Usability requirements for exploratory learning environments: The case of educational argumentation systems

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Abstract. Learning to argue requires a creative, explorative learning process by working out the nature of argumentation. In the field of argumentation learning, several online collaborative argumentation tools with different user interface styles exist. The empirical results on the success of these systems so far were quite mixed. This paper presents the results of a cognitive walkthrough study performed on the LASAD system, which led to usability requirements and design challenges for educational argumentation systems. One of these challenges is how to provide learners with a better overview of an argumentation. This is needed to improve awareness of new contributions and to assist learners when exploring argumentations. We sketch approaches to improve overview by different representations and by providing a scripting engine enabling the students to work more concentrated and guided on their tasks.

Keywords: Explorative Environment, Collaborative Argumentation, Educational Argumentation System, Usability

1 Introduction

For some time, the field of learning science research has focused on the educational benefits of argumentation (e.g., [1]). Understanding the syntax of argumentation models does help to choose right representations of argumentation model elements in collaborative argumentation systems. However, to understand argumentation, the semantics of these model elements has to be worked out, tested out and trained by real argumentation. For this reason, collaborative, explorative learning systems to learn argumentation are helpful in learning the syntax as well as training and learning the semantics of argumentation elements.

Particularly, collaborative argumentation [2] is seen as a method for teaching critical thinking, elaboration, and reasoning. Consequently, many educational tools for argumentation exist (see [3] for a recent survey). The user interfaces and interaction paradigms of these systems differ, as do results of empirical studies with these tools. One reason why the potential of online argumentation tools may not have been fully exploited yet (and why study results may differ) is the actual software used. Compared to face-to-face scenarios, learners in computer-aided learning settings are disadvantaged as they have to deal with software issues before they can benefit from the software and ”learn to argue”.

In order to determine potential obstacles (i.e., usability issues) specific to argumentation systems, we conducted two cognitive walkthrough studies during which we observed users of the LASAD software during their learning process. LASAD [4] is a software system to support students as they learn argumentation (see Fig. 1). It enables students to discuss and argue with peers over the web. Using LASAD, students can chat with each other, create visual argumentation maps, request support using a so-called feedback client, and they can also replay a previous argumentation session. An argumentation map is space, on which argumentation elements can be posted as visual representations, e.g. as a box. Which types of argumentation elements can be used on a map is defined by an underlying argumentation model. This model may vary from domain – there are several proven argumentation models like Toulmin's argumentation model.

The elements are used to structure the argumentation into predefined (argumentation model dependent) basic elements, represented as boxes and their relations. In a predefined Toulmin's argumentation model a learner may choose a data box, a claim box, or a rebuttal box. He may link a data box together with a claim box by a qualifier link (see Fig. 1). The more demanding phase of learning to argue is the deductive task in learning the semantics of these boxes, which means using them in a right way to build appropriate arguments resulting in a good argumentation. This paper focuses on how students and teachers

Fig. 1. User interface of the LASAD System – the student's view

would like to use the LASAD system. We recognized three simple principles about what users are missing in such a collaborative argumentation tool and what prevents them from focusing on learning to argue. Based on these aspects we suggest approaches to increase usability and learnability to support learners and teachers in using a collaborative argumentation tool like LASAD.

In the following, we first describe the walkthrough study focusing on its resulting aspects. Afterwards we provide our approaches to support learners.

2 Evaluating the users' needs

In previous studies investigating the efficiency and effectivity of argumentation learning we observed that LASAD users have to get used to the argumentation system before they learn to argue. After analyzing different studies and argumentation systems we wanted to derive, what hinders learners and what teachers are struggling with when they are preparing learning sessions. Thus we prepared a cognitive walkthrough [5], a well known Usability inspection technique.

We conducted our studies with two groups: one consisting of 12 students, the other consisting of 5 teachers. Using predefined tasks (e.g. explore an argument, visualize an argument, etc.), the walkthrough was carried out to identify problems of the LASAD system. Our most important findings can be summarized by three aspects: orientation, awareness of peer contributions, and differentiation.

2.1 Orientation

Whenever learners collaborate to generate content, the structure of this content may become chaotic, resulting from the complexity of the content as well as from an increasing number of contributions within a short period of time or within a limited space in the user interface. Since arguing is a deductive process, much space is needed to represent many argumentation elements during an argumentation. Argumentation maps created by learning groups take a lot of space on screen. One of the problems is that each learner typically only is capable of focusing on a small excerpt from the whole argumentation at a time and thus easily loses orientation. Figure 2 illustrates this problem. In our walkthrough learners consequently stated "I feel lost" or "where is my argument I have been working on?". Moreover, we cannot assume that all users are present during the complete argumentation process: thus learners joining an argumentation at a later point in time need to be able to orientate quickly.

2.2 Awareness of peer contributions

Whenever learners argue online, they add content (e.g. arguments, or rebuttals) at different positions within the argumentation map. One of the problems here is that the students may not be aware of content, which is added (or modified) at another place of the argumentation map. Indeed, we observed in the cognitive walkthrough as well as in other studies like [6] "island discussions", where students discussed in several places of the argumentation map without connecting their contributions to others (see Fig. 2). Not being aware of peer contributions leads to such situations where parts of the discussion fade out for a group of learners, or where identical discussions appear at different locations, decreasing the argumentation quality as well as the learning effect.

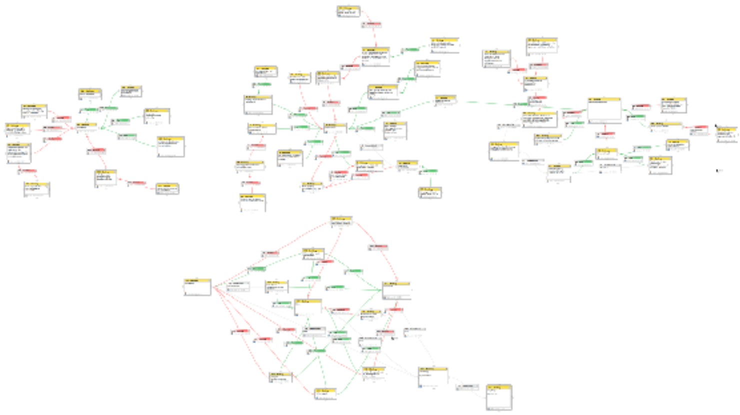

Fig. 2. Structure of argumentation map developed in a group argumentation session

2.3 Differentiation

Learners may rejoin a discussion they have been involved in before.Thus, they need to quickly find their own contributions and to recognize other's actions. Some statements made during our walkthrough illustrate this need: "I can't find my argument, it's lost", or "why does he use my cursor?" (stated as a comment related to indistinguishable awareness cursors). Thus, content contributed by a learner should be presented in a way that clearly separates it from somebody else's contributions. This enables learners to find their own contributions even in large argumentations. The need for visualization of ownership affects the visualization of argumentation elements as well as the communication functions of the system (e.g. cursor changes, when used as pointer by other learners).

3 Addressing the users' needs

As presented above, users need more orientation, they need more awareness of other contributions, and they need more differentiation of their contributions. Addressing these needs, a collaborative argumentation system – like other explorative learning systems – can be greatly improved. In the following we will sketch our approaches to address these aspects.

3.1 Orientation – ease exploring and information gathering

To improve orientation in a collaborative argumentation system means to assist learners exploring an argumentation map and to support the organization of argumentation elements. This will also enable learners to get an overview of an ongoing argumentations easily, if they (re-)join an argumentation in progress.

Learning argumentation consist of two parts: first, learning the syntax of an argumentation model to use the correct vocabulary for argumentation elements like claims, grounds, rebuttals or backings in Toulmin's argumentation model. Second, it means to understand the semantics of these argumentation model elements. In a graphical representation, as it is common in classical argumentation systems, this means choosing the right box (named like an argumentation model element), *and* understanding how different model elements play together to build an argumentation by "linking the boxes". Choosing and combining argumentation elements is a creative process. When using a collaborative argumentation system, the learner in addition has to perform a transfer process to transfer the argumentation in his mind into their graphical representations. Additionally, the arrangement and location of an argumentation element may have a semantic meaning: a learner may group argumentation elements with similar topics by moving them into the same area of an argumentation map.

Considering the creative process and these semantic dimensions an argumentation map contains, it is obvious that the representation of the argumentation elements, must not be reorganized or changed by the system to improve orientation. Looking for another solution, we discovered approaches in the software engineering field, especially in usability engineering. Here proven solutions for recurring usability problems are described in so called interaction patterns. A pattern called "Overview beside Detail" [7, 8] suggests having a "detail view" and an overview. The overview shows shrunk version of the overall picture while the detail view provides a zoomed part of the overview display in more details.

Applying this pattern, we provide a mini map for our argumentation map, to ease orientation in argumentations. It displays a simplified structure of the argumentation map and highlights the detailed view's area using a rectangle. Figure 3 shows a prototypical implementation of the mini map in LASAD. A mini map eases orientation and navigation within the argumentation map. However the process of learning to argue does not consist of a single argumentation but of a consecutive order of argumentation tasks. Thus, a further step is to provide orientation to learners in their task fulfillment. This means that we need to support coordination between different task steps to enable a better overview about the task fulfilled within an argumentation map.

As Weinberger states in [9] collaborative learners supported by a script can outperform individual learners. Thus, we suggest supporting collaborative learners by a script in our collaborative argumentation learning system. This enables learners to keep the overview of their task and to perform better.

Existing process oriented learning scripts define connections between phases, tasks, roles or groups, within special conditions or modes, and with resources (e.g. [10, 11]). Tutors may specify, which phases can be fulfilled by a group or a role - in which conditions with which task and resources, as well as the transition of theses phases. Such a script is intended to implement a pedagogical goal within one or more collaborative learning systems.

To ensure that sequences defined in these scripts don't restrict a learner's actions too much, like Dillenbourg warns in [11], we encourage the tutors to define tasks in correspondence to learning goals. Tutors can enter tasks as well as corresponding learning goals when defining a script.

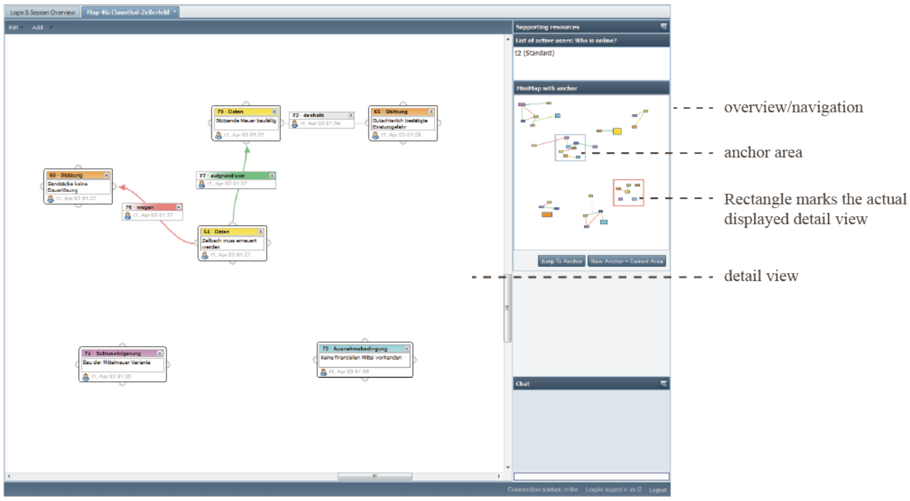

Fig. 3. Screenshot of LASAD system with the detailed view displaying current argumentation space and the mini map showing the overall argumentation map (the anchor area is explained in 3.2).

Defining learning goals provides a benefit for learners: The learning goals can be displayed next to their tasks, acting as a guideline. By considering this guideline, learners will get an impression, what the result of a specific task should be. This is expected to be enough guidance without restricting learners' creativity. Our script will be instructive, not restrictive. Thus, learners are still able to choose appropriate actions to fulfill their tasks and to reach their learning goals.

It is well known from goal setting theory that people with specific goals will perform better than without goals [12]. This is one main motivation, why we chose this approach regarding our scripting engine.

3.2 Awareness of peer contribution – recognizing what is going on

Having several learners arguing on a single map, each learner tends to search for free space to arrange his argumentation elements. They concentrate on their own argumentation elements, not realizing other learners' contribution.

If something happens in the actual displayed argumentation map part, in LASAD a learner will see added or changed content highlighted by a green frame. If something happens out of this area, it is more challenging for the learner to track changes. Currently in LASAD the only way for learners to track such activities is reading chat messages or message boxes, which appear at the user interface. Learners tend to recognize these chat messages late – they have phases of reading chat messages and phases working on their argumentation elements.

As described above, we introduced a mini map to improve the overview of the argumentation. This mini map displays the whole argumentation space, while a

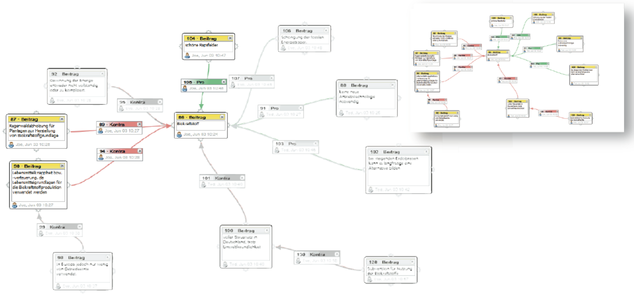

Fig. 4. Sketch, how a grayed out map part could help learners to find own contributions.

bigger space displays a zoomed part in a more detailed view. By updating the mini map during the argumentation process, learners have a complete overview of the argumentation and are aware of what is going on where. They see where arguments are added, reducing the risk of "argumentation islands".

In addition we introduced an anchor area. This means, that a learner may define a currently shown detail area as his anchor area. Whenever a learner explores the overall argumentation space, he may return to his anchor area by one mouse click. By this, we want to improve interaction with other learners.

3.3 Differentiation – personal and others' contributions

Learners need to quickly discover own contributions and to recognize others' actions, especially in larger argumentations. They also have to be able to recognize, if the activity they see (e.g. a moving mouse cursor) is caused by themselves or by other learners. Thus, we derive the following two requirements: First, content (argumentation elements) needs to be presented in a way that clearly separates learner A's from learner B's content. Second, actions should be presented in a way clearly separating learner A's from learner B's actions.

To address the first requirement we introduce highlighting and search mechanisms, enabling learners to display and navigate through their own content. A visual filter will highlight a learner's content and gray out or remove content from other learners. Figure 4 sketches how an argumentation map part looks like when a filter grays out content from other learners improving content differentiation.

To address the second need we display group actions in a more contrasting way. We do already support a group cursor, but it has to be made more obvious for learners, that this cursor is not a specific learner's cursor. We do show locks of argumentation elements when someone is adding content. These locks should be more differentiated: it should be visible who caused them.

These are examples of changes we will implement to improve action differentiation. These changes will be made with sensitivity and user tests: If they are too colorful and "noisy", they may hinder students to learn effectively with the argumentation learning system. If they are too small, they won't show an effect.

4 Implications

We identified user problems in our collaborative argumentation learning system, which can also be found in other exploratory environments. Having identified three key aspects of learners' needs we are now implementing the suggested approaches in a prototype. To ensure their effects we will evaluate whether the modified LASAD system supports learners in a better way.

However, there are some more general results of the cognitive walkthroughs that may constitute challenges for the designers of explorative collaborative learning systems like educational argumentation systems.

First, the optimal degree of intrusiveness for further awareness mechanisms is hard to determine: If messages for ongoing actions are too disturbing, learners could be interrupted in their thoughts which is undesirable for argumentation tasks – if they fade in the background, they won't be noticed and have no effect.

A similar problem is related to the differentiation visualization: How colorful and different should it be to be noticed by learners without disturbing them?

Finally, the combination of the three principles is a challenge that requires trade-offs: a high degree of awareness and differentiation takes screen space (and cognitive capacity of users) and thus makes orientation more difficult. Further research will be required to address these three challenges.

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