Automated and Adaptive Support for Educational Discussions: Results to Guide in Making this a Reality

Oliver Scheuer, Bruce M. McLaren, Armin Weinberger, Saarland University, Saarbrücken, Germany
Email: o.scheuer@mx.uni-saarland.de, bmclaren@cs.cmu.edu, a.weinberger@mx.uni-saarland.de

Abstract: A potential way to enhance CSCL systems with adaptive support is to capitalize on the pre-structuring of student input that comes from the use of sentence openers and diagram references. An analysis of students' use of structuring elements reveals differences in the level of their adoption and a variety of ways in which students interpreted their task and used the learning environment for their purposes. We discuss possible enhancements to facilitate automated interpretation that might guide students towards more effective discussions.

Introduction

A focus in CSCL has been on promoting high-quality forms of argumentation (Scheuer, Loll, Pinkwart, & McLaren, 2010). Precondition for *adaptively* supporting argumentation is the complex task of analyzing verbal discourse automatically. We explore the potential of two structuring elements to facilitate such automated analyses: *sentence openers* (*SOs*) and *argument diagrams*. Combining these two elements helps classify chat contributions along two crucial dimensions: (1) *communicative intentions* (through SOs), and (2) *propositional content* (through diagram references; *DRs*). We present results regarding students' use of SOs and DRs and discuss changes to our learning environment that would maximize the amount and precision of information that can be derived from student discussions. The goal of our research is to use inferences made from a heuristic interpretation of SOs and DRs to inform automated feedback to help students have more effective discussions.

Background

SO-based interfaces are designed to encourage specific interaction patterns considered conducive to learning. Students choose from short predefined phrases when composing new messages (e.g., "I disagree because," and "Can you explain why/how"). It has been proposed to also exploit SOs to make inferences regarding dialogue structure and meaning (Soller, 2001). Yet, there are several problems in the interpretation of SOs. (1) When the use of SOs is optional, students might not use them, so no inferences can be drawn (Lazonder, Wilhelm, and Ootes, 2003). (2) When the use of SOs is obligatory, students might misuse them when none of the offered choices satisfies their needs (Soller, 2001). (3) Even if the SO matches the message body, multiple interpretations might be possible (Lazonder et al., 2003). (4) Messages might express multiple ideas at once, which not only violates guidelines regarding efficient communication but also hampers the interpretation of SOs (Israel & Aiken, 2007). Our second structuring element is argument diagrams. Diagrams decompose the discussion domain into referable chunks of knowledge (e.g., claims, arguments, and facts). While students use the diagrams as a resource and guide during their discussions (Suthers & Hundhausen, 2003), they can also explicitly *refer* to diagram elements, e.g., to create a joint focus of attention with their learning partner.

Method

The study used a control group design with 22 dyads. Dyads used the LASAD argument-diagramming system to analyze and discuss two conflicting texts on climate ethics. The learning task comprised four phases: analyzing (phase 1; individual), discussing (phase 2), and interrelating (phase 3) the two texts with the goal to generate a joint conclusion (phase 4). The treatment group (12 dyads) used the full version of the system including a chat tool with SOs. The control group (10 dyads) used an ablated version of the system with a standard chat with no SOs. As for SOs, we analyzed the treatment group alone (the control group did not include SOs). As for DRs, we analyzed phases 2 and 3 only (phase 1 is an individual phase; phase 4 is about students' own opinions with less need to use DRs). DRs were coded based on references to diagram box numbers in the chat. Results regarding process and learning are reported in Scheuer, McLaren, Weinberger, and Niebuhr (in press).

Results

Students used an SO in one out of five chat messages (20%) with notable differences between dyads: five dyads made frequent use (> 25% SO messages), three dyads made occasional use (> 10% SO messages), and four dyads rarely used SOs (< 10% SO messages). Note that 25% SO messages is already considerable since a substantial portion of each discussion (about 1/3) is not about the subject matter. Students within the same dyads significantly influenced each other in terms of the extent of SO uses ($ICC = 0.83$; $F = 10.6$; $p < .001$). That is, if one student decided to use (or not use) SOs, it was very likely that the other student decided so as well. Although students rarely misused SOs (4%), some SOs were used with varying meanings. For instance, the SO

"Could you explain to me" was used not only to elicit explanations in a neutral way, but also to raise concerns or objections against previous points. The SO "For instance" was used not only to illustrate some previous point, but also to list one or more exemplary arguments to support a previous point. Some messages expressed multiple independent ideas at once. For instance, some students presented an argument and asked a question within the same message. In other cases, students provided several independent reasons to support a claim in the same message. Finally, the point of reference of messages was not always clear. For instance, sometimes the SO "A supporting argument is" was used to present an argument regarding a recent claim. In other cases, they referred to the general discussion topic. In either case, supporting SOs are typically used to support one's own position and opposing SOs to oppose the partner's position, a useful heuristic.

Across all dyads about 12% of all messages contained a DR, again, with notable differences between dyads: five dyads made frequent use (> 25% DR messages), five dyads made occasional use (> 10% DR messages), and twelve dyads rarely made use of DRs (< 10% DR messages). That is, almost half of all dyads (45%) used DRs in their contributions at least occasionally. A rate of 10%, or even 25%, is substantial, since about 1/3 of all messages are not about the subject matter. It is also not unusual that students exchange multiple messages regarding one and the same diagram element. Also, we did not require that students use DRs, we only hinted at the possibility to do so. DRs were used in a variety of ways. For instance, DRs were added to messages to cite the diagram element as the source of the information used in the message, to comment on the content of a diagram element, or as a shortcut / placeholder for the content of the referenced element, which saves the effort of typing the entire statement of the DR into the chat. One student complained about this practice, annoyed with searching for the referenced contents in the diagram. Finally, students had different approaches about where to post DRs: in the very message that contained a statement based on or related to the referenced element, or in a separate message before or after that message.

Discussion

In summary, we found that most students made reasonable use of SOs and DRs. Whether the extent of use provides sufficient information to effectively support students with automated feedback is an empirical question still to be investigated. Even if students make frequent use of the provided structures, they may use them in different ways, giving rise to multiple possible interpretations, a difficulty in generating precise feedback. A more effective and uniform usage may be achieved through: (1) *message categories* (clearer interpretation of intention compared to SOs), (2) *threaded discussions* (unambiguous point of reference of messages), (3) *more explicit instructions* (clearer expectations), (4) *incentives for use* (e.g., highlighting of referenced diagram elements when hovering over chat messages to save time-consuming search in the diagram), and (5) *explicit feedback* (e.g., sending of messages to students who rarely use SOs).

The generation of effective feedback is only one concern in the design of adaptive CSCL systems and sometimes is at odds with usability and pedagogical concerns. That is, improving the precision of an automated analysis may lead to undesirable side effects. Some relevant tradeoffs are: A more restrictive script / user interface may: (pros) (1) provide better-structured user inputs to inform the automated analysis of interactions in a more precise way and (2) guide students towards modes of interaction closer to the ideal model of interaction the instructional designer had in mind vs. (cons) (1) lead to more mechanical and unnatural forms of interactions, or obstruct fruitful forms of interaction, and (2) lead to user frustration, decreased engagement, and unintended forms of use, particularly when users perceive the structure as a burden rather than an aid.

References

Israel, J., & Aiken, R. (2007). Supporting collaborative learning with an intelligent web-based system. *Intl. J. of Artificial Intelligence in Education, 17*, 3-40.

Lazonder, A. W., Wilhelm, P., & Ootes, S. A. W. (2003). Using Sentence Openers to Foster Student Interaction in Computer-Mediated Learning Environments. *Computers & Education, 41(3)*, 291-308.

Scheuer, O., Loll, F., Pinkwart, N., & McLaren, B.M. (2010). Computer-Supported Argumentation: A Review of the State of the Art. *Intl. J. of Computer-Supported Collaborative Learning, 5*(1), 43-102.

Scheuer, O., McLaren, B.M., Weinberger, A., & Niebuhr, S. (in press). Promoting Critical, Elaborative Discussions through a Collaboration Script and Argument Diagrams. *Instructional Science*.

Soller, A. (2001). Supporting social interaction in an intelligent collaborative learning system. *Intl. J. of Artificial Intelligence in Education, 12*, 40-62.

Suthers, D. D., & Hundhausen, C. (2003). An experimental study of the effects of representational guidance on collaborative learning processes. *Journal of the Learning Sciences, 12*(2), 183-219.

Acknowledgments

This work was supported by the German Research Foundation under the grant "LASAD—Learning to Argue: Generalized Support Across Domains."