Facilitating classroom argumentation with computer technology

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Abstract

In the last two decades or so, argumentation has become a prominent topic of educational reform and psychological and educational research. It has been recognized as an important competence to be developed and practiced in classrooms, to lie at the basis of thinking and reasoning within and across different disciplines, and to foster thinking skills and complex learning processes. Unfortunately, however, when compared to normative criteria and models of good argumentation, most people demonstrate only rudimentary argumentation competencies. The question then is how educational activities and experiences can be designed to foster these competencies effectively? In this contribution, I will review developments from a number of research strands that have addressed this question, with a specific focus on the use of computer-technology to foster dialogic argumentation for educational purposes. Based on theoretical distinctions and recent empirical findings, the affordances and limitations of computer technology for dialogic argumentation are reviewed. Finally, I will outline some of the unresolved issues and new challenges in this relatively new field of research.

Keywords: argumentation, computer-supported collaborative learning, design features, computer-mediated communication
1. Introduction: Why does education need argumentation?

Argumentation has become a prominent topic of psycho-educational research and of educational reform initiatives within the last twenty years or so. As is often the case when a term is taken up by a broader variety of professional networks and interest groups, it is not always clear whether all parties involved are referring to the same phenomenon. Drawing on pragmatic-dialectic approaches to the study of argumentation, it is defined here as a social and verbal activity of reason in which interlocutors attempt to decrease or increase the acceptability of one or more propositions (Baker, 2003; Van Eemeren et al, 1996; Walton, 2006). There are several aspects to this definition that are well-worth emphasizing (Schwarz & Asterhan, 2010): Argumentation is first and foremost defined by its goal, which is the establishment of the epistemic status of one or more assertions (Baker, 2003). As opposed to other forms of conflict resolution, such as for example physical coercion, participants attempt to reach this goal by engaging in verbal reasoning: They propose arguments in favor or against a certain thesis, standpoint, or solution (Walton, 2006). In argumentation, two or more standpoints, ideas or theses compete with one another. These may be distributed between different opponents, such as in a dispute, where each discussant defends a certain thesis, but they do not have to be. It should also be distinguished from other verbal activities of reason such as, for example, explanation which serves the goal of clarification (Osborne, 2011; Schwarz & Asterhan, 2010). Finally, argumentation is in essence a social activity that presupposes the presence of an audience (Leitao, 2000; van Eemeren et al, 1996; Walton, 2006). The existence of an audience may be directly observable by the senses, such as in argumentative dialogues or oral speeches in face-to-face settings, or it may be virtual, such as in essay writing, computer-mediated communication or even individual deliberation.

An increasing number of educational researchers, policy makers and practitioners have come to realize that argumentative practices should be a focus of learning and teaching in schools. First of all, argumentation has been recognized to lay at the basis of successful participation in a democratic society (e.g., Andrews, 1994; Michaels, O’Connor & Resnick, 2007; Schwarz & Asterhan, 2010). This was also true before the internet era, albeit more so for certain social groups than for others, but it is even more evident in the current globally connected society in which information is freely accessible for all and from all. In today’s global society, solutions to complex political, medical, and environmental problems have to be negotiated between multiple culturally, socio-economically and ethnically diverse parties (Michaels et al, 2007). Multiple perspectives and information sources have to be evaluated and weighed against each other before decisions can be made. Formal schooling should then offer students adequate opportunities to prepare themselves for this role and become familiar with the skills, norms and principles of argumentation.

The increased interest in argumentation also reflects current didactical developments in a number of school disciplines. Didactical experts from different disciplinary domains have come to realize that, since argumentation lies at the basis of scientific thinking and practices in their domain, classroom activities should reflect this. This trend is particularly strong in, but not limited to, science education (e.g., Duschl et al., 2007; Driver et al, 2000; Erduran & Jimenez-Aleixandre, 2007; Osborne, 2010). It is argued that instead of only teaching the accomplishments of a domain, that is the major explanations, findings and theories, students should also be taught about the process through which this knowledge was established (Osborne, 2010). This means learning about how evidence supports theory building, what is considered “good” evidence and
what the process is for establishing which of two competing explanations is more likely to be
correct. Teaching science as a process of inquiry and discovery is not enough, however. Students
need to understand the discursive modes of argumentation that are valued by the discipline and
the practices that are used by the discipline in order to construct knowledge, by engaging in such
practices themselves (Clark & Sampson, 2007; Duschl & Osborne, 2002).

Finally, there is mounting evidence from empirical research that participation in argumentative
discourse improves individual reasoning skills (e.g., Kuhn & Crowell, 2011; Mercer et al, 2004;
Reznitskaya et al, 2001). Recent research shows that under certain circumstances it may even
benefit processes of knowledge construction and conceptual understanding of complex academic

Unfortunately, however, the demands of skilled argumentation are considerable and research
shows that few individuals attain proficiency during adolescence and adulthood (Brem & Ripps,
2000; Felton & Kuhn, 2001; Jonassen & Kim, 2010; Kuhn, 1991; Kuhn & Udell, 2003; Perkins,
Faraday, & Bushey, 1991). For example, people find it difficult to separate between evidence
and explanation (Brem & Ripps, 2000), to provide adequate evidence for their claims (Bell &
Linn, 2000), and they tend to focus on providing evidence for their own claim while ignoring the
opponent’s claims (Felton & Kuhn, 2001; Kuhn & Udell, 2007). Students have particular
difficulty challenging and refuting arguments or simply to consider alternative ideas in science
domains (de Vries, Lund & Baker, 2002; Asterhan & Schwarz, 2009).

Even though interpersonal differences in cognitive ability are certainly likely to play a role (Voss
& Means, 1996), underdeveloped argumentative skills may be as much a matter of inadequate
practice and socialization than of ability. Currently, schools only offer very few opportunities to
practice and develop the skills, dispositions, norms and motivation for reasoned argumentation
(e.g., Duschl & Osborne, 2002; Mercer & Littleton, 2007). Students, especially those from
underserved populations, cannot be expected to just pick up on the norms and skills for
argumentation without sufficient modelling and practice. Indeed, an increasing body of research
has shown that when specifically designed activities become an integral part of the everyday
classroom experience, students can become quite capable in argumentation (e.g., Frijters et al,

During the first decade of this century, psycho-educational research of argumentation then
shifted from research on the nature and development of argumentation skills to research on
pedagogy and educational design for supporting argumentation. A great deal of this more
educationally oriented research focuses on the development of computer-supported collaborative
learning (CSCL) environments to facilitate and support argumentation in educational settings.
CSCL environments offer a range of features that are believed to facilitate and support
argumentation. This chapter reviews the research on computer-supported argumentation, with a
specific emphasis on how certain design features may facilitate the argumentation process. I will
conclude this chapter by outlining a number of venues for future research.

2. **Argumentation in computer-supported collaborative environments**

This section will review features of CSCL environments that are believed to facilitate student
argumentation, the rationale behind their development and the research on their benefits and
limitations. The organization of this review is feature-driven, with short descriptions of selected
CSCL environments for purposes of illustration only. Topic wise, I will discuss the affordances and limitations of different media-specific features, of several different software design features, and the role of teachers and teacher support in these online environments.

2.1 Affordances of the communication media

As anyone who has participated in instant messaging, email-based or forum board discussions will confirm, online communication is in many ways significantly different from its face-to-face (F2F), oral counterpart. It is suggested that some of these medium-specific characteristics may in and by themselves facilitate student argumentation, when compared to F2F communication settings (e.g., Asterhan & Eisenmann, in press; Kim, et al, 2007).

First of all, a great deal of the non-verbal cues that are present in F2F communication is absent in common textual formats of computer-mediated communication (Kiesler, Siegel & McGuire, 1984). Since these non-verbal cues are used to assess, among others, social status, computer-mediated communication has the potential of being more democratic (Herring, 2004). Research has shown that in online environments people are less inhibited, self-disclose more frequently, and are more inclined to reveal their personal, individual standpoints (Hamburger, & Ben-Artzi, 2000; Hamburger, Wainapel, & Fox, 2002; Suler, 2004) and to take academic risks (Blau & Caspi, 2008). Specifically with regard to argumentation, students are then expected to be more inclined to express dissenting ideas and be critical towards the standpoints and ideas of others, which are crucial feature of “good” argumentation.

It has also been argued that the ability to re-read and revise contributions - both before as well as after posting contributions - encourages reflection (Guiller, Durndell, & Ross, 2008; Kim, Anderson, Nguyen-Yahiel, & Archodidou, 2007). The ability to print out or revisit completed discussions has several pedagogical advantages: Students may be asked to review and evaluate their own or each other’s discussion contributions and compare them to models and criteria for “good” argumentation. In addition, the absence of non-verbal communication cues, such as facial expressions, body language and intonation, requires more effort to sustain, comprehend and engage in conversation. This has not been found to deter students (Tiene, 2000). In fact, it may have certain pedagogical benefits, such as the need to more concise, specific and explicit in communication. Indeed, several empirical studies have found that compared to F2F settings, participants in asynchronous online discussions were more explicit and showed higher rates of substantive and reasoned contributions (Jonassen & Kwon, 2001; Newman, Webb & Cochrane, 1995; Suthers, Hundhausen & Girardeau, 2003).

Finally, in most online communication environments, students do not need to compete for speaking rights, since they can post contributions simultaneously and at their own pace. This then often leads to increased and more egalitarian participation (Hampel, 2006; Weasenforth, Biesenbach-Lucas & Meloni, 2002). In a recent study we asked secondary school students to compare their experiences with face-to-face and online discussions in the classroom (Asterhan & Eisenmann, in press). Since students in regular classrooms are rarely given opportunities to participate in either, all students in this study participated in classrooms whose teachers participated in a project that promoted the implementation of dialogic argumentation in online and face-to-face classroom practices. We found that students reported on higher participation rates and more dialogic interaction with other students in the online discussion format. They also experienced fewer classroom disturbances and disciplinary interventions.
There are also disadvantages related to online communication. This is particularly true for the more commonly used discussion formats, where turn adjacency is based on chronological precedence (such as in instant messaging or threaded discussion boards). Conversational overlap can prove to be quite problematic in these environments, especially when used synchronously and in groups that have more than two participants: Unrelated messages from other participants often intervene between an initiating message and its response (Condon & Cech, 1996; Murray, 1989) and discussants tend to address recently posted messages (Hewitt, 2003). This sequential incoherence poses a substantial cognitive load for participants and causes rapid topic decay (Herring, 2001). Software design can provide solutions for these difficulties, however. Instead of limiting communication sequencing to a vertically organized, chronological order, interfaces can be designed such that they allow a flexible organization and interlinking of postings. For example, in discussion environments such as Digalo (Asterhan & Schwarz, 2010; Schwarz & Asterhan, 2011; Schwarz & de Groot, 2007), jigaDREW (Lund et al 2007) and Knowledge Forum (Scardamalia & Bereiter, 2006) participants are free to post their contributions anywhere in a two-dimensional discussion map and link it to any posting of their choice. With several different, but interconnected discussion threads developing simultaneously and students moving from one to the other, this flexibility is much needed.

In conclusion, online discussion formats may offer several advantages for dialogical argumentation that researchers have begun to explore. However, a word of caution is needed on empirical studies that directly compare the quality of dialogue in F2F and online communication formats. Reported results from such studies should always be interpreted with caution. Comparing the quality of face-to-face and computer-mediated dialogue empirically is a complex endeavour. The nature and processes of communication are too different to be assessed with a common coding methodology. In addition, differences in experimental settings often make proper comparisons very difficult. A study by Joiner and Jones (2003) nicely illustrates this difficulty. The results of this particular study showed that quality of student argumentation was higher in F2F than in asynchronous online settings. However, this difference cannot be attributed to the effect of the media per se: Students in the F2F condition were summoned to the lab to engage in argumentation for a fixed time interval (1 hour), and videotaped while doing so to record the discussion. Students in the asynchronous condition, on the other hand, could contribute to the discussion at their own convenience, how much and whenever they felt like it and from any location of their choice. The conversation protocol was automatically and unobtrusively logged by the software. The reported difference may be then as much a matter of student motivation as it may be of the medium.

In addition, more attention should be paid to the different affordances of asynchronous and synchronous modes of communication. Asynchronous tools allow people to read and post contributions at any point in time. They then allow students to spend more time on reflecting and constructing a well-founded and elaborate argument (Marttunen & Laurinen, 2001). Synchronous tools, on the other hand, enable real-time communication between people at a single point in time, at the same time. Interlocutors may share a physical space (co-located settings) or they may be physically distributed. Synchronous modes of communication allow immediate feedback and joint task coordination. Since it is closer to spoken conversation it is often experienced as more engaging (McAllister et al, 2004) and ensures higher participation and more contributions than asynchronous conferencing (Cress, Kimmerle & Hesse, 2010). Synchronous formats then seem to better serve tasks that require collaborative, dialogical
argumentation between students. However, more comparative, empirical research is needed to substantiate these suggestions.

2.2 Software design to support argumentation

Research on computer-supported collaborative learning is deeply rooted in constructivism, and guidance of group processes is often delegated to the design of online environments. This section will review different software features that have been particularly designed to support online student argumentation: computerized collaboration scripts, graphical displays, classifying messages and group composition.

2.2.1 Computerized collaboration scripts

A particularly influential approach CSCL research in recent years has been the computerized collaboration script approach (Fischer, Kollar, Haake, & Mandl, 2007). The main idea of computerized collaboration scripts is to promote productive, structured interaction by designing the environment such that they coerce collaborating students to engage in specific activities that might otherwise not naturally occur (Kollar, Fischer, & Hesse, 2006). This can be achieved by software design such as, for example, by blocking the ability to post a message until all group members have reacted, by prompting certain sequences of dialogue moves (e.g., claim – counterclaim – rebuttal), or by assigning and rotating specific responsibilities and roles (e.g., analyst and critic, to collaborating learners.

Different families of scripts have been designed and explored that can be coarsely categorized into macro and micro scripts (Dillenbourg & Tchounikine, 2007; Fischer et al., 2007). Macro scripts orchestrate learning activities by grouping and regrouping learners, distributing (different) resources and access rights, as well as sequencing different learning arrangements, e.g., intertwining individual with collaborative learning phases. Macro scripts organize groups and sequences of learning arrangements. Micro scripts support collaborative processes within a given task and group of learners, by specifying roles and activities. They inform learners what to do and how to engage in specific learning activities. This is typically accomplished by structuring the communication interface (Kollar et al., 2007; Stegmann et al., 2007; Weinberger et al., 2010). For example, in order to support the construction of single arguments, students may be asked to fill in claims, grounds and argument qualifications in specific windows (Weinberger et al, 2010). Micro scripts to support the construction of collaborative sequences, on the other hand, may ask students to alternately fill in a sequence of pre-set, labelled messages (e.g., claim, counterargument, rebuttal, integration).

Several studies have shown that software-embedded CSCL scripts may improve on-line group functioning (e.g., Rummel & Spada, 2005; Scardamalia & Bereiter, 1996; Stegmann et al., 2007; Weinberger, Ertl, Fischer & Mandl, 2005). However, results for individual pre-post effects of computerized scripting have been mixed, with few reporting positive results (Stegmann et al, 2007; Weinberger et al, 2010), and others showing no significant differences between scripted and unscripted conditions (e.g., Hron, Hesse, Cress & Giovis, 2000; Rummel et al, 2009; Weinberger et al, 2005)

Collaboration scripts have also been criticized: One critical issue is the degree of coercion in which scripts suggest or dictate interaction. Overly coercive micro scripts may dampen student
motivation (Rummel et al, 2009), they may interfere with their personal, possibly well functioning internally represented collaboration scripts (Kollar et al, 2007) and may prevent their independent, playful and exploratory thinking (Dillenbourg, 2002). The fact that only few studies have found effects of scripted conditions on subsequent individual outcomes may implicate that even though learners often comply with the scripts, they may do so without any genuine deep engagement.

2.2.2 Graphical representations

Another way to support argumentation is to help learners visualize arguments with graphical representations (Kirschner, Buckingham Shum, & Carr, 2003). Even though a variety of representations exists, the most common type in argumentation systems are diagrams (e.g., Belvedere (Suthers, 2003); Digalo (e.g., Asterhan et al., 2010); jigaDREW (Lund et al., 2007)). The nodes of such diagrams contain labelled textual content, such as “arguments”, “questions” and “evidence,” while the links represent relations between the constructs, such as “supports”, “opposes” or “neutral” (see Figure 1 for an illustration of a Digalo discussion map).

Larkin and Simon (1987) found that diagrammatic representations of information require less search, comprehension and inference compared to representing the information in sentences. With regard to argumentation, diagrammatic representations are considered to have several specific advantages: First of all, the different components of argument structure and the relations between them are more salient in diagrams then they are in text (Suthers, 2003; Suthers & Hundhausen, 2003). For example, separating a claim and the external evidence supporting that claim into two separate boxes and drawing a supporting relation between them may help students to distinguish between evidence and theory. Secondly, complex arguments may be better represented in diagrams since they support non-linear, non-sequential representations and multiple relations (Schwarz, Neuman, Gil & Ilya, 2000; van Amelsvoort et al., 2007). In addition, with visual clues such as different colors, shapes, relations and position in space, argumentation diagrams are believed to require less interpretation than reading argumentative texts. As Lund et al. (2007) concluded, “(...) marking one’s opinion is easier ‘on the fly’ (...) than when painstakingly locating and transposing arguments from chat.”

An important issue to consider is when and how to use argumentation diagrams during the course of a learning sequence. Students may be asked to construct a diagram in preparation for a discussion (e.g., Van Amelsvoort et al, 2007), or to build a diagram after the discussion phase, such that it represents the debate (Lund, et al, 2007) or a personal viewpoint. Research has shown that using multiple representations can lead to more abstract and generalizable knowledge (Ainsworth 1999). Similarly, using argumentation diagram as a means for representing the underlying structure of texts or discussion protocols requires students to analyse and organize textual information and is therefore likely to benefit learning (Lund et al., 2007). Indeed, results has shown that constructing argumentation diagrams either before or after the discussion improves argumentative quality, provided that students create them themselves and do not merely inspect diagrams that were created by others (van Amelsvoort et al., 2007).

Argumentation graphs may also be collaboratively constructed during the discussion phase. This usually means that the group collaboratively creates a diagram alongside a chat discussion (e.g.,
Munneke et al., 2007). In this set-up, students can freely choose to alternate between the two representations, the diagram and the textual debate, which appear in two separate boxes or windows on the screen. They often, but not always, receive instructions to use the argumentation diagram as a means for representing the underlying structure of the textual chat debate. Alternatively, discussions may be mediated through the graphical interface only, without a separate chat window. This is the case in software such as Digalo (e.g., Asterhan et al., 2010; Schwarz & Glassner, 2007), where the diagrammatic representation is the arena of the debate.

To date there are no empirical studies that have directly compared these two means of using diagrams during discussions (i.e., simultaneous use of both representations or communicating through a diagrammatic representation only). However, there is mounting evidence that the simultaneous coordination and alternation between the textual, sequential chat exchanges and a shared diagrammatic representation is very complex and may lead to cognitive overload (e.g., Lund et al., 2007; Munneke et al., 2007; Van Bruggen et al., 2002; Veerman & Treasure-Jones, 1999). Conducting discussions through means of diagrams only, on the other hand, does not seem to cause such problems. However, it may lead to cluttered and complex diagrams, especially if the number of participants is too high and the duration of discussions too long. From our extensive experience with Digalo in authentic school settings we have learned that discussions are optimal with 3-4 discussants and last between 20-30 minutes. Moreover, classroom activities with Digalo always include a summarizing phase in which students are asked to, for example, present their group’s main arguments to the class, write essays, evaluate discussion maps, or discuss a common conclusion in face-to-face mode. Activities of summary and consolidation such as these are often required, since coordinating a common conclusion that incorporates the different perspectives that were put forward during the discussion is a daunting task in online environments.

2.2.3 Classifying messages
Online argumentation may also be supported by constraining the discourse of learners by requiring them to organize their textual contributions from a menu of predefined sentence openers or functional classifier. These may include predefined sentence openers such as “I agree because…”, “Research shows…” “I believe…” (e.g., McAlister et al., 2004; Oh & Jonassen, 2007). Alternatively, they may require students to classify and label each posted message to a specific functional category, such as “argument”, “question”, “claim” (e.g., Asterhan, Schwarz & Gil, 2011; Jeong, 2005). In both cases, students’ options of the types of messages and responses they can post are restricted to a prescribed and stringent set of message categories presented within the discussion environment. After selecting a message classification from the menu, participants enter their text and post it to the discussion space. Even though they differ in the extent to which they allow learners freedom of action, the purposes of classified message constraints are very similar to those of micro-scripting: The primary purpose is to assist students in maintaining a task-oriented discussion based on some presumed model of good argumentation (Jeong & Joung, 2007). The second purpose of message classifications is to visualize the structure of arguments that are collaboratively constructed in the course of the discussion (Veerman, Andriessen, & Kansellaar, 1999). Finally, the act of deciding which functional classifier to attach to a textual contribution is thought to improve students’ meta-cognitive awareness to the elements and process of argumentation.
Results from studies that have empirically compared the effect of classified message constraints are few and the results have thus far been mixed. For example, Cho and Jonassen (2002) reported that requiring students to use predefined sentence openers increased the number of coherent arguments and resulted in more problem-solving activity. Positive results have also been reported by Schwarz and Glassner (2007) and McAlister et al (2003). In a study by Jeong and Joung (2007), on the other hand, students were asked to tag each discussion contribution from a prescribed set of message labels that categorized each contribution as argument, evidence, critique, or explanation. They found that message labels inhibited the processes needed to produce critical argumentation: Students who used message labels were 2–3 times less likely to challenge other students and 2–3 times less likely to respond back to challenges. The authors concluded that the “critique” label could have carried negative connotations and made the contributors seem overly confrontational. Students therefore avoided using these labels. Label for message constraints should then be carefully designed and align with local norms for civilized dialogue.

Another issue concerns the extent to which learners choose the right label for their messages. From our own experiences with synchronous Digalo discussions in secondary school classes, learners often make hasty decisions about which functional label to use and that these do not match the textual content of their postings (see also, Suthers, 2003). The research on constraining discourse with classified messages is relatively new. Even though they promise enhanced argumentation, more research is needed to confirm their effectiveness with regard to the three purposes that were outlined here: Improved argumentation during the interaction phase, improved ease of identifying argumentation during online discussions and improved procedural knowledge of argumentation.

2.2.4 Group arrangements

One of the central components of argumentation is the consideration of different perspectives. This may be facilitated by composing groups based on maximized heterogeneity of initial viewpoints, conceptions or opinions (deVries et al., 2002). Assessing students’ initial viewpoints and composing groups based on them usually is a painstaking task for teachers. Several software programs have been developed to automatize this process. For example, Jermann and Dillenbourg (2003) designed ArgueGraph, which identifies students’ opinions through a questionnaire and then represents them on a graph. Students are then automatically matched into pairs, based on the maximum distance between the opinions of two students. They demonstrated that groups composed in this manner showed higher engagement in argumentation. Clark and Sampson (2007) developed an additional component to an existing scientific inquiry environment. Students used a drop-down menu to build principles to describe data they had collected. These principles became the seed comments for the online discussions. The software sorted students into discussion groups with students who had built different principles to facilitate the consideration and critique of multiple perspectives. Compared to data from studies that assessed argumentative quality in F2F settings, Clark and Sampson (2007) showed that these online, personally-seeded discussions led to higher frequencies of complex argumentative moves, such as rebuttals.

However, it is not clear to what extent this difference may be attributed to the group composition, or to other aspects of the environment, such as the online group setting versus the F2F teacher-led classroom discourse. Furthermore it is not clear to what extent the forced posting
of students’ personal explanations, as opposed to just different explanations without further identification, is conducive or detrimental to argumentation. On the one hand, discussing and defending a personally proposed explanation or viewpoint may increase commitment and engagement with the topic. On the other, however, it may also turn the competition between ideas into a competition between individuals, as was suggested by data from a follow-up study by Clark and colleagues (Clark, d’Angelo & Menekse, 2009). The fear of losing face, of fellow students discussing one’s incomplete or even erroneous explanation may in fact impair the quality of argumentation and cause students to engage in ego-enhancing or ego-defensive behaviour (Asterhan, Butler & Schwarz, submitted). Future research should disentangle the potentially differential effects of these different design aspects.

An alternative way to facilitate argumentation through group composition is by distributing different roles among individual group members. These can be different functional roles within a group activity (e.g., Schellens, van Keer, de Wever, & Valcke, 2007; Weinberger et al., 2005), such as “analyst”, “summarizer”, “moderator”, and “defender”. Alternatively, students may be assigned to play the role of different representatives in a debate. For example, they may be asked to represent historical figures such as Lamarck and Darwin and discuss theories of evolution, or play the role of representatives of different interest groups. Role-playing may alleviate some of the emotional and social inhibitions that cause students to refrain from being critical and exploring different (unpopular) perspectives, without having to worry about social consequences and retaliations.

In a recent study, we asked 86 Israeli 9th graders to discuss the topic of (dis)obedience in the national defence forces (Asterhan & Gazit, in preparation). National military service is mandatory for all Israeli citizens over the age of 18, and questions regarding exemptions to conscription and boundaries of (dis)obedience regularly surface in public discourse. Moreover, since these students were expected to be drafted in 3 years’ time, the topic was particularly engaging for them. All students participated in a learning sequence that, spread out over several classes, exposed them to a range of different perspectives that were presented by different interest groups. They were then assigned to same-sex discussion groups of 3 to 4 students and participated in online, synchronous discussions on disobedience in the military service. In half of the groups, students were asked to represent one of the interest groups they had been exposed to during previous classes, e.g., an army spokesperson, a parent of a fallen soldier, a spokesperson of an anti-occupation organization, or a soldier. Students in the remaining groups were not given any roles. Results showed that compared to control groups, online dialogues of role-playing students were overall more critical and included more explanations. More interesting, however, these overall effects were mediated by gender: Even though male students’ discussion behaviour was not affected by role-playing, the quality of female students’ argumentation was significantly better in the role-playing condition. These results may reflect a general trend of differential role-playing effects for male and female students. However, it is also possible that such results are topic-specific: Since female students are less likely to take part in combat-related functions when joining the military service, they may feel less strongly committed to a certain position on the topic of disobedience than male students do, and may thus be more easily affected by efforts to

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1 Some ethnic minorities, such as Arab citizens, are exempted if they so please and other exceptions may be made on religious, physical or psychological grounds.
open them up to different perspectives. More research is then needed to further explore the effects of role-playing and of their potential interaction with gender.

2.3 Online teacher support for argumentation

Teachers plan, design and give feedback on students’ collaborative activities. They may also play an important role during these activities: They moderate, coach and guide groups of students. Whereas research on F2F settings has unequivocally shown the positive effects of carefully calibrated, non-intrusive human facilitation of small-group discussions on their quality (Webb, 2009), until recently the role of the human instructor in CSCL research had scarcely been considered (Lentell & O’Rourke, 2004; Lund, 2004). In an important analysis and synthesis of the literature on technology-enhanced learning, Puntambekar and Hubscher (2005) noted that even though many software tools provide novel techniques to support student learning, they often lack crucial features of genuine ‘scaffolding’, such as ongoing diagnosis, calibrated support, and progressive fading. Traditionally, genuine scaffolding had been accomplished by human experts, such as teachers. Not surprisingly, research on online argumentation has then recently taken a turn towards investigating the role of teacher or tutor guidance in online environments.

Human facilitation is particularly important for ill-defined problem solving activities that involve multiple participants, such as small group argumentation on social dilemmas and controversial topics. These activities do not have canonically correct answers or common misconceptions that can be easily recognized by a computer agent. The strength of a certain proposition or standpoint cannot be simply assessed by the appearance of linguistic markers only (e.g., using “but”, “to the contrary”, “evidence shows”). In addition, such discussions often touch upon personal value systems and emotions. Guiding such discussions then requires a deep understanding of rather complex group dynamics and subtleties. In a recent case study, Schwarz and Asterhan (in press) showed how human expertise and judgment is often called for in such tasks: (1) to adequately evaluate the social and motivational dimensions of these complex interpersonal situations; (2) to flexibly and instantly adapt support for individual and group processes in ways that were foreseen or unforeseen; and (3) to intervene in a matter that is sensitive to these subtleties.

The question is, however, how can teachers make sure that what goes on in the digital environments meets the intended educational goal of the activity? Student discussants and teachers may share a physical space (the classroom), but unless teachers go online themselves, they will have little knowledge about the content of the discussions. Online support and guidance of computer-mediated learning by a human instructor is generally referred to as e-moderation (Salmon, 2004). Nowadays, many tutors and teachers are asked to contribute to their institution’s online courses or to blend their F2F teaching with computer-mediated activities. Interest in e-moderation has then increased substantially in the last decade or so and a number of pedagogical frameworks have been developed (e.g., Goodyear, Salmon, Spector, Steeples & Tickner, 2001; Palloff & Pratt, 2001; Salmon, 2004). Most of these frameworks are based on extensive personal experience from e-course development in post-secondary education. In general, they aim to conceptualize the role of the human tutor in distant, online learning and provide helpful guidelines for newcomers to the field. They are therefore an important step forward. However, empirical research on e-moderation practices outside these settings is still relatively sparse and has only recently begun. This review will then discuss first findings from a new line of research.
2.3.1 Frequency of teacher interventions.

The e-moderation literature generally suggests that it is important that instructors play an active, visible part in online discussions, especially in distant, asynchronous settings (Berge, 1995; Salmon, 2004). Still, too much tutor intervention may dampen students’ motivation to actively participate. Mazzolini and Maddison (2003), for instance, showed that the number of postings contributed by the e-tutor was negatively related with length of discussions in an asynchronous discussion board environment. Similar findings have also been reported from face-to-face settings (Hogan, Nastasi & Pressley, 2000). However, the Mazzolini and Maddisson study (2003) failed to take in account one important aspect of e-moderation, namely the content of different tutor interventions. For example, interventions that contain direct, pedagogical support (i.e., tutor solved the issue and revealed the "correct" answers) may shorten discussions, whereas those that aim to increase interaction and responsiveness between participants may lead to longer discussions. To accurately characterize moderation practices the content and function of tutor-discussant(s) communications should be taken into account.

2.3.2 Content of teacher interventions

Pedagogical models of e-moderation have attempted to describe the many different goals that moderators have to accomplish (e.g., Anderson et al., 2001; Denise, Watland, Pirotte & Verday, 2004; Goodyear et al., 2001; Lund, 2004). These can broadly be summarized in the following five categories (Lund, 2004): Pedagogical support aims to improve students' learning, understanding and reasoning; Social (or emotional) support focuses on the social relations between discussants and on maintaining student motivation; Interaction support aims to maintain student participation and interaction; Managerial support focuses on task design, completion, and monitoring; and Technical support aims at detecting and assisting with operational and technical issues.

Dependent on the settings, different moderation goals will receive more or less emphasis: In distant e-learning such as adult e-courses, for example, learners are spatially and often temporally distributed, almost all communication is computer-mediated and asynchronous, and there are none-to-few F2F meetings. It is therefore not surprising, that pedagogical frameworks for support in such settings strongly emphasize motivation and socialization as crucial components for maintaining student engagement and preventing attrition (e.g., Paloff & Pratt, 2001; Salmon, 2004). When small-group online discussions are integrated in a sequence of F2F classroom activities, on the other hand, motivation and socialization are maintained through other channels and teacher moderation almost solely focuses on pedagogical and interaction support (Asterhan, 2011; Asterhan & Schwarz, 2010).

2.3.3 Form of teacher interventions

Research from a range of face-to-face settings such as peer tutoring (e.g., Chi, Siler, Jeong, Yamauchi, & Hausmann, 2001), peer collaboration (e.g., Gillies, 2004; Webb, et al., 2008) and teacher-guided classroom dialogue (e.g., Resnick et al., 2010; Yackel, 2002) has unequivocally shown the effectiveness of ‘what I will refer to here as- ‘generic instructor prompts’ to scaffold student reasoning and learning. Generic prompts such as “Why do you think that?”,” “Can you please elaborate?”,” “Can anyone think of a different explanation?” do not include any direct reference to topic content, but instead encourage students to continue, explicate and further
develop their own line of reasoning. Even though they have been found to be very effective for promoting student reasoning in face-to-face settings, the question remains whether this is also true for online settings. In a recent study (Asterhan & Schwarz, 2010), we explored this question by relating the characteristics of moderator interventions in a synchronous discussion environment with discussant responsiveness to these interventions and discussants’ subsequent evaluations of the moderator behaviour. We found that students did not appreciate, nor responded to moderators when they used generic prompts to scaffold student reasoning. Content-specific scaffolding prompts, on the other hand, were very effective at eliciting responses and were much appreciated by discussants. These included among others paraphrasing of discussant’s contribution and elaborating on it or strategically challenging students’ claims by posing content-specific critical questions that hinted at alternative viewpoints.

The results of this study, first and foremost, show that findings from one communication format cannot simply be transferred to another. Two different explanations were suggested for why generic scaffolding prompts did not seem to be successful in these settings (Asterhan & Schwarz, 2010): One possibility is that the lack of non-verbal cues, in combination with the scattered and non-chronological organization of threaded and/or diagram-based interfaces creates a temporal schism in inter-subjectivity between interlocutors of two adjacent discussion contributions. As a result, moderators may have to be more explicit and specific to re-establish this inter-subjectivity.

An alternative explanation focuses on how design shapes social expectations: In this study, discussants and moderators shared the same end-user environment in this study. Thus, the moderator’s comments appeared and persisted side-by-side with the discussants’ and were not spatially or graphically distinguished from them. Subsequent student evaluations of moderation practices seemed to suggest that generic prompting was perceived as annoying, since it was interpreted to indicate detachment and a lack of interest. Visually, the moderator’s postings were an integral part of the discussion map and were therefore perceived as part of the commonly constructed product, for which all participants shared a common responsibility. Generic scaffolding prompts (such as, “Could you elaborate some more?”) were then simply out of place. Thus, by not actively participating in the discussion, the moderator may not have been perceived as contributing sufficiently to the discussion.

2.3.4 Effects of moderation

Even though several studies have described e-moderation practices of peer discussions in blended learning settings (Asterhan, 2011; Asterhan & Schwarz, 2010; De Groot, in press; Schwarz & Asterhan, 2011; Walker, 2004) these did not compare conditions of guided and unguided discussions. It is therefore not possible to determine whether human guidance actually improves the quality of peer discussions, or whether it interferes with group functioning. To date, there are two studies have experimentally tested the added value of teacher guidance on discussion quality: Veerman et al (2000) compared the effect of two different types of guidance (a focus on improving argumentation structure vs. argumentation strength) on undergraduates’ synchronous argumentation in a chat-based environment. Compared to an unguided control condition, they did not find any significant differences in discussion quality. However, undergraduate students can reasonably be expected to be capable of conducting a good argumentative discussion on a topic of their interest. Human support may therefore have been redundant for this population. Young teenagers, on the other hand, have been reported to have...
underdeveloped argumentation skills (Kuhn, 1991) and may therefore benefit more from online teacher support.

Indeed, a recent study by Asterhan, Schwarz and Gil (in press) showed that teacher guidance affected the quality of 9th graders’ small-group discussions. Based on differences in moderation behaviour that were documented in a field study (Asterhan, 2011), two different types of human guidance for improving student argumentation were defined: Epistemic guidance aims to assist the group in presenting clear, sound arguments and counterarguments and in considering different perspectives. Interactional guidance, on the other hand, aims to improve group argumentation by exploiting the social situation, that is: through encouraging students to express their opinions, to listen and to respond to students with different viewpoint. The results showed that epistemic guidance improved argumentative quality of discussions, but did not improve rates of participation or interactivity between students. Vice versa, teacher support that focused on the interactional aspects of peer argumentation increased participation and interactivity, but did not improve argumentative quality. This study then shows that teacher guidance in online environments can have an effect on student discussions that reasonable fits the intended goal of moderation.

2.3.5 Supporting the moderator.

E-moderation of group learning is not an easy task: Teachers not only have to monitor task progress and subject matter understanding, but the collaborative process as well. In an average-sized classroom or e-course with students working in small groups, the amount of information available to a teacher can become quite overwhelming. Compared to face-to-face group learning, this workload is even increased in CSCL environments (and especially in synchronous discussion formats), since it lacks many of the traditional, non-textual cues that teachers use to detect group dysfunction or individual difficulties. Moreover, since most CSCL environments are student-focused they do not offer tailored moderator tools that will allow teachers to unobtrusively intervene and support group work.

Although e-moderation is a challenging task, computerized environments also offer an opportunity to support e-moderation: Since many aspects of the collaborative process are logged, this information can be made available to teachers with the help of teacher-tailored visualizations of group interaction features (i.e., awareness tools), alerts and off-line analysis tools. Teachers can subsequently use this information to determine which activities or interventions they further need to initiate.

A recent multi-national development initiative that involved pedagogical experts, computer engineers, artificial intelligence experts, and teachers set out to translate these ideas and develop a computerized system that is specifically designed to support teachers in their attempts to provide real-time, online support of several student discussions at once. The result of this initiative is the ARGUNAUT system (freely downloadable at http://argunaut.collide.info/ and described in a/o Hoppe, de Groot & Hever, 2009; McLaren, Scheuer & Mikšátko, in press; Schwarz & Asterhan, 2011). I will shortly describe one of its main components here, the Moderator's Interface.

The Moderator's Interface (MI) is a multipurpose tool that can be used for real-time moderation of ongoing Digalo discussions as well as offline analysis of completed discussions. Despite these
multiple uses, the main design goal was to generate a user interface for real-time moderation. It provides an interface capable of supporting simultaneous moderation of parallel discussions. The main user interface of the MI is a single window with a predefined layout. A typical view is shown in Figure 2. The window contains four main components: The session and user list (left column), the main focus view (center), remote control panel (bottom center), and aggregated miniature views (right column). I will shortly describe the first three:

Insert Figure 2 About Here

The session and user list includes tools for monitoring presence and for selecting groups and/or individuals within groups to be shown in the main focus view. Switching between different group discussions is done through this list. It is also responsible for showing alerts of important events in sessions other than the currently observed one. The alerting options that the MI offers range from the detection of superficial discussion features (based on keywords, inactivity, participation, responsiveness, etcetera’s) to alerts based on content-related dialogue analyses (e.g., patterns of reasoning, of interaction, see McLaren, Scheuer & Mikšátko, in press). Prior to starting the discussion sessions, teacher moderators choose and define the events they would like to be alerted about.

The main focus view shows detailed information on the currently selected discussion with the help of a range of awareness displays that are continuously updated in real time. They are designed to provide quick and accurate updates on group and individual processes. Figure 3 presents four of the array of Awareness Displays moderators can choose from. By default, however, the main focus view shows the discussion graph of a selected discussion session, which is almost identical to the discussants’ Digalo interface. Navigation through the main discussion graph enables the moderator to read the content of contribution (with a tooltip) and see how they are arranged. The moderator can resize and rearrange maps to follow the discussion as well as make patterns in the discussion appear clearer, all without affecting the discussants’ environment.

Insert Figure 3 About Here

The Remote Control panel enables real-time moderation of discussions (see bottom column in Figure 2). It offers a collection of tools to intervene in the discussion without actually being defined as one of the map’s discussants and without acting from within the discussants’ EUE. Thus, this design defines the teacher as a guide-on-the-side, who operates from outside the group space. Moderators can choose to send these interventions to all groups, selected groups only, subgroups or even individuals. This then enables both private and public communication, since the interventions are only shown on the screens of selected users. The three most relevant intervention options are (1) sending pop-ups with graphical and/or textual content which the student clicks away after reading; (2) attaching textual “stick-it” notes to one or more selected contribution shapes that are visually distinguishable from the discussants contributions; and (3) highlighting selected contributions.

Accurate assessment of individual and group processes is a prerequisite for effective teacher support of group work (Webb, 2009). The ARGUNAUT system is first and foremost designed to facilitate unobtrusive assessment and monitoring of these processes with the help of a range of personalizable alerting and awareness tools. Its design also separately defines the roles of the teacher-moderator and the student-discussants by assigning them different graphical displays,
environments and communication channels. The system does not provide, however, suggestions on whether, when and how the teacher should intervene. This is left to human judgment. As I hoped to have shown in previous section, it is not clear (yet) what effective online moderation of critical group discussions looks like. Thus far, there is very little empirical evidence available, especially at the grain size that will be required for real-time suggestions from an intelligent agent. This may then be the focus of future developments.

The ARGUNAUT system was tested in a range of laboratory and authentic classroom settings in four different countries (Israel, Germany, United Kingdom and Colombia). Our own research with the system shows that, with practice, moderators are capable of handling up to 4 synchronous discussions simultaneously and that the different system features afforded the development of novel moderation strategies that were previously not possible (Schwarz & Asterhan, 2011). It then did not only help moderators with enacting their regular moderation strategies more efficiently, but also shaped their moderation behaviour.

A multitude of research questions can be generated and studied in future studies with systems such as ARGUNAUT. For example, what are teachers’ strategies and decision-making-processes during moderation of (multiple) small-group discussions? How do students perceive, evaluate and interpret moderator actions in different settings (e.g., when present in the same discussion environment or when communicating from outside the group)? How do different representations of moderator interventions affect student behaviour?

3. Conclusions and future directions

The use of computer technology for facilitating argumentation has become a productive and promising theme of educational research and development efforts. In addition to affordances attributed to computer-mediated communication formats themselves, much of the research focus has been on developing and designing computerized environments for student–to-student interaction. Software design features believed to support argumentation are, among others, collaboration scripts, graphical representations, message classifiers and group composition. Furthermore, a relatively new line of research is now exploring the role of the teacher in these environments and how specifically designed technology may support teacher moderation of small-group argumentation.

First findings from each of these lines of research show the potential of computer technology design in supporting student argumentation. Still, the empirical basis for their effectiveness is more solid for some features than it is for others. In any case, much more research is needed in each of these relatively new lines of investigation, since the findings that were reviewed here often raised more questions than that they were able to provide clear answers. Moreover, the sheer majority of research has thus far focused on immediate changes in students’ online argumentation within one or two trials. It remains an open question what the long-term impact of these practices may be and whether or how they will transfer to other settings. For example, does repeated engagement in computer-supported argumentation have an impact on students’ argumentative competence in face-to-face settings, or in real-world argumentative practices?

Too often, research in this field is design-driven and characterized by cycles of developing a new system and short-term implementations to test its effectiveness, before moving on to the next design project. There is no follow-up on the impact of these new tools on teaching practices. It is
not clear whether they are at all picked up by schools and teachers to become part of their pedagogical and didactical tool box. Neither argumentation, nor computer-mediated tools for classroom discussions are common in today’s classrooms. Successful implementation of computer-mediated argumentation in classrooms then requires not only adequate software design, but also the development of pedagogical models and professional training.

Finally, in spite of the progress that has been made with technology and tool development, these can only be expected to have an impact on student argumentation if the local and the larger cultural context values, expects and encourages critical argumentation. As Deanna Kuhn, who has been the most prominent researcher of student argumentation in the last two decades, recently noted that “[T]he challenge, then, may be less one of executing the skill (…) than it is one of recognizing the need to do so.” (Kuhn, Goh, Iordanou & Schaenfeld, 2008). If the first decade of psycho-educational research on argumentation was characterized by a focus on (cognitive) skill development and the second on software and other tool design for supporting argumentation, it seems that the field is now taking a turn towards the social and affective dimensions of argumentation.

For example, we have recently started to explore how students perceive the social setting, their partners and the goals for argumentation (e.g., Asterhan, in press; Asterhan, Butler & Schwarz, submitted) and how these, in turn, may inhibit or promote productive argumentative discourse and learning. Kuhn, Wang and Li (2011) recently explored how students from different cultures understand the values and desirability of argumentative discourse. Several researchers have investigated the relation between students’ beliefs about the nature of knowledge (i.e., epistemic beliefs) and argumentation (e.g., Mason & Scirica, 2006; Nussbaum, Sinatra & Poliquin, 2008). Lastly, indications from recent research show the importance of including gender in future investigations (Asterhan et al., submitted; Asterhan et al., in press). Research studies from the fields of sociolinguistics, developmental psychology and discourse analysis have long reported on differences in male and female discourse. Surprisingly, however, gender has thus far not been considered in argumentation research. These recent developments then seem to outline an exciting, new line of research on the social-affective aspects, one that is expected to complement the existing and still evolving research on computer design and support for argumentation.
References


Figure 1. Interface of the diagram-based discussion environment Digalo

Figure 2. Main window of Argunaut’s Moderator's Interface

Figure 3. The four main Awareness Display tabs in the Moderator Interface
(a) Group Relations

Each node represents a different discussant; width of links represents the frequency with which two discussants created links between each others’ contributions (exact number visible with tooltips).

(b) User Activity

The x-axis shows nr. of activities. The y-axis shows name of participants and different bar colours represent different type of activities (e.g., create/delete/modify shape/link).

(c) Ontology Use

Pie charts show relative frequency of the use of different shape types (left chart; e.g., argument, question, explanation, claim) and different link types (right chart; e.g., neutral, opposing and supporting) in the discussion graph.

(d) Chat Table

Each column contains all the textual contributions from one discussant in a session. Contributions are vertically organized according to chronological order. Deletions or modifications are marked with the help of strike-through font and font colours.