argumentation sessions, they frequently have problems with orientation in the group argument maps once these get larger.

How can the orientation of students using group argument maps be improved? To help users understand and navigate within large and complex argument maps, we implemented an initial version of mini maps within an existing tested argumentation system. This is an implementation of the general usability pattern “overview + detail” (Plaisant, Carr & Shneiderman, 1995; Tidwell, 2010). A mini map displays a small, summarized version of a (possibly quite complex) argument map and indicates the currently zoomed-in portion of that map with a rectangle.

Another approach that we recently implemented to facilitate the interaction with larger argument maps allows students to define an “anchor area” in a workspace, to which they can easily return by pressing a button “jump to anchor.” This enables learners to interrupt their current work, to move to another area on the map to read the arguments shown there, and then return to the original focus, all in just two clicks.

In the next section, we briefly review existing principles of orientation. In Section 3, we describe how mini-maps and anchors for argument maps have been implemented. Section 4 is devoted to evaluate whether the chosen orientation principles (mini-maps and anchors) really help students create argument maps. In Section 5, we discuss the implemented approaches and summarize our conclusions.

2 Principles of Orientation

In this section, we review several essential orientation principles which have been introduced in (Cockburn et al, 2009) and evaluated.

2.1 Mini-Map (Overview + Detail)

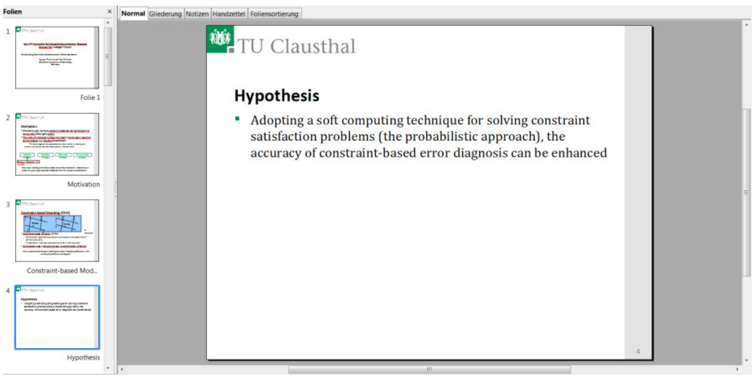

Fig. 1. An example of the principle "overview + detail"

The principle “overview + detail” describes two separated display areas. The user interacts with one of the two display areas, although the interaction on one display area impacts on another one. An example is an excerpt of the workspace of the program “OpenOffice.org Impress” (Figure 1). The overview is shown on the left area, and the detail is displayed on the right area. Based on a series of studies, Cockburn and colleagues (Cockburn et al., 2009) stated that the principle “overview + detail” is superior compared to other principles in the context of understanding documents. However, this principle has the disadvantage that the user needs time to establish a connection between the overview and the detail areas, and thus, this principle is less effective in other contexts such as driving simulations (Baudisch et al., 2002).

2.2 Zoom

Following this principle, the overview and the detail views are displayed on the same area. The user can change the perspective in several detail levels. For example, Google Maps (http://maps.google.de) provides a zoom tool to change the size of the focus point on the overview (Figure 2). This principle makes a temporal breakup in order to establish the connection between the overview and different detail views. Cockburn and Savage (2003) stated that the user needs to re-orientate after each zooming action. Bederson and Boltman (1999) suggested that animations can be used to reduce this problem, but cannot eliminate it.

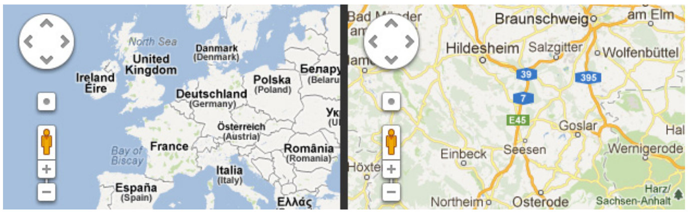

Fig. 2. An example of the principle "zoom"

2.3 Focus + Context

The previously presented principles make use of the spatial or temporal strategy to display the overview and the detail views separately. The principle “focus + context” bind the overview and the detail view on one display area. This principle can be found, for example, using the operating systems “Mac OS X”: when the mouse pointer moves to the dock, objects under the loupe will be enlarged (Figure 3). Cockburn and colleagues (2009) argued that applications of this principle suffer under a strained presentation in the focus area, because the scale and the distance between the objects are not displayed correctly. Thus, the so-called “fish-eye” effect occurs when the user focuses on an object.

Fig. 3. An example of the principle "focus + context"

2.4 Cue

The principle “cue” can be combined with all principles presented above and is often used with search tools. Here, the objects found by the search tool are marked. The type of presenting found objects differs (Kosara et al., 2001). For instance, areas can be highlighted with colors; or the not-found objects can be made diffuse visually, and thus, the unmarked objects are moved to the back in order to emphasize the existence of found objects.

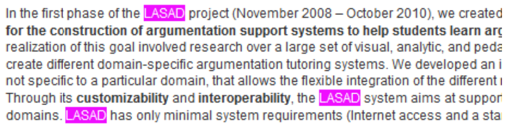

Fig. 4. An example of the principle "cue"

2.5 Anchor

Applying this principle, an anchor can be marked on a view area and represents a position to which the view can be switched back at any time. This principle can be compared with a bookmark when reading a book in order to mark a page without having to memorize the page number.

3 Implementation

We suppose that users are familiar with the “overview + detail” principle, because this principle has been applied in many web applications (e.g., Google Maps) and in computer games (e.g., Siedler IV). In addition, the requirements of LASAD are in accordance with many strategic computer games. That is, the actions the user performs should be synchronized with the overview area and the navigation on the overview area should be supported. In order to satisfy these requirements, we decided to apply the “overview + detail” principle and to implement the overview of group argument maps as mini-maps in LASAD to enhance the orientation.

Figures 5 and 6 show the current prototype implementation of two mini maps. The mini-map is positioned under the user list (at the right top corner). On the mini-map (Figure 5) we can identify two rectangles. The upper one marks the current anchor area and the lower one shows the current displayed detailed area.

We implemented an abstract mini-map version (Figure 5) and a detailed mini-map version (Figure 6). The detailed version of mini-map displays all colors and connection arrows in a minimized form. The abstract version of mini-map consists of only the boxes representing arguments; the connection arrows are not shown. In the abstract version, colors of the boxes are same and independent on the type of boxes (because in LASAD the color of each box represents an argument type and each connection arrow depends on the box' type and the arrow's type).

We developed two versions of mini-map, because one might hypothesize that, using detailed mini-maps the user would not benefit from the color and connection arrows in terms of orientation and thus, information displayed on a detailed mini-map could cause a high cognitive load for a user. The abstract version could be more useful, because abstract mini-maps display less information and help users focus on essential information (i.e., the argument boxes).

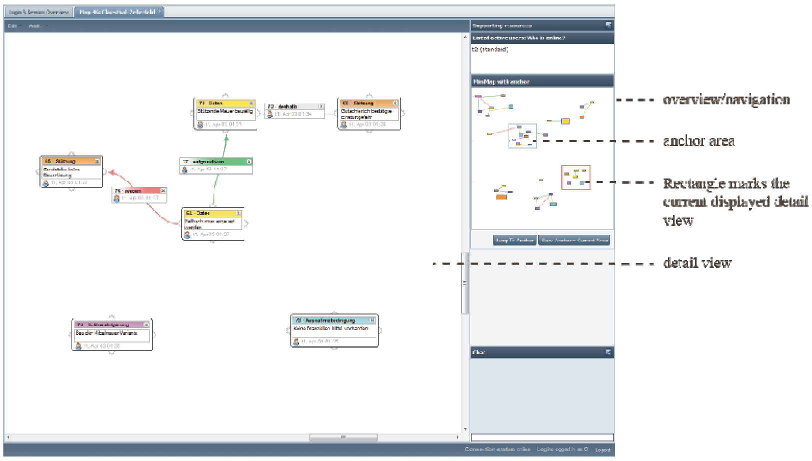

Fig. 5. The argumentation system LASAD with an abstract version of mini map (showing the overall argument map) and an anchor area

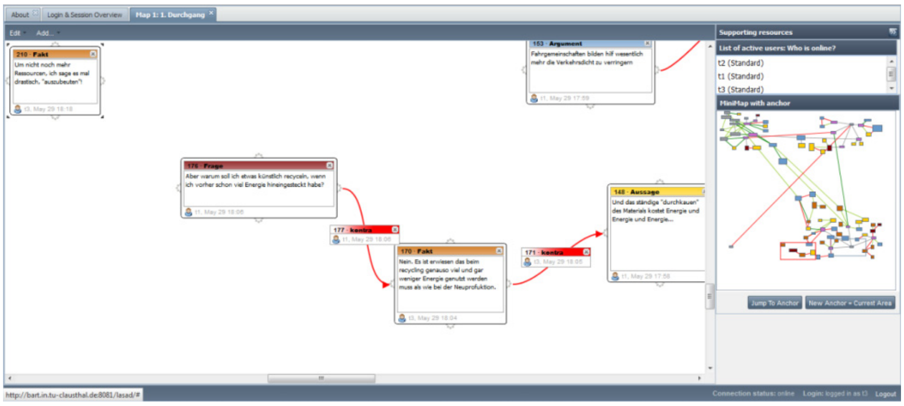

Fig. 6. The argumentation system LASAD with a detailed version of mini map

In addition to implementing the principle “overview + detail”, we applied the anchor principle to enhance the orientation in LASAD because using an anchor in this argumentation system the user has the possibility to mark any position on the argument map as an anchor and to jump back to a marked position on a large argument map immediately without having to move around the map. For this purpose we added two buttons below the mini-map (Figures 5 and 6). The left one will lead the user to the anchor position and clicking on the right one will mark the current view as a new anchor. Of course, we can think about a new variant with several anchors on a map and each anchor can be labeled with a name. But we suppose that this variant with several anchors would make the use less intuitive and slow down the usage of anchors, because the user needs to find out which anchor will be moved to next. This needs further investigation.

4 Evaluation

We conducted an evaluation study to determine how mini-maps enhance the usability and the orientation in the context of a computer-supported argumentation system like LASAD. We evaluated the effectiveness of mini maps by testing three hypotheses:

1. The creation of an argument map deployed with mini maps is at least 10% faster than without;
2. The reaction time on contributions made by other users to an argument map deployed with mini maps is at least 10% faster than without;
3. The attractiveness of the argumentation learning system LASAD integrated with mini maps is at least 5% higher than without.

4.1 Design

We invited 24 students and divided them randomly into three conditions, each with 8 persons: A) a control group using the LASAD software without mini maps, B) an experimental group with abstract mini maps, and C) an experimental group with detailed mini maps. The experiment session consisted of two parts: 1) group argumentation and 2) single argumentation.

In the first part, participants were asked to carry out an election campaign and to represent one of the four political parties in Germany (CDU, SPD, Green, Piraten). The participants were asked to make their own arguments using the software in a competitive setting where each participant in a group had to support a specific pre-assigned political position. The participants started on one of the four corners of a large argument map (5000x5000 Pixel) and had one hour for the election campaign. During the second part of the experiment, on each individual argument map, a contribution with the content “alternative energy source” has been initiated. Twelve other contributions (of which six arguments are pro and the rest are contra alternative energy sources) in this context were also prepared. The participants should select the arguments and model them using the LASAD tool appropriately (i.e., assigning pro/contra arguments to the correct box type and connecting the boxes to the topic “alternative energy source”). We captured the computer screen of each participant in order to determine the time participants required for creating an argumentation map (Hypotheses 1 and 2).

For Hypothesis 3 we applied the "AttrakDiff" model (Burmester et al., 2002) to measure the attractiveness of LASAD. The goal of this model is to assess the pragmatic quality (PQ) (e.g., controllable), the hedonic quality in terms of identity (HQ-I) (valuable), and of stimulation (HQ-S) (innovative), and attractiveness (ATT) (simpatico). For this purpose, all participants were required to answer a questionnaire after finishing the second part of the experiment.

4.2 Results

Hypothesis 1

Table 1. Time required for creating a map

Condition	Mean	Variance	Difference
A	06:29 min	01:46 min	
B	05:00 min	00:47 min	-22.96 %
C	04:49 min	01:10 min	-25.79 %

From Table 1 we can notice that the mean time the experimental groups B and C required to create a map (the second part of the experiment) is about 20% less than the control group A. The difference of time requirements between the experimental groups (B and C) and the control group is significant (Table 2) at the significance level of 5% (We applied the t-test method to perform all significance tests for this evaluation study). As a conclusion, Hypothesis 1 is confirmed: the orientation in LASAD using mini maps improves the creation of argument maps at least 10% faster than the usage of an argumentation system without deploying them.

Table 2. Significant test

Comparison	A vs. B	A vs. C	B vs. C
t-Test	0.05	0.04	0.4

Hypothesis 2

In the first part of the experiment, each participant was asked to start with an initial corner of a map. The time each participant required from the creation of the first element to the first observation of a new corner is measured. The results are shown in Table 3 and Table 4.

Table 3. Reaction time on a new corner area

Condition	Mean	Variance	Difference
A	07:05 min	04:28 min	
B	06:20 min	06:09 min	-10.54%
C	04:56 min	03:12 min	-30.19 %

The mean required time for reaction on a new corner area of the experimental groups B and C was about 10% and 30% less than the control group A, respectively. However, the difference of time required for reaction on a new corner between the groups is not statistically significant (Table 4). The reason for this non-significance might be explained by the fact that the variance of reaction time is too large, i.e., the behavior between participants varies remarkably: several participants dwelled very long time at their own corner area and others joined quickly in new areas. As a consequence, Hypothesis 2 cannot be confirmed.

Table 4. Significance tests for reaction time on a new corner

Comparison	A vs. B	A vs. C	B vs. C
t-Test	0.42	0.21	0.34

Hypothesis 3

Statistically, the difference between conditions A and B as well as between conditions A and C in terms of four dimensions (PQ, HQ-I, HQ-S, and ATT) was not significant at a significance level of 5%.

When comparing between conditions B and C, the difference of the hedonic quality in terms of identity (HQ-I) (valuable) and of stimulation (HQ-S) was not significant. On the contrary, with respect to the dimensions of pragmatic quality (PQ) and attractiveness (ATT), the difference between conditions B and C was significant.

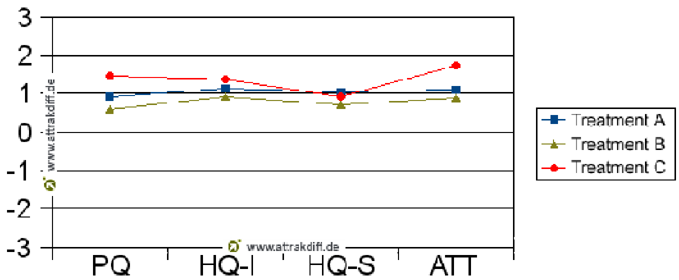

Fig. 7. The mean values of AttrakDiff

Figure 7 summarizes the assessment of participants with regard to the attractiveness of using mini-maps. The scale of values for assessing the attractiveness varies between -3 and 3. We identified that the experimental group B rated LASAD worse than the control group A on all indicators. A possible explanation is that abstract mini-maps could have affected the general view of LASAD negatively, and thus, the effect occurred that LASAD seemed to the participants be a preliminary prototype only. On the contrast, the experimental group C rated LASAD better than the control group A on three indicators except in the context of stimulation (HQ-S).

However, the difference between the experimental group C and the control group A was not significant on all four indicators, so that Hypothesis 3, which claims that the attractiveness of an argumentation system deployed with mini-maps is at least 5% higher than without them, cannot be confirmed.

In addition, from Figure 7 we can learn that the difference between condition B (abstract mini-maps) and condition C (detailed mini-maps) is larger than the difference between conditions A and C. Especially, condition C was significantly better than condition B with respect to the dimensions pragmatic quality (PQ) and attractiveness (ATT). That is, the version with abstract mini-maps has less pragmatic quality and is less attractive than the version with detailed mini-maps.

5 Conclusion

We have enhanced the computer-supported argumentation system LASAD with mini-maps which implement the principle "overview + detail" and the possibility to specify anchors on an argument map. The goal was to improve the orientation for users when working with (group) argument maps.

The contribution of this paper is three-fold. First, using mini maps the orientation in LASAD improved by at least 10%. Second, although not statistically significant, using mini-maps, in most cases the mean of required time for reaction on a new corner area of an argument map was lower than without using them. Third, users of LASAD deployed with detail mini-maps rated the system better than the group without using mini-maps on three dimensions: pragmatic quality, the hedonic quality in terms of identity, and attractiveness.

In the future, we will test the usability of LASAD on devices which support touch technology.

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