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Argumentation for Learning: Well-Trodden Paths and Unexplored Territories

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Abstract

There is increasing consensus among psycho-educational scholars about argumentation as a means to improve student knowledge and understanding of subject matter. In this paper, we argue that, notwithstanding a strong theoretical rationale, causal evidence is not abundant, definitions of the objects of study (argumentation, learning) are often not well-defined, and the variance in research methods is large. In this article, we systematically review the available research evidence by mapping it on the Argumentation For Learning (AFL) research framework, which specifies the different *antecedents*, *dialogue characteristics*, and *learning outcomes* of argumentation. In doing so, we identify claims that are supported with substantive empirical evidence and demonstrate which questions are still open to further empirical examination. We also uncover several promising, relatively unexplored venues for future research.

Interest in argumentation is as old as Western culture. The Platonic dialogues exemplify argumentation in beautiful, alluring dialogues, full of emotions, yet reaching "eternal truth" through critical moves. Aristotle's advancements in Logic, Dialectic, and Rhetoric are the ancestors of Argumentation Theory. This cultural legacy has served modern precursors to elaborate theories of argumentation: Masterpieces such as *La nouvelle rhétorique* (Perelman & Olbrechts-Tyteca, 1958*), Informal Logic: a handbook of critical argumentation* (Walton, 1989), and *Fundamentals of Argumentation Theory* (van Eemeren et al., 1996) systematically rely on their venerable predecessors, while basing it on real dialogues taken from court, politics, articles in newspapers or family discussions.

Interest from psycho-educational scholars started more recently, in the early 1990s or so. It has since grown into a prominent focus of empirical research, educational policy and developments efforts. One can think of many reasons for this rise, but a few stand out:

The first reason concerns the realization that argumentation is central to successful participation in 21st century democratic societies. With the increasing accessibility to modern communication technologies, regular citizens have access to vast amounts of information sources and freely participate in multi-participant, open discussions on a large variety of topics, often with participants from culturally, socio-economically and ethnically different backgrounds. In this reality, individuals negotiate solutions to complex political, social medical, and environmental problems through collaboration, discussion, and deliberation (Michaels, O'Connor, & Resnick, 2008; Schwarz & Baker, 2016). Formal education should prepare students to be able to participate in ways that reflect the basic principles of civilized, rational, collaborative reasoning. Perhaps not surprisingly then, argumentation is a prominent theme in different national and international initiatives that have mapped new educational goals and standards for today's society (e.g., 21st Century Skills, Common Core Standards, Next Generation Science Standards). Long-term intervention programs in which argumentive skills are modeled and intensively practiced have yielded remarkable results in general populations (e.g., Crowell & Kuhn, 2014; Kuhn, Hemberger, & Khait, 2014). Fostering argumentation is then a viable reason for promoting participation in a democratic society.

A second reason for the increasing interest in argumentation is a reconceptualization of learning in core school disciplines, such as mathematics (e.g., Arzarello & Sabena, 2011; Lakatos, 1976; Schwarz, Hershkowitz & Prusak, 2010), science (Berland, & Hammer, 2012;

Berland & Reiser, 2012; Driver, Newman & Osborne, 2000; Hammer & Elby, 2003; Osborne, 2010), and history (e.g., van Boxtel, & van Drie, 2004; Pontecorvo & Girardet, 1993). It is argued that children should not only come to know a body of knowledge, but should also develop an understanding of how these bodies of knowledge are established in a given discipline (Osborne, 2010). Notwithstanding many other differences, argumentation is one of the central means that scientists in *all* disciplines use to make their case for new ideas and new theories and for attempting to identify weaknesses and limitations in those of others (Latour & Woolgar, 1986; Ochs, Gonzales & Jacoby, 1996). Critique and argumentation are therefore core to scientific endeavors, and without argument and evaluation, the construction of reliable knowledge would be impossible (Osborne, 2010). It is then argued that argumentation should become commonplace in every classroom and discipline, instead of being restricted to debate club activities. Moreover, since each discipline has its own genre of talk (Wells, 1999) and criteria for evaluating good and sound arguments, students should have opportunities to observe, practice, and join in several different kinds of argumentive discourse: Just as the math student must learn the genre of mathematical explanation and proof, the student of history must acquire the history-specific genre of explanation and interpretation of historical events from multiple sources of evidence. The core disciplines of schooling provide the necessary structure to acquire these discourse-based reasoning abilities and "habits of mind".apprenticeship learning.

The third reason concerns important conceptual changes in theories of learning and development. Based on ideas proposed by theorists such as Vygotsky, Dewey, Mead, Bakhtin and Piaget, this body of research is based on the premise that individual cognition is shaped through social interactions and that verbal dialogue plays a special role in this process (Resnick, Asterhan & Clarke, 2015; Resnick, Levine, & Teasley, 1991). Accordingly, when students participate in verbal activities that require them to reflect upon, explain, and articulate their own thinking and reason about it, to clarify misunderstandings, to be challenged and to challenge other views, it is believed they better process the content of the discussion topic (thus, resulting in improved understanding). There is even some evidence, that recurrent participation in such classroom activities for a prolonged period can produce far transfer effects and increases

in standardized test of cognitive abilities (see reviews in Nussbaum & Asterhan, in press; Resnick et al, 2015).

In this article, we specifically focus on argumentation as a means to improve domain-specific content learning. It has also been labelled *arguing to learn* and contrasted with *learning to argue*, which refers to activities and programs that aim to improve students' argumentation competencies (e.g., Andriessen, Baker & Suthers, 2003; Reznitskaya & Gregory, 2013). Other foci, such as gains in declarative knowledge about argument and argumentation, are beyond the scope of the present paper.

Our main goal is to provide a comprehensive synthesis of the existing research evidence to better understand whether, when and how argumentation supports learning of domain-specific knowledge. As we will show, research in this field is abundant; however, causal evidence is not. Moreover, there is considerable variance between studies in how argumentation is conceptualized, the type of learning outcomes that are targeted, and the ways in which argumentation is supported. We provide a structure, the Argumentation For Learning research framework, on which we map the existing research. By doing so, we aim to bring some order to this field, by taking stock of what we reliably know, by identifying open questions, and articulating new hypotheses that can be empirically tested in future research.

Before turning to the review and the framework, we first provide a short rationale for the claim that argumentation supports learning.

Argumentation for Learning: A rationale

Based on previous publications (Andriessen, 2014; Chinn & Clark, 2013; Schwarz, 2009; Schwarz & Asterhan, 2010), we reiterate the main rationale for why argumentation should benefit learning: In argumentation, students engage in a host of activities that have each been associated with developing a better understanding of academic content. First of all, through articulating and publicly presenting their ideas, student make their own, often erroneous or incomplete understanding of complex concepts explicit and open to evaluation. Indeed, indirect evidence support these assumptions: Both the anticipation (Tetlock, 1992) and the actual act of explaining one’s own ideas to another human being (e.g., Chi, de Leeuw, Chiu, & Lavancher, 1994; Webb, Troper & Fall, 1995) have been found to improve student learning. The verbal articulation is directed at another person which may further promote reflection and awareness to

the incompleteness of one's own understanding (Amigues,1988; Keil, 2006), especially when one is attempting to convince others (e.g., Tetlock,1992).

Secondly, it is reasonable to assume that when engaging in *argumentive*[1] discussions, students actively explore different, alternative views and try to settle differences between these views through rational reasoning, thus leading to leaning gains. A recent study provides indirect evidence supporting this assumption: Anticipating an argumentive discussion with a disagreeing peer after reading an expository science text led to longer reading times and higher learning gains, compared to not anticipating any discussion or anticipating a consensual discussion (Miller et al., 2014).

Wiley and Voss (1999) proposed that acts of persuasion and justification induce higher levels of motivation and personal investment. In addition to the above-mentioned, in argumentive dialogue students are required to consider alternative positions to their own, to answer questions and to address discrepancies in their personal and in their collective understanding (Nussbaum & Sinatra, 2003; Stein & Miller, 1993). Providing reasons why a certain explanation idea or opinion is faulty not only allows one to propose convincing arguments to refute that position in a discussion, but is also likely to strengthen his/her understanding of the correct concept in the process (Durkin & Rittle-Johnsson, 2012; Kapur, 2008; VanLehn, 1999). Finally, by addressing these differences and exploring their respective and relative validity, students have to consider which view, idea or explanation is more acceptable than another and why. Among others, they have to consider whether a certain idea is or is not adequately supported by evidence and reason, or whether a proposed counterargument does or does not successfully challenge a certain idea. Through the combination of these processes, participation in argumentive dialogue is believed to result in deeper processing and to more meaningful and better elaborated knowledge structures.

A research framework for studying learning through argumentation

[1] The term "argumentive" was coined by Deanna Kuhn in her pioneering book *The skills of Argument* (1991) to stress that skillful argumentation is aimed at elaborating arguments. While our view of argumentation in this paper is more compound, our focus on argumentation for learning confers precedence to the ideational perspective. We hence use the term "argumentive" rather than the term "argumentative".

Our review of the empirical evidence supporting the claim that argumentation improves domain-specific content learning is organized around a three-node research framework (see Figure 1): The Argumentation For Learning (AFL) framework discerns between (1) the antecedents of argumentation and how they facilitate or inhibit argumentive discourse; (2) the characteristics of the actual dialogue; and (3) the learning outcomes of argumentation. Figure 1 includes the different antecedents, features and outcomes of argumentation that have been addressed in the research literature (some intensively, others sparsely) and which we will review in detail here.

Figure 1 about here

We argue that a comprehensive account of whether, when and how argumentation supports learning of domain-specific knowledge, all three parts have to be carefully specified and taken into account. We start with the central node – the discourse as it is actually deployed. The first question we address, obvious and complex at the same time, is the nature of the intended activity.

Productive argumentation for learning: What does it look like?

For a model of argumentation for learning to have any predictive value, it is imperative to first define what argumentation is (and what it is not) and describe what *productive* argumentive dialogue looks like. The widely accepted definition of argumentation by van Eemeren, et al (1996) captures the very essence of argumentation:

> "Argumentation is a verbal and social activity of reason aimed at increasing (or decreasing) the acceptability of a controversial standpoint for the listener or reader, by putting forward a constellation of propositions intended to justify (or refute) the standpoint before a rational judge" (p. 5).

Educational scholars have adapted these more basic distinctions into normative models for *productive* argumentation in *learning contexts* (e.g., Asterhan & Schwarz, 2009b; Berland & Hammer, 2012; Felton, Garcia-Mila & Gillabert, 2009; Ford, 2008; Keefer et al, 2000; Mercer, 1996; Nussbaum, 2008; Mercer, Wegerif & Dawes, 1999; Schwarz & Baker, 2015). Despite some inevitable differences, the descriptions of this idealized form of argumentive discourse for learning are quite similar, namely as one that balances between critical reasoning and collaborative knowledge construction and is characterized by the following characteristics (Asterhan, 2013):

(1) A general willingness to listen to and critically examine the different ideas that are proposed in the course of a discussion and to search for alternative perspectives that have not been considered yet;
(2) A willingness to make concessions in response to persuasive arguments;
(3) An atmosphere that is characterized by collaboration and mutual respect;
(4) A discussion that is *issue-driven* and not *position-driven*.

Following Felton and colleagues (2009), we call this type of ideal discourse *deliberative argumentation*. As an example of deliberative argumentation, Figure 2 includes a short protocol excerpt of two undergraduate students, having no previous training in biology who progressed in their understanding of natural selection through deliberative argumentation (Asterhan & Schwarz, 2007; 2009a). Students listen to and criticize each other's explanations. Even though there is disagreement between the two students, there are no manifest expressions of discomfort or interpersonal tension in the interaction. Clarifications are requested and each student attempts to understand the other.

Deliberative argumentation can be contrasted with at least two other dialogue types that have been the object of psycho-educational research: Disputative argumentation and consensual co-construction. We will refer to each of them in a separate section and compare them to deliberative argumentation.

Consensual co-construction vs. argumentation.

In consensual co-construction, speakers transact on each other's verbal contributions by expanding, elaborating or explaining ideas. Whereas they may develop justifications for a one-sided argument, they do not challenge or criticize ideas and do not juxtapose different alternatives (Asterhan & Schwarz, 2009a). A short fragment of consensual co-construction is included in Figure 2. Empirical research has provided extensive evidence that this type of dialogue predicts individual learning gains from peer interaction (e.g., Chi & Menekse, 2015; Coleman, 1998; Gillies, 2004; King & Rosenshine, 1993; Webb, Troper & Fall, 1995). Can these findings be incorporated into the body of evidence for learning effects from argumentation? Or are argumentation and explanation-driven dialogue two very distinctively different dialogue types?

Acts of explanation and argumentation are in fact not easily distinguishable in natural conversation (Asterhan & Schwarz, 2009a, 2009b): Acts of explanation development and acts of argumentation frequently occur in the same conversation and even have similar syntactic and formal structures. They are made up of at least two propositions, in which one is presented as the starting point, which leads to the other (the end point). They may also make use of similar indicator words, such as 'because', 'therefore', 'as a result of', and 'since'. Moreover, both explanation and argumentation are *verbal* and *social* acts of reasoning. Explanations, like arguments, are of a transactional nature: They have recipients, whether this occurs on the inter-personal plane between two individuals, or on the intra-personal level where an individual explains something to the self. In both cases, the goal of the explanation is to expand the recipient's understanding (Keil, 2006).

In spite of these resemblances, argumentation and explanation differ in at least one important aspect: their purpose. An explanation has a clarifying function within a dialogue, in the sense that the recipient should come to understand something better as a result of the explanation. It is often, but not always, preceded by requests for clarifications ("What are chloroplasts?", "What do you mean?") or expressions of confusion ("Can you explain that to me?", "I still don’t get it"). In argumentation, on the other hand, the proponent proposes reasons for the recipient to come to accept or to refute a certain thesis (Walton, 2006). Baker (2003; 2009) defines argumentation as an activity that involves establishing specific types of relations between the propositions being discussed and other sources of knowledge, the establishment of which is meant to influence the epistemic statuses of these propositions. The distinction between argumentation and explanation is then made by judging the context and goals of the dialogue, both in a local and a general sense (see also Osborne & Patterson, 2015). According to the definitions cited here, explanation-driven dialogue that is consensual in nature and in which participants do not question or challenge the epistemic status of a knowledge claim is not argumentation.

Why is it important to distinguish between argumentation and consensual co-construction? First of all, as Osborne and Patterson (2015) already pointed out, a lack of common conception hinders effective communication among researchers and practitioners, and does not do justice to the special role of argumentation in higher-order thinking. Second, given that argumentation and explanation are two different epistemic dialogue acts (de Vries, Lund & Baker, 2002; Keil, 2006; Walton, 2006), they are likely to reflect and to stimulate different (socio-)cognitive processes.

Thus, in some task designs and for some targeted learning outcome, consensual co-construction may not be sufficient. De Leeuw and Chi (2003) suggested that whereas explanation-driven discourse may indeed promote *incremental* learning, it may not suffice when a radical reorganization of conceptual knowledge (conceptual change) is required.

This was confirmed in an empirical study by Asterhan and Schwarz (2009a) that examined which peer dialogue characteristics predicted conceptual change in students' individual understanding of natural selection. A detailed coding scheme was developed to distinguish between dialectical argumentation moves (such as reasoned challenges, rebuttals and disagreement) and consensual co-construction (such as, one-sided justifications, elaborations, clarification, agreement). They found that dialectical argumentation (that characterize deliberative argumentation) predicted both dyadic and individual conceptual gains on delayed post-tests, whereas consensual co-construction did not. Similarly, Howe (2009) showed that overt contradiction in peer-to-peer dialogue predicted conceptual growth on delayed post-tests, but consensual, joint construction of explanations did not.

Even though more research is needed to further explore these findings empirically, they highlight the importance of careful descriptions and specifications the type of dialogue students engage in.

The effects of rhetorical style: Deliberative vs. disputative argumentation.

In disputative argumentation (*disputes* or *eristic dialogue* in Walton's terminology) speakers defend a viewpoint and undermine alternatives to convince an opponent to switch sides. The goal is to win at the expense of one’s opponent. Whereas both disputative and deliberative argumentation are rich in critical reasoning, the former is also characterized by competitive rhetoric and a lack of collaborative construction of knowledge (see Asterhan, 2013 for a detailed overview). A short example of disputative argumentation is shown in Figure 2.

Until recently, little attention was given to these distinct argumentive discourse types and how they may affect learning. Several scholars have argued that the distinction between disputative and deliberative argumentation is important, since they are expected to affect learning outcomes differently (Asterhan, 2013; Asterhan & Babichenko, 2015; Felton et al., 2009; Garcia-Mila, Gilabert, Erduran & Felton, 2013; Mercer, 1996): A

focus on the interpersonal, competitive dimension of social interaction may raise uncertainty and threaten self-competence (Butera & Mugny, 1995; Darnon, Butera & Harackiewicz, 2007), increase positive evaluations of the partner's competence (Darnon, Muller, Schrager, Pannuzzo & Butera, 2006; Gabriele & Montecinos, 2001), and raise concerns about group belonging or interpersonal relationships. Perceptions of interpersonal competition also reduce cognitive flexibility and a person's openness to alternative viewpoints (Carnevale & Probst, 1998), and may cause discussants to concede upfront without further consideration and engagement (Smith, Johnson & Johnson, 1981; Weinberger & Fischer, 2006). Extrapolating to argumentation for learning, learners would be expected to be less likely to share their own incomplete ideas, to consider alternative viewpoints, to collaboratively construct new explanations, and to critique their partner's ideas. Since these actions are believed to be the crux of learning through argumentation (Asterhan & Schwarz, 2009a; De Vries et al, 2002; Keefer et al, 2012; Osborne, 2010), by not engaging in them, students would then forego important opportunities for learning.

In a recent experiment by Asterhan and Babichenko (2015), undergraduates interacted in computer-mediated interactions with a confederate on their understanding of a scientific concept they had just studied (i.e., diffusion). The peer confederate's verbal behavior was scripted to evoke argumentive discourse, while controlling exposure to conceptual content and the type of dialogue moves (e.g., requests for clarifications, challenges), but differing in argumentive discourse style (i.e., disputative or deliberative). Results showed that learners who participated in the deliberative discourse style condition outperformed those in the disputative condition on individual learning scores. Scrutiny over the dialogues showed that students in the deliberative condition more openly shared their incomplete understandings with the dialogue partner.

In a follow-up study, these findings were replicated in a setup in which learners *read* an online, small-group discussion with links to informational resources (Asterhan & Hever, 2015). Rhetoric style of the online discussion was manipulated (disputative or deliberative), whereas topic content and argumentive structure was once more held constant. Students learned more about the topic when the discussion they read was deliberative, as opposed to disputative. No differences were found on different measures of reading behavior, indicating that the knowledge gain differences could not be explained by overt cognitive behaviors.

These first findings confirm the expectation that deliberative argumentation fosters content learning, whereas the effects of disputative argumentation are less favorable. However,

more research is needed to further examine the scope and robustness of these first findings. Moreover, we need to understand how these different types of argumentation are "created". We will review some first efforts in this direction further on.

In summary, we argue that it is important to distinguish between argumentation and other epistemic dialogue acts, as well as between different types of argumentive dialogue, since these are likely to offer different opportunities for learning. Instead of *assuming* that students engage in a particular type of discourse (e.g., because we told them so, or because we expected them to), it is imperative to carefully describe and measure the *actual* dialogue that ensued. This may shed light on some of the disparate empirical findings from research on the effectiveness of argumentive task design, as well as their effect on learning outcomes (discussed next). Finally, deliberative argumentation is also preferable from a normative perspective, as it embodies important educational and social values (e.g., respect of different views and perspective, listening to others, accountability to reasoning).

In the next section, we focus on the link between the second and the third node of the framework – namely on the evidence of links between argumentation and content learning.

Linking argumentation with content learning: What is the evidence?

Notwithstanding the solid theoretical rationale for learning through argumentation, the general consensus among scholars of argumentation about this rationale and the abundance of research on argumentation, scholarly works reporting evidence of a causal link between argumentation and domain-specific knowledge gains are few.

Earlier works from the 1970-s and 1980-s focused on learning through socio-cognitive conflict and manipulated the conditions of social interaction by pairing learners with different initial cognitions (e.g., conservers with non-conservers) and comparing the outcomes of different pairing options (Ames & Murray, 1982; Doise, Mugny & Perret-Clermont, 1975; Tudge, Winterhoff, & Hogan, 1996). However, the social interaction and the dialogues were not systematically recorded or analyzed and it is therefore not clear if and how argumentation may have played a role in these studies. One cannot simply assume that pairing students with different views, ideas or understanding will necessarily result in argumentive discourse during the interaction (see further on).

A substantive portion of scholarly work focusing on argumentation to learn involves in-depth case studies (e.g., Asterhan & Schwarz, 2009b; von Aufschnaiter, Erduran, Osborne, & Simon, 2008; Berland & Hammer, 2012; Chin & Osborne, 2010; Keefer et al, 2000; Schwarz, Perret-Clermont, Trognon & Marro, 2008). These studies offer rich descriptions of how knowledge is negotiated and constructed in argumentive discourse and provide valuable insight into the mechanisms and dynamics of learning *in* argumentation. However, they often focus on a selective subset of successful cases drawn from a larger data set. In other words, even though it showcases *how* it supports learning when it does, it does not show how often this happens. Moreover, it is not possible to deduce whether these processes also translated into lasting individual gains outside of the group setting.

Other studies did test individual knowledge before and after argumentation, but did not always compare gains to a control condition (e.g., Jimenez-Aleixandre, 1992; Bell & Linn, 2000; Schwarz, Neuman, Gil, & Ilya, 2003; Schwarz, Schur, Tayer, & Pensso, 2011), or compared achievements in control classrooms to those of students who received instruction according to a novel instructional approach which also included argumentation (e.g., Schwarz & Linchevski, 2007; Zohar & Nemet, 2002). It is not clear from these latter designs whether differences in learning gains should be attributed to argumentation or to other aspects of the novel instructional approaches and learning materials. To make the case for argumentation as a mechanism for learning, ideally it would have to be separated from other learning activities: Argumentation should have an added value over and beyond the other components of the novel instructional approach.

Another approach has been to analyse covariance between argumentive behaviour during the interaction phase and individual learning gains following that interaction. For example, Schwarz, Neuman and Biezuner (2000) found that pairing children with different misconceptions can indeed lead to conceptual gains, provided that the two engage in an argumentive discussion (see also Asterhan & Schwarz, 2009a). These studies rely on correlational evidence and can, therefore, not provide decisive answers about the causal mechanism behind improvement. Does argumentation, for example, lead to better understanding, or are individual differences in intelligence, skill, knowledge, or experience responsible for both the engagement in argumentation and for improved understanding? To answer such questions, experimental research designs are required. This presupposes, however, that argumentation can be

manipulated as an independent variable and isolated in order to study its effect on learning. One possibility is to compare the effects of different instructions. Another is to include a confederate who elicits argumentive discourse. A crucial difference with the aforementioned neo-Piagetian studies on socio-cognitive conflict, is that these studies specifically focus on the deployment of argumentation and include detailed analyses of dialogue in addition to experimental effects on learning. By doing so they provide proof that the compared conditions differ in the absence or appearance of argumentation.

For example, Felton and colleagues (2009) found that 7th graders who participated in an 8-session long unit on climate change showed larger gains on a knowledge tests when this program included recurrent argumentive discussions, compared to a condition in which students were given extra time to read the materials instead. In a study on 8th graders' conceptual understanding of chemical reactions, Yeh and She (2010) showed that embedding small-group argumentation into the instructional sequence improved students' knowledge gains, compared to a control group who only received the instructional materials, without argumentation. Mercer and colleagues (2004) tested the effects of a 23-week long teaching program for 5th grade science classes, in which students were taught to externalize reasoning through small-group, deliberative argumentation (or: *exploratory talk* in Mercer's terms). Compared to children in control classes which followed the same curriculum without the group discussion component, experimental children performed better on national achievement tests covering areas of the science curriculum and performed better on researcher-designed concept-mapping tests. Similar results were found in a second study (Wegerif, Mercer & Dawes, 1999).

However, in spite of the impressive outcomes of these four in-vivo experiments, effects of social interaction and argumentation could not be fully isolated, as group work was not an aspect of the control group classrooms. It is then not clear whether the effects could be attributed to the mere opportunity for social, verbal interaction in peer-led groups, or to argumentation *per se*.

Two studies by Asterhan and Schwarz (2007) addressed the issue of the exclusive effect of argumentation by comparing conditions in which social interaction components were held constant and argumentation was isolated: In a first experiment, undergraduates learned about natural selection and were then assigned to dyads. Half of these were instructed to engage in argumentive dialogue on their respective explanations and

received written examples of argumentive moves. The other dyads received "regular" instructions for collaboration (e.g, "Listen to each other", "Work and discuss together", "Try to "Try to come up with the best solution possible"). Students in both conditions improved their conceptual understanding immediately following the social interaction, but only experimental subjects retained these gains a week later. The advantage of argumentation observed in collaborative dyadic situations was then replicated in a follow-up, confederate study, which showed similar gain patterns for the experimental condition. No differences were found in either study on measures of factual or propositional knowledge (Asterhan & Schwarz, 2007).

In a study by Nussbaum and Sinatra (2003) undergraduates were asked to predict the path of a falling object dropped in different settings and subsequently provide explanations for their choices. After each prediction, subjects in the experimental condition were instructed to argue in favour of an alternative prediction they were given. Whereas no difference was found in the accuracy of their predictions, experimental subjects' conceptual explanations were more accurate.

Wiley and Voss (1999) reported that undergraduates who were instructed to write an argumentive essay on an historical topic attained better conceptual understanding than those who received other instructions (narrative, summary or explanation). They did not demonstrate better retention of factual information, however. Sampson and Clark (2008) found that the addition of argumentive group discussion further improves learning gains over and above essay writing itself: High school students who engaged in argumentive discussions demonstrated greater mastery and transfer on the topic domains' concepts (heat and temperature), than did students who wrote arguments individually but did not engage in collaborative argumentation.

In spite of these encouraging positive findings, however, other experimental studies that have isolated argumentation from (other forms of) collaboration have failed to find learning gains: Wecker & Fischer (2014) conducted a meta-analysis of experimental studies that examined the effects of different computer-supported collaborative learning (CSCL) efforts to support argumentation (such as, argumentation diagrams and collaboration scripts). Twelve such experimental studies were identified. They reported an overall moderate effect of these CSCL designs on argumentation and argumentive skills, but no overall effect on domain-specific knowledge gains. It is plausible that additional studies exist that did not find knowledge gains and were, therefore, never published. The reason that we know of these CSCL studies' null

results on content learning is ostensibly that they did find effects of the computerized design on argumentation, and were therefore published.

We propose several tentative reasons for the relatively scarce and somewhat disparate experimental evidence for effects of argumentation on domain-specific content learning: First of all, effects may be contingent on the type of learning that is targeted: Argumentation may not have a particular added value over other instructional activities when the topic domain is not very complex, when assessment focuses on superficial knowledge aspects (e.g., factual knowledge), and/or when deep cognitive processing is not required for success on the task. This may echo a fundamental distinction between learning as gap filling of incomplete knowledge, or as restructuring existing misconceived knowledge structures, i.e., *conceptual change* (Chi, 2008). In contrast to most of the CSCL studies included in the aforementioned meta-analysis, the experiments that *did* report on positive effects of argumentation all targeted on conceptual knowledge of complex (mostly scientific) content, for which students are known to have misconceptions. Moreover, in a subset of these (Asterhan & Schwarz, 2007; Nussbaum & Sinatra, 2003; Wiley & Voss, 1999) no effects werefound on more superficial measures of knowledge acquisition or problem solving. Future research should then be more explicit about the type of learning that argumentation is (and is not) expected to support, as well as include multiple measures of knowledge to allow for comparisons.

Secondly, a prerequisite for studying the effects of argumentation on content learning is to elicit productive argumentive discussions. However, this is not an easy feat. Simply telling students to conduct a critical discussion is often not enough, especially in domains and settings where students have little prior experience with argumentation. Moreover, simply going through the motions of argumentation, - without deep engagement with the pivotal issues that may “trigger” understanding, - may not be sufficient. Wecker and Fischer (2014) suggest that measures of argumentation in the aforementioned CSCL studies may have focused too often on superficial or structural aspects of argumentation. It requires expertise to choose the topic and to create the conditions, expectations and climate that elicits and supports productive peer argumentation. Some of these may be more easily malleable with the right knowledge (e.g., task design, instructions), whereas others may prove to be more difficult to change

in a short period of time (e.g., students' epistemological beliefs, motivation structures, cultural and social norms).

Finally, even carefully planned designs may only be partly effective. The extent to which students actually engage in productive argumentation may differ greatly between discussion groups, which substantially diminishes statistical power of predictive models. Inevitably then, research investigating the link between argumentation and content learning cannot be detached from research into the conditions that promote or inhibit productive argumentation. The three nodes - enablers, process and outcomes of argumentation - are intricately related and should be researched together. They do not simply represent a classical manipulation-process-product paradigm.

Enablers and inhibitors of argumentive dialogue

Thus far, we have discussed the research on what constitutes productive argumentation for learning (node two) and reviewed the empirical evidence on domain-specific learning gains (node three). In this section, we review research on the conditions and characteristics that enable (or inhibit) argumentation (node one). We discern between five different categories of enablers/inhibitors that have been the focus of empirical study: Task design, communication media, process support, individual characteristics, and social and cultural factors. The first three, task design, communication media and process support for argumentation, have been studied quite intensively and have each been reviewed elsewhere (Andriessen, & Baker, 2015; Andriessen & Schwarz, 2009; Asterhan, 2012; Noroozi et al., 2012; Scheuer et al, 2010; Schwarz, 2009). In contrast, systematic research into the role of individual characteristics (particularly the non-cognitive ones) and social-cultural factors has begun only recently. We then dedicate more detailed attention to the research in those new venues of research.

Task design

Task design refers to the design decisions educators make when a learning task is developed, including the choice of topic for argumentation, the way in which the topic is presented, the type of resources that learners will be able to access, the group formation, and the sequencing of activities learners will engage in. Design decisions regarding these particulars affect the likelihood that students will in fact engage in argumentive discourse (e.g., Andriessen & Schwarz, 2009; Jiménez-Aleixandre, 2007).

First and foremost, the topic has to be discussable, that is: the content has to be problematized (Engle & Conant, 2002). This may be achieved by using ill-structured problems, which do not have clear solutions on which all experts agree (e.g., moral dilemmas, socio-scientific dilemmas). A second way to problematize tasks in the eyes of students is to sensitize the students to the issues at stake: To encourage students' questions, proposals, challenges, and other intellectual contributions, rather than expecting that they should simply assimilate facts, procedures, and other "answers" (Lemke, 1990). Thus, problems do not necessarily need to be open from the experts' perspective, but they have to be from the perspective of the students interpreting them, using their available knowledge and resources (Hiebert et al., 1996; Henningsen & Stein, 1997). Encouraging student questioning has been identified as pivotal in this regard (Chin & Osborne, 2009; Golanics & Nussbaum, 2008; Nussbaum & Edwards, 2011). It has also been proposed that framing scientific topics within social and moral dilemmas is likely to heighten student engagement with argumentation (e.g., Sadler, Barab, & Scott, 2007). Compared with 'purely' scientific issues, students have more experience with argumentation on social and moral topics and are more likely to regard them as debatable. However, even though improved socio-scientific reasoning is in and by itself an (officially recognized) important educational goal (Sadler & Zeidler, 2009), and even though it may increase group argumentation (which is likely, but has yet to be empirically proven), the question still remains whether students also learn the targeted scientific concepts better.

Since argumentation is by definition a dialectical activity, design efforts have also focused on how to ensure that participants will consider and discuss differences in opinions, ideas and viewpoints. This may be achieved by grouping students with different initial understanding, ideas or opinions in order to create socio-cognitive conflict (Doise et al., 1975). However, in and by itself this design principle of mixed group formation has yielded mixed results, both on individual content learning gains (Asterhan, Schwarz, & Cohen-Eliyahu, 2014, for a review) as well as on argumentive discourse (e.g., de Vries et al., 2002). The mere grouping of two (or more) students according to initial cognitions does not *ensure* that they will actually articulate, explore and juxtapose these differences in dialogue. First, different answers on a pre-test may not reflect a genuine difference in stable knowledge structures that will re-appear during the discussion. Moreover, even

when discussant introduce different respective answers into the discussion, the pragmatic nature of verbal interactions and ambiguous language use may create an 'illusion of consensus' between dialogue participants, believing that they are in fact proposing similar solutions and are in agreement (Sfard, 2008). Finally, even if students are aware of differences in opinions or ideas, social conventions, motivation and goals may steer them towards reaching a quick consensus instead of exploring them further (see sections on motivation, gender and norms, further on).

Thus, additional tools or resources may be needed to fuel the dialogue by bringing differences to the front. One rather simple and straightforward way is to ask students to write down their reasoned opinion or viewpoint and to introduce it as artefacts in the discussion (e.g., de Vries et al., 2002). Another is hypothesis-testing: Students may be asked to discuss these different answers and then be given the opportunity to test them with an objective testing device (such as scales, a calculator, an experiment), which either settles the difference or shows that neither was right and more exploration is needed (Asterhan et al., 2014; Howe et al., 2000; Schwarz & Linchevski, 2007; Schwarz et al., 2000). Research has also focused on the provision of argument representation tools, such as diagrams, tables or vee-diagrams, that require students to write their claims, counterarguments, warrants and justifications (van Amelsvoort, Andriessen & Kanselaar, 2007; Nussbaum, 2008; Schwarz et al., 2003; Suthers, 2003).

Another means to increase the likelihood that students actually discuss and explore differences is to provide them with textual resources that each convey a contradictory viewpoint, which discussants can draw upon (e.g., Britt & Aglinskas, 2002; Goldberg, Schwarz & Porat, 2011; Reisman, 2012; Schwarz, 2003). Refutation texts in which common misconceptions about scientific phenomena are presented and then refuted (Sinatra & Broughton, 2009) are also likely to benefit student argumentation, particularly in conceptual change tasks. Thus far, however, the use of refutation texts in collaborative learning settings has yet to be examined in empirical research.

In sum, research in the field of argumentive task design has yielded several design recommendations to increase the likelihood of productive argumentation. Taken together, these design features focus predominantly on ways to elicit and maintain a variety of different opinion, solutions and viewpoints in an open discussion space.

Communication media

Media and communication scholars have shown that communication media shape the content and nature of human communication (e.g., Brennan, Galati, & Kuhlen, 2010; Kiesler, Siegel, & McGuire, 1984; Kraut, Fussell, Brennan, & Gergle, 2002). Some scholars of argumentation have proposed that textual, computer-mediated communication can, under certain conditions, address some of the difficulties in establishing productive peer-to-peer argumentation (e.g., Asterhan, 2015; Iordanou, 2013; Kim, Anderson, Nguyen-Yahiel, & Archodidou, 2007): The content of computer-mediated textual conversations can be retrieved and reviewed at a later time, as opposed to oral talk which is ephemeral. The ability to re-read and revise contributions - both before as well as after posting contributions - encourages reflection (Guiller, Durndell, & Ross, 2008). Computer-mediated communication often contains less "social", off-topic communication, is more structured, and is less ambiguous than communication conducted in person (e.g., Kraut et al., 2002). Moreover, participants do not need to compete for speaking rights, which leads to increased and more egalitarian participation in argumentive group discussions (Asterhan & Eisenmann, 2011). Finally, participants in computer-mediated dialogue are less inhibited, more inclined to reveal their personal, individual standpoints and to take risks in online communication environments (e.g., Suler, 2004). Premature consensus seeking (e.g., Weinberger & Fischer, 2006) and a tendency to ignore dissenting claims (Felton & Kuhn, 2001; Kuhn & Udell, 2007) are a common concern in argumentation research. As aforementioned, this is not likely to be merely the result of cognitive difficulty or of coordination costs, but also of social concerns (Asterhan, 2013; Asterhan & Babichenko, 2015; Berland & Hammer, 2012): Engaging in a critical discussion with a disagreeing peer may be perceived by participants as threatening their social standing and interpersonal relations, as well as their desire to be perceived as competent and knowledgeable. The decrease in social presence in computer-mediated discussions may provide a "buffer" which allows participants to become less inhibited and be more inclined to express and respond to critique. In a recent controlled experiment by Asterhan and Babichenko (2015), students who believed they interacted in online argumentive discourse with a disagreeing computer peer agent on their own

misconceived understanding of a complex science concepts showed larger learning gains, compared to students who believed they interacted with a disagreeing human peer. .

For the purpose of this paper, however, there are considerable caveats in the literature comparing F2F with computer-mediated argumentation. First, in spite of the theoretical rationale presented here, there is almost no empirical research that specifically focuses on effects of media on argumentation in educational settings. Second, there is a large variability in online communication environments (e.g., in terms of their affordances) and in ways that people have come to use them. Finally, even though online dialogue and the subjective experience of online interaction is in many ways different from its F2F counterparts, it is not clear whether these differences ultimately result in different learning gains (e.g., Sins et al., 2011). In sum, despite a convincing rationale for potential benefits of online communication formats for productive argumentation, more empirical research is needed that specifies media characteristics, focuses on argumentation in educational settings specifically, and takes into account learning gains.

Process support for argumentation

Whereas task design and choice of communication media affect *the likelihood* that argumentation may ensue, in this section we discuss direct, intentional support for and during argumentive discourse. We distinguish between three different types of process support that each have received empirical attention: Discourse instructions, human (teacher) scaffolding and software design for argumentive discourse.

Discourse instructions. One of the more obvious ways to elicit students' argumentation is by giving them instructions about the type of discourse they are expected to engage in. Different instructions convey different goals, however, and there has been increasing empirical interest in how different types of discourse goal instructions shape student argumentation. Nussbaum and colleagues (Golanics & Nussbaum, 2008; Nussbaum, 2005; Nussbaum & Kardash, 2005) compared the effects of general versus specific goal instructions on argumentive essay writing. They found that general instructions to persuade others led to arguments that were more adversarial, but also somewhat better supported.

Others have specifically focused on the effects of framing argumentation as a deliberative or as a disputative activity, that is: whether the goal of argumentation is to win the argument (disputative) or to collaboratively explore which idea is more convincing (deliberative). In a study on Spanish 7th graders, student dyads were instructed to reach consensus on a socio-

scientific dilemma rather than to persuade their peer. They produced a greater variety of complex argument structures and a higher number of rebuttals in their discourse (Garcia-Mila et al, 2013), as well as improved essay writing (Felton et al, 2009; see also Felton, Crowell, & Liu, 2015 for similar findings).

Asterhan, Butler and Schwarz (2010) studied the effect of disputative and deliberative discourse goal instructions on Israeli undergraduate's argumentation on their explanations for a scientific topic (i.e., natural selection). The goal instructions for deliberative and disputative argumentation are presented in Figure 3. Dialogue protocol analyses separately focused on features of epistemic dialogue (*what* was said) as well as interpersonal regulation of verbal interaction (*how* it was said). They found that, overall, disputative goal instructions led to higher frequency of competitive interpersonal regulation (e.g., increase of face threat, markers of interpersonal conflict, moves promoting the devaluation of the partner's contributions) and less collaborative interpersonal regulation (e.g., attempts of joint problem solving, reduction of face threat, self-deprecating statements, expressions aimed at maintaining a pleasant atmosphere, and more). Surprisingly, however, it also led to more critical reasoning than in the deliberative goal condition, even though critique was an essential part of *both.* type of instructions (see Figure 3).

These results show that discourse goal instructions do shape student discourse, but that the relations between goal instructions and the actual dialogue are not as straightforward as could have been expected. More research is needed to specify which and how discourse goal instructions affect student argumentation. In addition, their effect is likely to be dependent on existing discourse routines and norms, as well as individual attributes, such as a student's sense of self-efficacy in the topic domain and (as we will show later on) gender.

Teacher scaffolding. There is ample research on teacher scaffolding of whole classroom and small-group student discourse. Even though the majority of this research does not specifically focus on argumentation *per se* or does not distinguish between argumentation and other discourse types, much can belearned from it. Moreover, while not using the term *argumentation*, the discourse that is targeted in several prominent programs -such as "Collaborative Reasoning" (e.g., Anderson, Chinn, Waggoner, &

Nguyen, 1998), "Accountable talk" (Resnick, Asterhan, & Clarke, 2015; Resnick, Michaels & O'Connor, 2010), or "Exploratory Talk" (Mercer & Littleton, 2009)- is in essence very similar to what we referred to here as deliberative argumentation.

Webb (2009) has succinctly reviewed the empirical research on teacher support of students' small-group discourse. Overall, low-content teacher interventions that aim at eliciting student thinking seem to be more effective in sustaining productive student dialogue than providing explicit, content-specific explanations and instructions (e.g., Webb et al., 2008, Chiu, 2004; Gillies, 2004). Although the teacher does not control the peer discussions, (s)he prompts students to use evidence to support their arguments, asking for clarification, challenging students' arguments, or praising students who state their own ideas or challenge others' (Anderson et al., 1998; Chinn, Anderson, &Waggoner, 2001; Mercer & Littleton, 2009).

Research on teacher-guided classroom discourse similarly emphasizes the importance of teacher scaffolding and probing of student reasoning (Mercer & Littleton, 2010; Michaels et al., 2007; Resnick et al, 2010), for example by asking students to apply their own reasoning to someone else's ("Do you agree or disagree and why?"), prompting students for further elaboration ("Would you like to add on?"), challenge ideas ("Is this always true?"), and asking students to explicate their reasoning ("Why do you think that?"). In addition to having a direct effect on the teacher-guided discussion quality, teacher behavior during whole classroom (Webb, 2015) and small group discussions (Jadallah et al., 2011) also serves as a model, which is imitated in peer-to-peer dialogue when teachers are absent. Finally, long-term programs in which teacher-guided small-group argumentation was iterated show immediate and delayed effects on the quality of students' small group discussions (Jadallah et al., 2011; Mercer et al, 2004; Wegerif et al., 1999).

Traditionally, teacher scaffolding has been studied in face–to-face, classroom setting. A considerable amount of communication between teachers and students has migrated to the digital sphere, however, either alongside or instead of face-to-face communication. Given the differences between discussions in the two settings (see the discussion on Communication Media), questions are raised as to whether teacher scaffolding will be equally effective in online argumentation. Little empirical research is available, but first findings indicate that the quality of online student argumentation indeed improves with real-time, online teacher monitoring and interventions (Asterhan, Schwarz, & Gil, 2012; Schwarz & Asterhan, 2011). However, the type

and form of teacher interventions that are effective for online student argumentation may prove to be somewhat different from their F2F counterpart, tending towards more involved and direct styles, such as Devil's advocate strategies (Asterhan & Schwarz, 2010). These first tentative conclusions about differences in teacher scaffolding of argumentation in online and face-to-face settings will have to be subjected to further empirical investigation.

Software design for supporting argumentation processes. A number of software tools have been designed and developed to facilitate argumentation processes in real-time. Prominent software design features that have been examined empirically are, among others, computerized collaboration scripts (e.g., Fischer, Kollar, Stegmann, & Wecker, 2013; Weinberger et al, 2005), visual representations of argumentation structures (e.g., van Amelsvoort et al., 2007; Schwarz & de Groot, 2007), predefined sentence openers and dialogue move classifiers (e.g., Jeong & Joung, 2007; Oh & Jonassen, 2007), and automated group arrangement to create maximal divergence of ideas (e.g., Clark & Sampson, 2007; Jermann & Dillenbourg, 2003). Most of these computerized support tools could be (and have been) implemented in face-to-face settings as well (e.g., King & Rosenshine, 1993 for collaboration scripts and Mercer & Littleton, 2007 for cards with sentence openers). However, the advantage of the computerized counterparts of these external support tools for real-time argumentation is that they are less obtrusive and require less cognitive effort from the discussants themselves, as they are embedded in the discussion environment.

A detailed description of this extensive field of design research is outside of the scope of the current paper and can be found in other published reviews (e.g., Asterhan, 2012; Noroozi et al., 2012; Scheuer et al, 2010; Wecker & Fischer, 2014). Taken together, these reviews show that there is considerable promise for technology design to support students' online argumentation. However, several lacunae need to be mentioned here: First, results in this field of research are often specific to design decisions made during the tool development phase and the particular communication format that is chosen. A more integrative approach is needed to arrive at a clear set of general design recommendations for real-time support of argumentation in online and face-to-face settings (Asterhan, 2013; Scheuer et al, 2010). Secondly, research in this field is often

design-driven and characterized by cycles of system development and short-term implementations to test its effectiveness. There is little follow-up research that examines student student argumentation in novel settings without the software support (but see Wecker & Fischer, 2011, and Iordanou, 2013, for exceptions). Thus, it is not always clear if and to what extent these external supports may have affected the learner's *internal* scripts (Fischer et al, 2013), routines or norms. Third, as pointed out by Fischer et al (2103), real-time process guidance should be carefully calibrated with existing *internal scripts* and existing skill development. Similar to the *expertise reversal effect* (Kalyuga, Ayres, Chandler, & Sweller, 2003), externally imposed collaboration support tools can be counter-effective, when they inhibit the learner's autonomous application of procedural knowledge, internal scripts and skills that are already available and productive (Dillenbourg, 2002; Fischer et al., 2013).

Finally, and most pertinent to our current purpose, the majority of this CSCL research has focused on the effects of software design on online argumentation or on individual knowledge gains about argumentation, without empirically considering its effects on individual domain-specific learning gains. As aforementioned, the recent meta-analysis by Wecker and Fischer (2014) revealed that, when included, there was no overall effect on domain-specific learning. One reason may be that many of these software design initiatives have focused primarily on the more structural components of argumentation (e.g., distinguishing between evidence and claims, providing an argument, a counterargument, or a synthesis of the two), and less so on the social, transactive aspects of argumentive dialogue (Fischer et al., 2013; Noroozi et al., 2013). Amputating argumentation from its social-dialogic dimension may impair learning gains. In any case, more research is needed in each of these directions.

Individual characteristics

Research on individual differences that enable or inhibit productive argumentation has traditionally focused on cognitive variables, such as prior domain-specific knowledge and argumentation skill, as well as on epistemological beliefs. Recently, scholars of argumentation have begun to explore non-cognitive factors, such as motivation and gender, as well.

Cognitive characteristics. Research shows that prior domain-specific knowledge is predictive of the quality of student argumentation in that domain (Golanics & Nussbaum, 2008; Means & Voss, 1996). This makes sense, since in order to generate and weigh meaningful alternatives, to produce counterclaims and to rebut challenges, one cannot be ignorant on the

topic of discussion and its domain. If prior knowledge cannot be assumed, then the argumentation activity is typically preceded by an individual or collaborative studying of instructional materials on the topic. Little is known, however, about whom gains most from argumentation: Students with high or students with low prior-knowledge? Moreover, even if they should equally gain from argumentation, the way in which argumentation may support learning may be quite different: High prior-knowledge learners may consolidate existing knowledge structures through challenges and refutations, whereas low prior knowledge students may discover and resolve gaps in understandings through moves in which consensual argument elaboration is more frequent.

Individual differences in the skills of argumentation have been studied intensively since the early 1990-s. This body of research shows that, compared to ideal standards of rational argumentation, few individuals attain proficiency during adolescence and adulthood (Brem & Rips, 2000; Felton & Kuhn, 2001; Kuhn, 1991; Kuhn & Udell, 2003; Perkins, Faraday, & Bushey, 1991). Among others, people find it difficult to separate between evidence and explanation (Brem & Rips, 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 (Glassner & Schwarz, 2005), and to generate alternative ideas in science domains (de Vries et al., 2002; Asterhan & Schwarz, 2009a).

Even though interpersonal differences in cognitive ability are certainly likely to play a role (Voss & Means, 1996), underdeveloped competencies in argumentation may be as much a matter of insufficient skill practice and socialization, both inside as well as outside of school settings (Duschl & Osborne, 2002; Mercer & Littleton, 2007; Osborne, 2010). Children from different social backgrounds (Bernstein, 1975; Hart & Risley, 1995) and in different educational tracks (Applebee, Langer, Nystrand, & Gamoran, 2003; Pauli & Reusser, 2015) experience different amounts and quality of language at home and in school. Picking up on the norms and skills for argumentation requires sufficient modelling and practice. Indeed, an increasing body of research has shown that when argumentation activities become an integral part of the classroom experience,

students can become quite capable in argumentation on similar and new topics (e.g., Frijters et al, 2008; Iordanou, 2010; Kuhn, Goh, Iordanou & Schaenfeld, 2008; Kuhn & Crowell, 2011; Mercer et al, 2004; Reznitskaya et al, 2001).

Whereas these studies show that argumentive skills can be honed through programs of recurrent practice in dialogic argumentation (i.e., learning to argue), they do not explore how this in turn may impact the learning of domain-specific knowledge (i.e., arguing to learn). Arguably, improved argumentation skill should enable students to better profit from argumentive discussions and gain more knowledge from participating in them. Some studies have reported on positive associations between argumentive skills and domain-specific learning gains in science classrooms (Bathgate et al., 2015; Zohar & Nemet, 2001). However, and as aforementioned, it is not clear whether other individual differences, such as cognitive competencies, can account for this covariance. Moreover, task design in some intervention programs for argumentive skill development (e.g., Kuhn et al, 2008; Kuhn & Crowell, 2011) mainly promote debate-like, competitive argumentation. Given our previous review on the differential effects of disputative and deliberative argumentation for domain-specific learning, it is then not clear whether these gains from debate-like activities would in turn promote content learning gains.

Epistemological beliefs. Epistemic thinking involves metacognitive awareness of and reflection on the individual's personal knowledge and knowing, as well as on the nature knowledge and knowing in general (Barzilai & Zohar, 2014; Chinn, Buckland, & Samarapungavan, 2011; Hofer, 2004; Mason & Bromme, 2010). Research on epistemic thinking spans a broad field and includes many different conceptualizations. One particular model that is often referred to and particularly relevant to argumentation, concerns the distinction between absolutist, multiplist and evaluativist levels of epistemic understanding (Kuhn, Cheney, & Weinstock, 2000). From an absolutist perspective, knowledge consists of facts that are to be discovered or uncovered. From a multiplist perspective, on the other hand, knowledge consists not of facts but of opinions, freely chosen by their holders as personal possessions. Multiplists are then less likely to explore differences and inconsistencies and less likely to become genuinely involved in argumentation (Kuhn, Wang & Li, 2011). From an evaluativist perspective, knowledge assertions are judgments that can be evaluated and compared according to criteria of argument and evidence (Kuhn et al., 2000). Evaluativists are then more likely to appreciate the value and even necessity of argumentation, and are therefore more disposed to engage in it.

Indeed, substantive empirical evidence has now accumulated showing that such individual differences in epistemological understanding play an important role in argument skill demonstration (Kuhn, Wang & Li, 2011; Mason & Scirica, 2006; Nussbaum, Sinatra, & Poliquin, 2008; Weinstock, 2011; Weinstock, Neuman, & Tabak, 2004).

However, more research is needed to address two particular caveats in the literature on epistemology and argumentation to learn: First of all, the research on personal epistemology, argumentation and learning has mainly focused on correlative designs exploring the relation between existing individual differences in epistemological beliefs and the latter two in separation. Experimental designs areneeded to eliminate the possibility of spurious correlations. Secondly, research on the role of personal epistemology in argumentation tasks has been limited to essay writing and interviewing, whereas its role in peer argumentive discourse has been explored only minimally (see Nussbaum et al, 2008 for a notable exception). Finally, recent research has emphasized the malleable nature of epistemic perspectives and stance and how these may be induced by, for example, manipulating the epistemic representation of scientific information (Kienhues, Bromme, & Stahl, 2008; Porsch & Bromme, 2011) and specifically designed classroom activities (Louca, Elby, Hammer & Kagey, 2004). Chinn et al (2011) pledge for a context-specific analysis based at a fine size-grained observations to study the role of epistemic aims and of the sources and justification of knowledge in classroom activities. These perspectives view epistemic cognition less as unitary and stable characters of the individual, but more as a local, temporarily induced state. This has implications for argumentive task designs and teacher scaffolding, as well as for empirical research on argumentation and epistemic cognition: If epistemic stance can be induced and shaped, then experimental research into effects of epistemic sensitization on argumentation and learning seems a natural next step.

Motivation. Even though there seems to be general agreement about the necessity of active student engagement, surprisingly little is known about the role of motivation in argumentation. An exception to this paucity of attention is the study of achievement goals. According to achievement goal theory (e.g., Dweck, 2006; Harackiewicz, Barron, Pintrich, Elliot, & Thrush, 2002; Nicholls, 1984), students pursue mastery goals when they define success in terms of learning and progress and strive to acquire worthwhile skills and understandings. In contrast, students pursue performance goals when they define success in terms of proving their ability, especially relative to others, and strive to

demonstrate superior ability (performance-approach goal) or to avoid the demonstration of inferior ability (performance-avoidance goal). Achievement goals and their effect on learning behaviours have been studied primarily in individual settings, showing that they lead to different responses when students meet with challenges and difficulty (see Butler, 2000; Midgley, Kaplan & Middleton, 2001). Until recently, little was known about the effect of achievement goals in social learning interactions, however. Darnon and colleagues (e.g., Darnon et al., 2007; Darnon, Muller, Schrager, Pannuzzo, & Butera, 2006) showed that achievement goals affect how students attempt to resolve conflict: Performance-approach goals orient students to focus on the interpersonal dimension of a disagreement, whereas mastery goals orient students to its epistemic dimension.

More recent research specifically examined achievement goals in argumentive discourse and in learning settings: In a first study (Asterhan, Schwarz, & Butler, 2009), undergraduates solved a challenging science task in astronomy. They were then asked to report how they would behave if they were required to collaborate with a peer student who disagreed with their solution. Individual differences in achievement goal orientations predicted differences in self-reported behavioral intents: Performance-approach goals and confidence were associated with disputative argumentation (e.g., trying to defend one's own solution at any price, proving that the other is wrong), mastery goals were associated with deliberative argumentation (e.g., trying to understand what the other person thinks, considering different alternatives together) and performance-avoidance goals positively predicted quick consensus-seeking (e.g., trying to avoid confrontations, deferring to the other person's views). In a follow-up study (Asterhan, in preparation), this pattern of association between achievement goals and discourse types was replicated on a novel learning task in a different domain (economics).

In an experimental study by Sofer-Vital, Schwarz and Butler (2012), undergraduate student dyads received different achievement goal instructions prior to conducting an argumentive discussion on a socio-scientific topic. Students who received mastery and performance-approach goal instructions showed similar learning gains, which were higher than those who received performance-avoidance instructions. Post-hoc dialogue analyses revealed that the latter were more likely to avoid argumentation, but that disputative argumentation was overall rare in this setting. As is the case with research on discourse goal instructions, the

outcomes of achievement goal instructions on peer-to-peer argumentation are once again not straightforward.

Based on these first findings, we propose the following tentative conclusions, which need to be subjected to further research: Individual differences in achievement goals are well aligned with differences in the goals that students pursue and how they behave during peer learning interactions. Attempts to change social interaction through goal *instructions* (whether these are achievement or discourse goals) have met with mixed success, however: Even though goal instructions do seem to affect peer discourse overall, these effects are not always in the intended direction. More research is needed that takes into consideration individual variables that are likely to moderate the effectiveness of such goal instructions.

Finally, even though some headway has been made regarding achievement goals, research should include additional motivational variables that are likely to affect argumentation and learning from argumentation, such as students' belief about effort and intellectual competence (Dweck, 2006) and their perception of whether they have a right to speak (Clarke, 2015).

Gender. Men and women differ in the degree to which they tend towards more confrontational or more consensual discourse (e.g., Cameron, 1998; Leman, 2010; Stokoe, 2000; Weatherall, 2000). In their early review of research on same-sex peer groups, Maltz and Borker (1982) distinguished between the competitive, adversarial speech of boys which aims at asserting and maintaining dominance and the collaborative, affiliative speech of girls which aims to "create and maintain relationships of closeness and equality" (p. 424). Socio-linguist Deborah Tannen (1990) proposed that men are more comfortable with public speaking (report talk) and women with private speaking (rapport talk). Rapport talk establishes relationships, seeking similarities and matching experiences. Men tend to approach conversations more often as "negotiations in which people try to achieve and maintain the upper hand if they can, and protect themselves from others' attempts to put them down and push them down" (p. 24-25). These distinctions have been supported in scores of studies that have examined conversational styles in a wide range of settings, domains, and ages (see Maccoby, 1998 for a review).

Against this background, it is surprising that research on argumentation has almost not considered gender. Modest steps have been taken by Asterhan, Schwarz and Gil (2012) in an in-vivo study on same-sex, online group discussion in collocated 9th grade classrooms. All-female groups scored higher than all-male groups on measures of participation rates, interaction density and argumentive quality (e.g., frequency of complex arguments and alternative perspectives). However, this study did not explore whether male and female students also engage in different *types* of argumentive discourse, as suggested from the communication studies on gender differences.

Based on the above-mentioned literature there are grounds for anticipating that argumentation in male groups will tend towards disputative, adversarial argumentation over other discourse types, while female learners will show the opposite tendency to engage in more consensual co-construction. However, argumentation research has yet to address whether such gender differences exist in formal learning settings.

If they do, one relevant question would be how such engendered discourse tendencies towards disputative debate (for males) and consensus-seeking (for females), could be countered to elicit deliberative argumentation that balances between co-construction and critique. Asterhan and colleagues (2010) tested the effect of different discourse goal instructions (disputative vs. deliberative argumentation) for same-sex, computer-mediated peer dialogue on a conceptual change task. Dialogue analyses showed that discourse goal instructions that were aligned with engendered discourse preferences exacerbated existing tendencies and led to unbalanced dialogue: For female dyads, instructions that emphasized collaboration led to mostly consensual dialogue that was void of critique, whereas for male dyads instructions that emphasized interpersonal conflict led to disputative discourse that was void of co-construction. However, discourse goal instructions that emphasized the opposites of existing tendencies towards engendered discourse evoked more balanced dialogue for both gender groups (that is: deliberative argumentation), particularly the female dyads, which ultimately resulted in superior individual learning gains compared to the gender-aligned instructions (Asterhan, et al., 2010). These first findings are intriguing and reveal how different enablers and inhibitors of productive argumentation (gender and goal instructions in this case) may interact in complex and sometimes surprising ways.

Clearly, more research is needed to investigate the role of gender and engendered discourse differences in argumentation. Even when the study of gender is not an explicit research goal, argumentation scholars should do well to control or to at least to report on gender composition in their samples, to allow for comparisons between research results.

Social and cultural factors

Social relations, peer status and friendship. In peer learning settings, students are not only concerned with mastering the academic content and with relative competence (see Motivation section), but also with social relations, social status and friendship (Hijzen, Boekaerts & Vedder, 2007). Quality of friendship, sense of relatedness and peer acceptance are major concerns for students of all ages (Aikins, Bierman, & Parker, 2005; Kingery, Erdley, & Marshall, 2011; Wentzel, Barry, & Caldwell, 2004). Students may then perceive the request to conduct a critical discussion with a disagreeing peer as conflicting or even incommensurate with the desire to maintain pleasant, harmonious relationships with peers (Asterhan, 2013), causing them to avoid disagreements and critique. In a self-report study, Nussbaum and Bendixen (2003) found that avoiding argumentation was predicted by an individual's need to maintain warm interpersonal relations. Van der Puil, Andriessen and Kanselaar (2004) reported that prolonged sequences of argumentation are often followed by time dedicated to repairing the relationship, as if argumentation itself has a negative effect on the relationship between the participants.

Research in the cooperative learning literature has shown that students of lower peer status participate less frequently in peer-led group work (see Webb, 2009, for a review). Thus far, the role of peer status and friendship in argumentive discourse has not been considered, however. A notable exception is a recent study on fourth-graders' small-group argumentation by Lin et al. (2015). They collected detailed data about 4th graders' small group argumentive discussion, as well as their friendship relations and peer status (peer network centrality). They found that children with higher network centrality (i.e., more popular ones) were more active and cogent discussants: They provided both more support as well as more challenges to their peers' arguments. Furthermore, children were also more likely to support the ideas proposed by their friends. On first impression, this corroborates with reports from adjacent research that agreement and quick resolving of

disagreement is more frequent in all-friend groups (Newcomb & Bagwell, 1995). However, Lin and colleagues also found that they were equally likely to disagree with friends than with other group members.

In fact, challenges and disagreement may play a different role in interactions with (close) friends in comparison with strangers or acquaintances: Whereas they may be perceived as threatening among non-friends, some research shows that challenges, teasing and playful condescendence are expected in and even signify close relationships among friends (Ogan, Finkelstein, Walker, Carlson & Cassell, 2012). In an exploratory study, Ogan et al (2012) found that whereas these behaviors positively predicted learning gains among dyads of friends, they were negatively associated with learning gains of individuals that had interacted with strangers. One may conclude, albeit cautiously, that friendship provides a safe zone, in which it is acceptable to challenge and to be challenged, while both partners actively listen to and respect each other. This combination of critique and challenge combined with openness and respect would arguably make for a potentially productive learning interaction.

While still very premature, these first findings point to an exciting new venue for further research, whose findings are likely to have a bearing on several of the aforementioned features of the AFL framework (e.g., characteristics of productive dialogue, motivation, task design) as well as the next and final one: Local and cultural norms of argumentation.

Local and cultural norms. We end our discussion of the enablers and inhibitors of argumentation with an obvious but often overlooked direction – the local and cultural norms that shape expectations about how, when and for whom it is acceptable to engage in argumentation. As aforementioned, argumentation is as much a matter of skill and practice, as it is a matter of recognizing the need to do so (Kuhn et al., 2008). Bathgate, Crowell, Schunn, Cannady and Dorph (2015) found that one's willingness to engage in argumentive discourse moderates associations between argumentive competence and learning in middle school science classes. Students' perceptions of argumentation as a devalued activity (e.g., because of inability to change another's opinion and/or that disagreement is 'not nice') were also associated with lower classroom learning. Linking back to some of the research mentioned in the previous sections, teachers should then model deliberative argumentation, to avoid that students come to perceive argumentation only as a matter of interpersonal conflict, as well as tackle multiplist epistemic beliefs, to avoid that students do not see the point in argumentation.

Cobb and colleagues (Cobb et al., 2001; Yackel & Cobb, 1996) have shown that mathematics teachers dedicated to progressive pedagogies create a *mini-culture* in which argumentation and collective reflection are worthwhile and valuable. Kuhn, Zillmer, Crowell and Zavala (2013) implemented a 1 *yr* long program in which argumentive practices were intensively iterated. They showed how the adoption of argumentive norms was reflected in increased meta-discourse on argumentation. Recently, Schwarz and Shahar (in press) showed how the enactment of various argumentive activities in a one-year long middle school history course led students to appropriate argumentation norms.

In addition to recognizing the value of argumentation, students' perceptions about when and with whom they are expected or entitled to participate in argumentation may also vary. Differences in such perceptions may depend on the academic discipline (is critique only expected in social studies, or also in science class?), the academic track (is discussion only expected in high-track classrooms?), and the teacher's behavior (is discussion a space for exploration or a podium for showing ability?). In a recent study, Clarke (2015) interviewed middle school students that were consistently silent during teacher-led classroom discussions. She found that these students believed that the right to speak is reserved for those who “know the correct answers”. Even though the importance of ground rules for productive argumentation has been emphasized repeatedly in different intervention programs (e.g., Mercer & Littleton, 2009), it seems that research could focus more on the students' viewpoint and how *they* perceive the unwritten norms for when and how to participate in argumentation.

The larger cultural context is also likely to play an important role as critique and dissent may be valued more in certain cultures than in others. However, little is known about cultural differences in (values of) argumentation. Muntigl and Turnbull (1998) reported that some types of disagreement are perceived as more or as less aggressive in certain cultures. Weinberger and colleagues (2013) compared between online argumentation of Finnish and German student groups. They found that German groups were more conflict-oriented and that agreements played a slightly different role in the two groups. In a series of studies that included samples of Chinese and US students, Kuhn et al. (2011) explored students’ values and beliefs about the desirability of argumentation. In spite of some intercultural and age-related differences, they also reported on considerable

variance between individuals. Schwarz (2015) studied traditional dyadic learning (called *Chavruta*) in *Yeshivas* (houses of study in (ultra-)orthodox Judaism). Typically, dyads learn learn complex, dialectical texts (Talmudic texts) for 6 days a week for at least 10 years. The texts concern edited confrontational discussions among sages, generally around proper conduct in diverse practical domains. Within this context, Yeshiva students collaborate to learn the texts through high-level argumentation with one another, pushing each other in cognitive effort, and appropriating highly critical norms of discussion.

These examples then suggest that the norms of argumentation vary in different cultural settings. What is common practice in one, seems unacceptable in others. More research is then needed to study the norms of argumentation in different cultures, or, as has become increasingly common, in multi-cultural contexts, when these cultural norms may clash.

Concluding thoughts on the inhibitors and enablers of argumentation

In this section, we discussed research on the conditions and characteristics that enable (or inhibit) argumentation. We referred to them as the antecedents of argumentation, to distinguish it from aspects and characteristics of the argumentive dialogue itself and because, in empirical research, they precede the collection of data on argumentive discourse: They are either implemented or designed *prior* to the onset of the actual dialogue (e.g., task design, instructions, process support tools), manipulated on purpose to test the effects of a particular psychological construct on argumentation (e.g., achievement goal motivation), or measured prior to the dialogue (e.g., argumentive skill, epistemological beliefs).

Our categorization of the different enablers and inhibitors of argumentation into the five categories (i.e., task design, communication media, process support, individual characteristics, and social and cultural factors) mainly reflects the different foci and the different methodologies that characterize particular research traditions and venues. For example, research in educational psychology tends to focus more on individual differences on relevant psychological constructs that are measured with self-report surveys. Research within the learning sciences, on the other hand, tends to focus more on task design and CSCL support. Research on dialogical teaching has focused more on teacher scaffolding of small-group and classroom discussions. We believe that this categorization has been helpful to map the different types of research available, their respective findings and future areas of research. As we have tried to emphasize several times, the relationship between these different types of enablers and inhibitors is mutually influential and

should be taken into account. For example, motivational constructs such as achievement goal orientations do show some stability across situations (Muis & Edwards, 2009), but they can also be (temporarily) changed by the classroom culture, the particular task design and instructions, and the behavior of the teacher involved (e.g., Belenky & Nokes, 2012; Muis & Edwards, 2009).

Discussion and Conclusion

We proposed the three-node AFL framework for organizing existing and for undertaking new research on argumentation for learning. The AFL framework distinguishes between the antecedents, the dialogue characteristics and the learning outcomes of argumentation. A priori, specifying these three parts and the links between them just seems common sense for empirical research in the social sciences. We argue, however, that in the case of the literature on argumentation and learning, this articulation is instructive and highly needed since, in spite of a convincing theoretical rationale, empirical findings have been somewhat disparate, definitions of the objects of study (argumentation, learning) are not always well-defined, and the variance between research paradigms is large. By mapping the existing research on this framework, we hope to have brought some order to the field. It enabled us to identify claims that are supported with substantive empirical evidence, to reveal claims that require further empirical examination, and to uncover promising, unexplored venues of research.

We articulated distinctions between different types of discourse (e.g., disputative and deliberative argumentation, consensual co-construction), between different types of learning outcomes (e.g., conceptual and factual knowledge), and between different types of enablers and inhibitors of argumentation. We hope to have shown that when such distinctions are take into account, findings about argumentation for learning become more consistent and hypotheses about links between the different components in the framework can be specified.

Based on this review, some new insights about the mechanisms of learning through argumentation were delineated. For now, each of these insights is based on a small number of pioneering studies only and therefore warrant further empirical research:

First, argumentation may not be beneficial for all types of learning. Based on the findings reviewed here, it seems that argumentation is likely to be more effective for

learning complex topics (e.g., complex conceptual knowledge) that require deep cognitive engagement and the exploration of alternatives.

Second, even though argumentation is in essence about disagreement and critique, in order to be productive it should be immersed in an atmosphere of support, trust and respect. The models and empirical research reviewed here emphasize the role of deliberative argumentation as the type of dialogue that supports domain-specific learning. Deliberative argumentation is issue-driven, as opposed to person-driven (Keefer et al, 2000). This may not be achieved easily, since critique and collaboration are often perceived as two competing goals.

Third, research on how to facilitate argumentation has predominantly focused on cognitive antecedents and dimensions of argumentation, but has met with partial success only. In order to engage in argumentation, students should not only know how to argue, but also be *willing* to argue, to *value* argumentation, to *expect* benefits from argumentation and to feel *confident* in argumentive interactions.

We discerned a pronounced shift towards research on the social, motivational and interpersonal dimensions of argumentation. These non-cognitive dimensions are studied predominantly in the first and the second node of the framework, that is: as enablers and/or as characteristics of the dialogue. However, changes in motivational structures, norms, epistemological beliefs, and social competencies could also be considered as outcomes of argumentation (node three). Traditionally, research has focused on cognitive outcomes of argumentation (knowledge, skills and competencies), but there are recent exceptions: Programs of successive group argumentation activities in classrooms have been shown to increase student motivation in primary school (Wu, Anderson, Nguyen-Jahiel, & Miller, 2013), as well as promote empathy towards dissenting views among 12th graders (Goldberg & Ron, 2014).

Thus, the AFL research framework presented in Figure 1 should not be considered as representing a horizontal process with a beginning and an end, but rather as cyclic (see Figure 4): The outcomes of one activity can (and are likely to) be multiple and, in turn, become enablers of argumentation in the next cycle of activity. For example, through deliberative argumentation, students may not only come to process new information better, but they also practice and refine their argumentation skills in the process. Through recurrent participation in teacher-designed argumentive activities, students may gradually come to change their epistemological stance

towards a more evaluativist perspective, which in turn facilitates more productive argumentation, and so forth.

Insert Figure 4 About Here

Even though we specifically focused on argumentation as a means to improve domain-specific content learning in this paper, the cyclic AFL framework then also allows for the inclusion of other research on argumentation, particularly those that focus on long-term goals, such as the development of argumentation skills (Kuhn & Crowell, 2011), socialization of intelligence (Resnick et al, 2015) and preparation for productive participation in a deliberative democracy (Michaels et al, 2007; Sadler et al, 2007; Schwarz & Baker, 2016) through programs of recurrent classroom argumentation activities,.

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References

Aikins, J. W., Bierman, K. L., & Parker, J. G. (2005). Navigating the transition to junior high school: The influence of pre-transition friendship and self-system characteristics. *Social Development*, *14*(1), 42–60.

Ames, G. J., & Murray, F. B. (1982). When two wrongs make a right: promoting cognitive development through cognitive conflict. *Developmental Psychology*, *18*(6), 894e897. http://dx.doi.org/10.1037/0012-1649.18.6.894.

Amigues, R. (1988). Peer interaction in solving physics problems: socio-cognitive confrontation and metacognitive aspects. *Journal of Experimental Child Psychology*, *45*, 141-158.

Anderson, R. C., Chinn, C., Wagoner, M., & Nguyen, K. (1998). Intellectually stimulating story discussions. In J. Osborn and F. Lehr (Eds.), *Literacy for all* (pp. 170–186). New York, NY: Guilford.

Andriessen, J. E. & Baker, M. J. (2015). Arguing to Learn. In R. K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences* (pp. 439-460). Cambridge University Press.

Andriessen, J., Baker, M. & Suthers, D. (Eds.) (2003). *Arguing to Learn: Confronting Cognitions in Computer-Supported Collaborative Learning environments*. Kluwer Academic Publishers.

Andriessen, J. E. B. & Schwarz, B. B. (2009). Argumentative Design. In N. Muller-Mirza and A-N. Perret-Clermont (Eds.), *Argumentation and Education – Theoretical Foundations and Practices* (pp. 145-174). Springer Verlag.

Applebee, A. N., Langer, J. A., Nystrand, M., & Gamoran, A. (2003). Discussion-based approaches to developing understanding: Classroom instruction and student performance in middle and high school English. *American Educational Research Journal*, *40*(3), 685-730.

Arzarello, F. & Sabena, C. (2011). Semiotic and theoretic control in argumentation and proof activities. *Educational Studies in Mathematics, 77*, 189–206 DOI 10.1007/s10649-010-9280-3

Asterhan, C. S. C. (2015). Introducing online dialogues in collocated classrooms: If, why and how. In: L. B. Resnick, C. S. C. Asterhan, & S. Clarke (Eds), *Socializing Intelligence through academic talk and dialogue* (pp. 205-218). Washington, DC: AERA.

Asterhan, C. S. C. (2013). Epistemic and interpersonal dimensions of peer argumentation: Conceptualization and quantitative assessment. In: M. Baker, J. Andriessen & S. Jarvela (Eds.), *Affective learning together* (pp. 251-272). New York, NY: Routledge, Advances in Learning & Instruction series.

Asterhan, C. S. C. (2012). Facilitating classroom argumentation with computer technology. In: R. Gillies (Ed), *Pedagogies: New Developments in the Learning Sciences* (pp 105-129). Nova Science Publishers.

Asterhan, C. S. C., & Babichenko, M. (2015). The social dimension of learning through argumentation: Effects of human presence and discourse style. *Journal of Educational Psychology*, *107*(3), 740-755.

Asterhan, C. S. C., Butler, R., & Schwarz, B. B. (2010). Goals for learning and interaction in argumentation and conceptual change. In: K. Gomez, L. Lyons, & J. Radinsky (Eds.) Learning in the Disciplines: Proceedings of the 9th International Conference of the Learning Sciences (ICLS 2010) - Volume 1. International Society of the Learning Sciences: Chicago IL.

Asterhan, C. S. C., & Eisenmann, T. (2011). Introducing synchronous e-discussions in co-located classrooms: A study on the experiences of 'active' and 'silent' secondary school students. *Computers in Human Behavior, 27,* 2169 - 2177.

Asterhan, C. S. C., & Hever, R. (2015). Learning from reading SNS group discussions: Rhetoric style matters (again). *Computers in Human Behavior*, 53, 570-576.

Asterhan, C. S. C., & Schwarz, B. B. (2009a). The role of argumentation and explanation in conceptual change: Indications from protocol analyses of peer-to-peer dialogue. *Cognitive Science, 33,* 373-399.

Asterhan, C. S. C., & Schwarz, B. B. (2009b). Transformation of robust misconceptions through peer argumentation. In: B. B. Schwarz, T. Dreyfus, & R. Hershkowitz (Eds.) *Guided Transformation of Knowledge in Classrooms* (pp 159-172). New York, NY: Routledge, Advances in Learning & Instruction series.

Asterhan, C. S. C., & Schwarz, B. B. (2007). The effects of monological and dialogical argumentation on concept learning in evolutionary theory. *Journal of Educational Psychology, 99,* 626-639.

Asterhan, C. S. C., & Schwarz, B. B. (2010). Online moderation of synchronous e-argumentation. *International Journal of Computer-Supported Collaborative Learning, 5,* 259 – 282.

Asterhan, C. S. C., Schwarz, B. B., & Butler, R. (2009). Inhibitors and facilitators of peer interaction that supports conceptual learning: The role of achievement goal orientations. In N. A. Taatgen & H. van Rijn (Eds), *Proceedings of the 31st Annual Conference of the Cognitive Science Society* (pp. 1633-1638). Mahaw, NJ: Erlbaum

Asterhan, C. S. C., Schwarz, B. B., & Cohen-Eliyahu, N. (2014). Outcome Feedback during Collaborative Learning: Contingencies between Feedback and Dyad Composition. *Learning & Instruction, 34* (4), 1-10.

Asterhan, C. S. C., Schwarz, B. B., & Gil, J. (2012). Small-group, computer-mediated argumentation in middle-school classrooms: The effects of gender and different types of online teacher guidance. *British Journal of Educational Psychology, 82,* 375-397.

Baker, M. J. (2009). Intersubjective and intrasubjective rationalities in pedagogical debates. In B. B. Schwarz, T. Dreyfus, & R. Hershkowitz (Eds.) (pp. 145-158), *Transformation of*

knowledge through classroom interaction. New Perspectives on Learning and Instruction. EARLI Publication. Routledge.

Baker, M. J. (2003). Computer-mediated interactions for the co-elaboration of scientific notions. In: J. Andriessen, M. Baker, & D. Suthers (Eds.), *Arguing to learn: Confronting cognitions in computer-supported collaborative learning environments*. Utrecht: Kluwer Academic Publishers.

Barzilai, S., & Zohar, A. (2014). Reconsidering personal epistemology as metacognition: A multi-faceted approach to the analysis of epistemic thinking. *Educational Psychologist*, *49*(1), 13-35.

Bathgate, M., Crowell, A., Schunn, C., Cannady, M., & Dorph, R. (2015). The learning benefits of being willing and able to engage in scientific argumentation. *International Journal of Science Education*, (ahead-of-print), 1-23.

Belenky, D. M., & Nokes-Malach, T. J. (2012). Motivation and transfer: The role of mastery-approach goals in preparation for future learning. *Journal of the Learning Sciences*, *21*(3), 399-432.

Belenky, M. F., Clinchy, B. M. V., Goldberger, N. R., & Tarule, J. M. (1986). *Women's ways of knowing: The development of self, voice, and mind*. New York: Basic Books.

Bell, P. & Linn, M.C. (2000). Scientific arguments as learning artifacts: designing for learning from the web with KIE. *International Journal of Science Education*, *22*(8), 797- 817.

Berland, L. K., & Hammer, D. (2012). Framing for scientific argumentation. *Journal of Research in Science Teaching*, *49*, 68-94. doi: 10.1002/tea.20446

Berland, L. K., & Lee, V. L. (2012). In pursuit of consensus: Disagreement and legitimization during small-group argumentation. *International Journal of Science Education*, *34*(12), 1857-1882. doi:10.1080/09500693.2011.645086

Berland, L.K., & Reiser, B. J. (2011). Classroom communities' adaptations of the practice of scientific argumentation. *Science Education*, 95(2), 191–216. doi: 10.1002/sce.20420

Bernstein, B. (1975). Class and Pedagogies: Visible and Invisible. *Educational studies*, *1*(1), 23-41.

Brem, S. K., & Rips, L. J. (2000). Explanation and evidence in informal argument. *Cognitive science*, *24*(4), 573-604.

Brennan, S. E., Galati, A. & Kuhlen, A. K. (2010). Two minds, one dialog: Coordinating speaking and understanding. In Brian H. Ross (Ed.), *The Psychology of Learning and Motivation*, Vol. 53 (pp.301-344). Burlington: Academic Press.

Britt, M., & Aglinskas, C. (2002). Improving students' ability to identify and use source information. *Cognition and Instruction, 20*(4), 485–522.

Butera, F. & Mugny, G. (1995). Conflict between incompetences and influence of a low-expertise source in hypothesis testing. *European Journal of Social Psychology, 25*, 457-462.

Butler, R. (2000). What learners want to know: The role of achievement goals in shaping seeking, learning and interest. In C. Sansone & J. M. Harackiewicz (Eds.), *Intrinsic and extrinsic motivation: The search for optimal motivation and performance* (pp. 11-194). San Diego, CA: Academic Press.

Cameron, D. (1998). Language, gender and discourse: A review. *Signs: Journal of Women, Culture and Society, 23*(4), 945-73. doi:10.1086/495297

Carnevale, P. J., & Probst, T. (1998). Social values and social conflict in creative problem solving and categorization. *Journal of Personality and Social Psychology, 74*, 1300-1309.

Chi, M. T. H. (2008). Three types of conceptual change: Belief revision, mental model transformation, and categorical shift. In S. Vosniadou (Ed.), *Handbook of research on conceptual change* (pp. 61-82). Hillsdale, NJ: Erlbaum.

Chi, M. T. H., DeLeeuw, N., Chiu, M., & Lavancher, C. (1994). Eliciting self-explanations improves understanding. *Cognitive Science, 18*, 439-477.

Chi, M. T. H. & Menekse, M. (2015). Dialogue patterns that promote learning. In L. B. Resnick, C. Asterhan, and S, Clarke (Eds.), *Socializing Intelligence through academic talk and dialogue* (pp. 263-273). Washington, DC: AERA.

Chin, C. & Osborne, J. (2010). Supporting argumentation through students' questions: case studies in science classrooms. *Journal of the Learning Sciences*, 19(2), 230-284. doi: 10.1080/10508400903530036

Chinn, C. A., Anderson, R. C., & Waggoner, M. A. (2001). Patterns of discourse in two kinds of literature discussion. *Reading Research Quarterly, 36*, 378–411.

Chinn, C. A., Buckland, L. A., & Samarapungavan, A. L. A. (2011). Expanding the dimensions of epistemic cognition: Arguments from philosophy and psychology. *Educational Psychologist*, *46*(3), 141-167.

Chinn, C. A., & Clark, D. B. (2013). Learning through collaborative argumentation. In C. E. Hmelo-Silver, C. A. Chinn, C. K. K. Chan, & A. M. O'Donnell (Eds.), *The international handbook of collaborative learning* (pp. 314–332). New York: Routledge.

Chiu, M. M. (2004). Adapting teacher interventions to student needs during cooperative learning: How to improve student problem solving and time on-task. *American Educational Research Journal*, 41, 365–399. doi:10.3102/00028312041002365

Clark, D. B., & Sampson, V. (2008). Assessing dialogic argumentation in online environments to relate structure, grounds, and conceptual quality. *Journal of Research in Science Teaching*, *45*, 293–321. doi: 10.1002/tea.20216

Clarke, S. N. (2015).The right to speak. In: L. B. Resnick, C. S. C. Asterhan & S. Clarke (Eds), *Socializing Intelligence through academic talk and dialogue* (pp. 167-180). Washington, DC: AERA.

Cobb, P., Stephan, M., McClain, K., & Gravemeijer, K. (2001). Participating in classroom mathematical practices. *The Journal of the Learning Sciences*, *10*(1&2), 113 – 164.

Coleman, E. B. (1998). Using explanatory knowledge during problem solving in science. *Journal of the Learning Sciences*, *7*(3&4), 387-427. doi: 10.1080/10508406.1998.967205.

Crowell, A., & Kuhn, D. (2014). Developing dialogic argumentation skills: A three-year intervention study. *Journal of Cognition and Development*, *15*, 363-381.

Darnon, C., Butera, F., & Harackiewicz, J. M. (2007). Achievement goals in social interactions: Learning within mastery vs. performance goals. *Motivation & Emotion*, *31*, 61-70. DOI 10.1007/s11031-006-9049-2

Darnon, C., Muller, D., Schrager, S. M., Panuzzo, N., & Butera, F. (2006). Mastery and performance goals predict epistemic and relational conflict regulation. *Journal of Educational Psychology*, *98*, 766-776. doi: 10.1037/0022-0663.98.4.766

deLeeuw, N. & Chi, M.T.H. (2003). The role of self-explanation in conceptual change learning. In G. Sinatra & P. Pintrich (Eds.), *Intentional conceptual change* (pp. 55-78). Erlbaum

De Vries, E., Lund, K., & Baker, M. (2002). Computer-mediated epistemic dialogue: Explanation and argumentation as vehicles for understanding scientific notions. *Journal of the Learning Sciences, 11*, 63-103.

Dillenbourg, P. (2002). Over-scripting CSCL: The risks of blending collaborative learning with instructional design. In P. A. Kirschner (Ed.), *Three worlds of CSCL: Can we support CSCL?* (pp. 61-91). Heerlen: Open Universiteit Nederland.

Doise, W., Mugny, G., & Perret-Clermont, A.-N. (1975). Social interaction and the development of logical operations. *European Journal of Social Psychology, 6*(3), 367-383. http://dx.doi.org/10.1002/ejsp.2420050309.

Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education, 84*, 287 – 312.

Durkin, K. & Rittle-Johnson, B. (2012). The effectiveness of using incorrect examples to support learning about decimal magnitude. *Learning and Instruction*, 22(3), 206-214.

Duschl, R. A., & Osborne, J. (2002). Supporting and promoting argumentation discourse in science education. *Studies in Science Education, 38*, 39-72.

Dweck, C. (2006). *Mindset: The new psychology of success*. Random House.

Engle, R. A. & Conant, F. R. (2002). Guiding Principles for Fostering Productive Disciplinary Engagement: Explaining an Emergent Argument in a Community of Learners Classroom, *Cognition and Instruction, 20*(4), 399-483.

Erduran, S., Osborne, J. F., & Simon, S. (2004). Enhancing the quality of argument in school science. *Journal of Research in Science Teaching, 41*(10), 994 – 1020. doi: 10.1002/tea.20035

Felton, M., Crowell, A., & Liu, T. (2015). Arguing to agree mitigating my-side bias through consensus-seeking dialogue. *Written Communication, 32*, 1-15.

Felton, M., Garcia-Mila, M. & Gilabert, S. (2009). Deliberation versus dispute: The impact of argumentative discourse goals on learning and reasoning in the science classroom. *Informal Logic, 29*, 417-446.

Felton, M., & Kuhn, D. (2001). The development of argumentive discourse skills. *Discourse Processes, 32*, 135–153.

Fischer, F., Kollar, I., Stegmann, K., & Wecker, C. (2013). Toward a script theory of guidance in computer-supported collaborative learning. *Educational psychologist*, *48*(1), 56-66.

Ford, M. (2008). Disciplinary authority and accountability in scientific practice and learning. *Science Education*, *92*(3), 404-423.

Frijters, S., ten Dam, G. & Rijlaarsdam, G. (2008). Effects of dialogic learning on value-loaded critical thinking. *Learning and Instruction, 18*(1), 66-82.

Gabriele, A. J. & Montecinos, C. (2001). Collaborating with a skilled peer: The influence of achievement goals and perceptions of partners' competence on the participation and learning of low-achieving students. *Journal of Experimental Education*, 69(2), 152-178.

Gillies, R. M. (2004). The effects of communication training on teachers' and students' verbal behaviours during cooperative learning. *International Journal of Educational Research, 41*, 257–279.

Glassner, A. & Schwarz, B. B. (2014). Learning argumentation practices in school with a graphical synchronous discussion tool. In L. Shedletsky (Ed.), *Cases on Teaching Critical Thinking through Visual Representation Strategies* (pp. 418-445). doi: 10.4018/978-1-4666-5816-5.ch016

Glassner, A. & Schwarz, B. B. (2005). The antilogos ability to evaluate information supporting arguments. *Learning and Instruction, 15*, 353-375.

Golanics, J. D., & Nussbaum, E. M. (2008). Enhancing collaborative online argumentation through question elaboration and goal instructions. *Journal of Computer Assisted Learning, 24,* 167–180. doi: 10.1111/j.1365-2729.2007.00251.x

Goldberg, T., & Ron, Y. (2014). 'Look, each side says something different': The impact of competing history teaching approaches on Jewish and Arab adolescents' discussions of the Jewish–Arab conflict. *Journal of Peace Education, 11,* 1-29.

Goldberg, T., Schwarz, B. B., & Porat, D. (2011). Changes in narrative and argumentative writing by students discussing 'hot' historical issues. *Cognition and Instruction*, *29*(2), 185–217.

Guiller, J., Ross, A. & Durndell, A. (2008). Peer interaction and critical thinking: face-to-face or online discussion? *Learning and Instruction, 18,* 187-200.

Hammer, D., & Elby, A. (2003). Tapping students' epistemological resources. *Journal of the Learning Sciences, 12*(1), 53-91.

Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experience of young American children*. Baltimore, MD: Paul H Brookes.

Henningsen, M., & Stein, M. K. (1997). Mathematical tasks and student cognition: Classroom-based factors that support or inhibit high-level mathematical thinking and reasoning. *Journal for Research in Mathematics Education, 28*, 524–549.

Hiebert, J., Carpenter, T. P., Fennema, E., Fuson, K., Human, P., Murray, H., et al. (1996). Problem solving as a basis for reform in curriculum and instruction: The case of mathematics. *Educational Researcher, 25*(4), 12–21.

Hijzen, D., Boekaerts, M., & Vedder, P. (2007). Exploring the links between students' engagement in cooperative learning, their goal preferences and appraisals of instructional conditions in the classroom. *Learning and Instruction, 17*(6), 673-687.

Hofer, B. K. (2004). Epistemological understanding as a metacognitive process: Thinking aloud during online searching. *Educational Psychologist, 39*(1), 43-55. doi:10.1207/s15326985ep3901_5

Howe, C. (2009). Collaborative group work in middle childhood: Joint construction, unresolved contradiction and the growth of knowledge. *Human Development, 52*(4), 215-239. doi:10.1159/000215072.

Howe, C., Tolmie, A., Duchak-Tanner, V., & Rattay, C. (2000). Hypothesis-testing in science: Group consensus and the acquisition of conceptual and procedural knowledge. *Learning & Instruction, 10*, 361-391. doi:10.1016/S0959-4752(00)00004-9.

Iordanou , K. (2013): Developing face-to-face argumentation skills: Does arguing on the computer help? *Journal of Cognition and Development, 14*(2), 292-320.

Iordanou, K. (2010). Developing argument skills across scientific and social domains. *Journal of Cognition and Development, 11*(3), 293–27. doi:10.1080/15248372.2010.485335

Jadallah, M., Anderson, R. C., Nguyen-Jahiel, K., Miller, B. W., Kim I., Kuo, L., Dong, T., & Wu, X. (2011). Influence of a teacher's scaffolding moves during child-led small-group discussions. *American Educational Research Journal*, 48(1), 194-230. doi 10.3102/0002831210371498

Jeong, A., & Joung, S. (2007). Scaffolding collaborative argumentation in asynchronous discussions with message constraints and message labels. *Computers & Education, 48*, 427-445.

Jermann, P., & Dillenbourg, P. (2003). Elaborating new arguments through a CSCL scenario. In G. Andriessen, M. Baker, & D. Suthers (Eds.), *Arguing to learn: Confronting cognitions*

in computer supported collaborative learning environments (pp. 205–226). Amsterdam: Kluwer CSCL Book Series.

Jiménez-Aleixandre, M. P. (2007). Designing argumentation learning environments. In *Argumentation in science education* (pp. 91-115). Springer Netherlands.

Jiménez-Aleixandre, M. P. (1992). Thinking about theories or thinking with theories? A classroom study with natural selection. *International Journal of Science Education, 14*(1), 51-61.

Kalyuga, S., Ayres, P., Chandler, P., & Sweller, J. (2003). The expertise reversal effect. *Educational psychologist, 38*(1), 23-31

Kapur, M. (2008). Productive failure. *Cognition & Instruction, 26*, 379-424. doi: 10.1080/07370000802212669

Keefer, M. W., Zeitz, C. M. & Resnick, L. B. (2000). Judging the quality of peer-led student dialogues. *Cognition and instruction, 18*(1), 53-81.

Keil, F. C. (2006). Explanation and understanding. *Annual Review of Psychology, 57*, 227–254.

Kienhues, D., Bromme, R., & Stahl, E. (2008). Changing epistemological beliefs: The unexpected impact of a short-term intervention. *British Journal of Educational Psychology, 78*(4), 545-565. doi: 10.1348/000709907X268589

Kiesler, S., Siegel, J., & McGuire, T. W. (1984). Social psychological aspects of computer mediated communication. *American Psychologist, 39*, 1123-1134.

Kim, I-H., Anderson, R. C., Nguyen-Jahiel, K. & Archodidou, A. (2007). Discourse patterns during children's collaborative online discussions. *The Journal of the Learning Sciences, 16*(3), 333-370. doi:10.1080/10508400701413419

King, A., & Rosenshine, B. (1993). Effects of guided cooperative questioning on children's knowledge construction. *Journal of Experimental Education, 61*(2), 127-148.

Kingery, J. N., Erdley, C. A., & Marshall, K. C. (2011). Peer acceptance and friendship as predictors of early adolescence' adjustment across the middle school transition. *Merril-Palmer Quarterly, 57*(3), 215–243.

Kraut, R. E., Fussell, S. R., Brennan, S. E., & Siegel, J. (2002). Understanding effects of proximity on collaboration: Implications for technologies to support remote collaborative work. In P. Hinds & S. Kiesler (Eds.), *Distributed work* (pp. 137-162). Cambridge, MA, US: MIT Press.

Kuhn, D. (1991). *The skills of argument*. Cambridge: Cambridge University Press.

Kuhn, D., Cheney, R., & Weinstock, M. (2000). The development of epistemological understanding. *Cognitive Development, 15*(3), 309-328.

Kuhn, D., & Crowell, A. (2011). Dialogic argumentation as a vehicle for developing young adolescents' thinking. *Psychological Science, 22*, 545-552. doi: 10.1177/0956797611402512

Kuhn, D., Goh, W., Iordanou, K., & Shaenfield, D. (2008). Arguing on the computer: A microgenetic study of developing argument skills in a computer-supported environment. *Child Development, 79*, 1310–1328.

Kuhn, D., Hemberger, L., & Khait, V. (2014). *Argue with me: Developing thinking and writing through dialog*. Bronxville, NY: Wessex Press.

Kuhn, D., & Udell, W. (2007). Coordinating own and other perspectives in argument. *Thinking and Reasoning, 13*, 90–104.

Kuhn, D., Wang, Y. & Li, L. (2011). Why Argue? Developing Understanding of the Purposes and Values of Argumentive Discourse. *Discourse Processes, 48*, 26 – 49. doi: 10.1080/01638531003653344

Kuhn, D., Zillmer, N., Crowell, A., & Zavala, J. (2013). Developing norms of argumentation: Metacognitive, epistemological, and social dimensions of developing argumentive competence. *Cognition & Instruction, 31*(4), 456–496.

Lakatos, I. (1976). *Proofs and Refutations: The logic of mathematical discovery*. Cambridge: Cambridge University Press.

Latour, B., & Woolgar, S. (1986). *Laboratory Life: The Construction of Scientific Facts.* Princeton, NJ: Princeton University Press.

Leman, P. J. (2010). Gender, collaboration and children's learning. In K. Littleton & C. Howe (Eds.), *Educational dialogues: Understanding and promoting productive interaction* (pp. 216-239). London: Routledge.

Lemke, J. (1990). *Talking science: Language, learning and values*. Norwood, NJ: Ablex.

Lin, T. J., Anderson, R. C., Jadallah, M., Nguyen-Jahiel, K., Kim, I. H., Kuo, L. J., ... & Li, Y. (2015). Social influences on children's development of relational thinking during small-group discussions. *Contemporary Educational Psychology, 41*, 83-97.

Louca, L., Elby, A., Hammer, D., & Kagey, T. (2004). Epistemological resources: Applying a new epistemological framework to science instruction. *Educational Psychologist*, *39*(1), 57-68.

Maccoby, E. E. (1998). *The two sexes: growing up apart, coming together*. Cambridge, MA: Harvard University Press.

Maltz, D., & Borker, R. (1982). A cultural approach to male-female miscommunication. In: Gumperz, J. (Ed.), *Language and Social Identity*, (pp. 281-312). Oxford.

Mason, L., & Bromme, R. (2010). Situating and relating epistemological beliefs into metacognition: studies on beliefs about knowledge and knowing. *Metacognition and Learning*, *5*(1), 1-6.

Mason, L., & Scirica, F. (2006). Prediction of students' argumentation skills about controversial topics by epistemological understanding. *Learning and Instruction*, *16*(5), 492-509.

Means, M. L., & Voss, J. F. (1996). Who reasons well? Two studies of informal reasoning among children of different grade, ability, and knowledge levels. *Cognition & Instruction*, *14*, 139-179.

Mercer, N. (1996). The quality of talk in children's collaborative activity in the classroom. *Learning & Instruction*, *6*, 359-375.

Mercer, N., & Littleton, K. (2007). *Dialogue and the Development of Children's Thinking: a sociocultural approach*. London: Routledge.

Mercer, N., Wegerif, R. & Dawes, L. (1999). Children’s talk and the development of reasoning in the classroom. *British Educational Research Journal*, *25*(1), 95-111.

Michaels, S., O’Connor, C. & Resnick, L. (2009). Deliberative discourse idealized and realized: Accountable talk in the classroom and in civic life. *Studies in Philosophy of Education*, *27*(4), 283-297. DOI 10.1007/s11217-007-9071-1

Midgley, C., Kaplan, A., & Middleton, M. (2001). Performance-approach goals: Good for what, for whom, under what circumstances, and at what cost? *Journal of Educational Psychology*, *93*, 77-86.

Miller, B. W., Anderson, R. C., Morris, J., Lin, T. J., Jadallah, M., & Sun, J. (2014). The effects of reading to prepare for argumentative discussion on cognitive engagement and conceptual growth. *Learning and Instruction*, *33*, 67-80.

Muis, K. R., & Edwards, O. (2009). Examining the stability of achievement goal orientation. *Contemporary Educational Psychology, 34*(4), 265-277.

Muntigl, P., & Turnbull, W. (1998). Conversational Structure and Facework in Arguing. *Journal of Pragmatics, 29*, 225-256.

Newcomb, A. F., & Bagwell, C. L. (1995). Children's friendship relations: A meta-analytic review. *Psychological Bulletin, 117*, 306–347.

Nicholls, J. G. (1984). Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. *Psychological Review, 91*, 328-346.

Noroozi, O., Weinberger, A., Biemans, H. J. A., Mulder, M., & Chizari, M. (2012). Argumentation-based computer supported collaborative learning (ABCSCL): A synthesis of 15 years of research. *Educational Research Review, 7*(2), 79–106.

Noroozi, O., Weinberger, A., Biemans, H. J., Mulder, M., & Chizari, M. (2013). Facilitating argumentative knowledge construction through a transactive discussion script in CSCL. *Computers & Education, 61*, 59-76.

Nussbaum, E. M. (2011). Argumentation, dialogue theory, and probability modeling: Alternative frameworks for argumentation research in education. *Educational Psychologist, 46*(2), 84-106. doi: 10.1080/00461520.2011.558816

Nussbaum, E. M. (2008). Using argumentation vee diagrams (AVDs) for promoting argument/counter-argument integration in reflective writing. *Journal of Educational Psychology, 100*, 549–565. doi: 10.1037/0022-0663.100.3.549

Nussbaum, E. M., & Asterhan, C. S. C. (in press). The psychology of far transfer from classroom argumentation. To appear in F. Paglieri (Ed.), *The psychology of argument: Cognitive approaches to argumentation and persuasion*. London: College Publications, Studies in Logic and Argumentation series

Nussbaum, E. M., & Edwards, O. V. (2011). Argumentation, critical questions, and integrative stratagems: Enhancing young adolescents' reasoning about current events. *Journal of the Learning Sciences, 20*, 433-488. doi:10.1080/10508406.2011.564567

Nussbaum, E. M., & Kardash, C. M. (2005). The effects of goal instructions and text on the generation of counterarguments during writing. *Journal of Educational Psychology, 97*, 157–169.

Nussbaum, E. M., & Sinatra, G. M. (2003). Argument and conceptual engagement. *Contemporary Educational Psychology, 28*, 384-395. doi:10.1016/S0361-476X(02)00038-3

Nussbaum, E. M., Sinatra, G. M., & Poliquin, A. (2008). Role of epistemic beliefs and scientific argumentation in science learning. *International Journal of Science Education, 30*(15), 1977-1999. doi: 10.1080/09500690701545919

Nystrand, M., & Gamoran, A. (1991). Instructional discourse, student engagement, and literature achievement. *Research in the Teaching of English, 25*(3), 261-290.

Ochs, E., Gonzales, P., & Jacoby, S. (1996). When I come down I'm in a domain state: Talk, gesture, and graphic representation in the interpretive activity of physicists. In E. Ochs, E. Schegloff, & S. Thompson (Eds.) *Interaction and grammar* (pp. 328-369). Cambridge: Cambridge University Press

Ogan, A., Finkelstein, S., Walker, E., Carlson, R., & Cassell, J. (2012). Rudeness and rapport: Insults and learning gains in peer tutoring. In: S. A. Cerri, W. J. Clancey, G. Papadourakis, & K. Panourgia (Eds). Proceedings of the 2012 conference on Intelligent Tutoring Systems, Vol 7315 of the series Lecture Notes in Computer Science (pp. 11-21). Berlin: Springer Verlag.

Oh, S.C., & Jonassen, D.H. (2007). Scaffolding argumentation during problem solving. *Journal of Computer Assisted Learning*, *23*(2), 95- 105. doi: 10.1111/j.1365-2729.2006.00206.x

Osborne, J. F. (2010). Arguing to Learn in Science: The role of collaborative, critical discourse. *Science, 328*, 463-468. doi: 10.1126/science.1183944

Osborne, J. F., & Patterson, A. (2011). Scientific argument and explanation: A necessary distinction?. *Science Education*, *95*(4), 627-638.

Pauli, C. & Reusser, K. (2015). Discursive cultures of learning in (everyday) mathematics teaching: A video-based study on mathematics teaching in German and Swiss classrooms. In L.B. Resnick, C. S. C. Asterhan & C. N. Clarke (Eds.), *Socializing Intelligence Through Academic Talk and Dialogue* (pp. 181-193). Washington DC: AERA.

Perelman, C. & Olbrechts-Tyteca, L. (1958). *Traité de l'argumentation: La nouvelle rhétorique*. Paris: Presses Universitaires de France.

Perkins, D. N., Farady, M., & Bushey, B. (1991). Everyday reasoning and the roots of intelligence. In J. F. Voss, D. N. Perkins, & J. W. Segal (Eds.), *Informal Reasoning and Education* (pp. 83-105). Hillsdale, NJ: Erlbaum.

Pontecorvo, C., & Girardet, H. (1993). Arguing and reasoning in understanding historical topics. *Cognition and Instruction, 11,* 365-395.

Porsch, T., & Bromme, R. (2011). Effects of epistemological sensitization on source choices. *Instructional Science, 39*(6), 805-819. doi: 10.1007/s11251-010-9155-0

Reisman, A. (2012). Reading like a historian: A document-based History curriculum intervention in urban highschools. *Cognition and Instruction, 30*(1), 86-112.

Resnick, L. B. R. (2015). Talking to learn: The promise and challenge of dialogic teaching. In: L. B. Resnick, C. S. C. Asterhan, & S. Clarke (Eds), *Socializing Intelligence through academic talk and dialogue* (pp. 441-450). Washington, DC: AERA.

Resnick, L. B., Asterhan, C. S. C., & Clarke, S. N. (in press). *Accountable Talk: Instructional Dialogue that Builds the Mind*. The International Academy of Education (IAE) and the International Bureau of Education (IBE) of the United Nations Educational, Scientific and Cultural Organization (UNESCO), Geneva, Switzerland.

Resnick, L. B., Asterhan, C. S. C., & Clarke, S. (Eds.) (2015), *Socializing intelligence through academic talk and dialogue*. Washington, DC: AERA.

Resnick, L. B., Levine, J. & Teasley, S. D. (Eds.) (1991). *Perspectives on socially shared cognition*. Washington, DC: APA.

Reznitskaya, A., & Gregory, M. (2013). Student thought and classroom language: Examining the mechanisms of change in dialogic teaching. *Educational Psychologist, 48*(2), 114-133.

Reznitskaya, A., Anderson, R. C., & Kuo, L. (2007). Teaching and learning argumentation. *Elementary School Journal, 107*(5), 449-472. doi: 10.1086/518623

Sadler, T. D., Barab, S. A., & Scott, B. (2007). What do students gain by engaging in socio-scientific inquiry? *Research in Science Education, 37*(4), 371-391

Sadler, T. D., & Zeidler, D. L. (2009). Scientific literacy, PISA, and socio-scientific discourse: Assessment for progressive aims of science education. *Journal of Research in Science Teaching, 46*(8), 909-921

Sampson, V., & Clark, D. B. (2008). Assessment of the ways students generate arguments in science education: Current perspectives and recommendations for future directions. *Science Education*, *92*, 447-472.

Scheuer, O., Loll, F., Pinkwart, N, & McLaren, B. M. (2010). Computer-supported argumentation: A review of the state-of-the-art. *International Journal of Computer-Supported Collaborative Learning*, *5*(1), 43–102.

Schwarz, B. B. (2015). Discussing argumentative texts as a traditional Jewish learning practice. In L. B. Resnick, C. S. C., Asterhan and S. Clarke (Eds.), *Socializing Intelligence Through Academic Talk and Dialogue* (pp. 153-162). Wawshington, DC: AREA Books.

Schwarz, B. B. (2009). Argumentation and Learning. In Muller-Mirza and A-N. Perret-Clermont (Eds.), *Argumentation and Education – Theoretical Foundations and Practices* (pp. 91-126). Springer Verlag.

Schwarz, B. B. (2003). Collective reading of multiple texts in argumentative activities. *The International Journal of Educational Research*, *39*, 133-151.

Schwarz, B. B., & Asterhan, C. S. C. (2011). E-moderation of synchronous discussions in educational settings: A nascent practice. *Journal of the Learning Sciences*, *20*(3), 395-442.

Schwarz, B. B., & Baker, M. J. (2016). *Dialogue, Argumentation and Education: History, Theory and Practice*. Cambridge University Press.

Schwarz, B. B., & Baker, M. J. (2015). Sur l'adéquation des théories de l'argumentation aux sciences de l'apprentissage et les fondements d'une théorie de « l'argumentissage. In N. Muller-Mirza and C. Buty (Eds.), *L'argumentation dans les contextes de l'éducation* (pp. 269-322). Bern: Peter Lang.

Schwarz, B. B., & de Groot, R. (2007). Argumentation in a changing world. *The International Journal of Computer-Supported Collaborative Learning*, 2(2-3), 297-313.

Schwarz, B. B., & Linchevski, L. (2007). The role of task design and of argumentation in cognitive development during peer interaction. The case of proportional reasoning. *Learning and Instruction*, *17*, 310-331.

Schwarz, B. B., Hershkowitz, R. & Prusak, N. (2010). Argumentation and Mathematics. In C. Howe & K. Littleton (Eds.), *Educational Dialogues: Understanding and Promoting Productive Interaction* (pp. 115-141). Routledge.

Schwarz, B. B., Neuman, Y., & Biezuner, S. (2000). Two wrongs may make a right...if they argue together! *Cognition & Instruction, 18,* 461-494.

Schwarz, B. B., Neuman, Y., & Gil, J., & Ilya, M. (2003). Construction of collective and individual knowledge in argumentative activity: An empirical study. *Journal of the Learning Sciences, 12*(2), 221-258.

Schwarz, B. B., Perret-Clermont, A-N., Trognon, A., & Marro, P. (2008). Learning processes within and between successive activities in a laboratory context. *Pragmatics and Cognition, 16*(1), 57-87.

Schwarz, B. B., Schur, Y., Pensso, H., & Tayer, N. (2011). Perspective taking and argumentation for learning the day/night cycle. *The International Journal of Computer Supported Collaborative Learning, 6*(1), 113-138.

Schwarz, B. B., & Shahar, N. (in press). Combining the dialogic and the dialectic: putting argumentation into practice for classroom talk. To appear in *Learning, Culture and Social Interaction*.

Sfard, A. (2008). *Thinking as communicating.* Cambridge: Cambridge University Press.

Sinatra, G. M. & Broughton, S. H. (2011). Bridging reading comprehension and conceptual change in science: the promise of refutation text. *Reading Research Quarterly, 46*(4), 374–393. doi 10.1002/RRQ.005

Smith, K., Johnsson, D. W. & Johnsson, R. T. (1981). Can conflict be constructive? Controversy versus concurrence seeking in learning groups. *Journal of Educational Psychology, 73,* 651-663.

Sofer-Vital, S., Schwarz, B. B., & Butler, R. (2012). Achievement goals, argumentation and conceptual change in science. Paper presented at the 8th International Conference on Conceptual Change. University of Trier, Germany.

Stein, N. L., & Miller, C. A. (1993). A theory of argumentative understanding: relationships among position preference, judgments of goodness, memory and reasoning. *Argumentation, 7*(2), 183- 204.

Stokoe, E.H. (2000). Towards a conversation analytic approach to gender and discourse. *Feminism & Psychology, 10,* 552-563.

Suler, J. (2004). The online disinhibition effect. *Cyberpsychology & Behavior*, 7, 321–326.

Suthers, D. (2003). Representational guidance for collaborative inquiry. In J. Andriessen, M. J. Baker, and D. Suthers (Eds.), *Arguing to Learn: Confronting Cognitions in Computer-Supported Collaborative Learning Environments* (pp. 27-46). Dordrecht, Netherlands: Kluwer Academic.

Tannen, D. (1990). *You just don't understand: Women and men in conversation*. New York: Ballantine.

Tetlock, P. E. (1992). The impact of accountability on judgment and choice: Toward a social contingency model. *Advances in Experimental Social Psychology, 25*, 331-376.

Tudge, J. R. H., Winterhoff, P. A., & Hogan, M. H. (1996). The cognitive consequences of collaborative problem solving with or without feedback. *Child Development, 67*(6), 2892-2909. http://dx.doi.org/10.1111/j.1467-8624.1996.tb01894.x

van Amelsvoort, M., Andriessen, J., & Kanselaar, G. (2007). Representational tools in computer-supported collaborative argumentation-based learning: How dyads work with constructed and inspected argumentative diagrams. *Journal of the Learning Sciences, 16*, 485-521.

van Boxtel, C., & van Drie, J. (2004). Historical reasoning: A comparison of how experts and novices contextualise historical sources. *International Journal of Historical Learning, Teaching and Research, 4*(2), 89–97.

van der Puil, C., Andriessen, J., Kanselaar, G. (2004). Exploring relational regulation in computer-mediated (collaborative) learning interaction: a developmental perspective. *Cyberpsychology and Behavior*, 7(2), 183 – 195

van Drie, J., van Boxtel, C., Jaspers, J., & Kanselaar, G. (2005). Effects of representational guidance on domain specific reasoning in CSCL. *Computers in Human Behavior, 21*, 572–602.

van Eemeren, F. H., Grootendorst, R., Henkenmans, F. S., Blair, J. A., Johnson, R. H., Krabb, E. C., Plantin, C., Walton, D. N., Willard, C. A., Woods, J. & Zarefsky, D. (1996). *Fundamentals of Argumentation theory: A handbook of historical background and contemporary developments*. Hillsdale, NJ: Lawrence Erlbaum.

VanLehn, K. (1999). Rule-learning events in the acquisition of a complex skill: an evaluation of cascade. *The Journal of the Learning Sciences, 8*, 71–125.

von Aufschnaiter, C., Erduran, S., Osborne, J., & Simon, S. (2008). Arguing to learn and learning to argue: Case studies of how students' argumentation relates to their scientific

knowledge. *Journal of Research in Science Teaching, 45*, 101 – 131. doi 10.1002/tea.20213

Walton, D. (2006). *Fundamentals of critical argumentation: Critical reasoning and argumentation.* Cambridge, UK: Cambridge University Press.

Walton, D. N. (1989). *Informal Logic: a handbook for critical argumentation*. Cambridge, UK: Cambridge University Press.

Weatherall, A. (2000). Re-visions for gender and language research in the 21st century. In J. Holmes (Ed.), *Gendered Speech in Social Context: Perspectives From Town and Gown* (pp. 39-51). Wellington, NZ: Victoria University Press.

Webb, N. M. (2009). The teacher's role in promoting collaborative dialogue in the classroom. *British Journal of Educational Psychology, 79*, 1–28. doi: 10.1348/000709908X380772

Webb, N. M., Franke, M. L., De, T., Chan, A. G., Freund, D., Shein, P., & Melkonian, D. K. (2009). Teachers' instructional practices and small-group dialogue. *Cambridge Journal of Education, 39*, 49-70. doi: 10.1080/03057640802701986

Webb, N. M., Franke, M. L., Turrou, A.C., & Ing, M. (2015). An exploration of teacher practices in relation to profiles of small-group dialogue. In: L. B. Resnick, C. S. C. Asterhan & S. Clarke (Eds), *Socializing Intelligence through academic talk and dialogue* (pp. 87-98). Washington, DC: AERA.

Webb, N. M., Troper, J. D., & Fall, R. (1995). Constructive activity and learning in collaborative small groups. *Journal of Educational Psychology, 87*, 406-423.

Wecker, C., & Fischer, F. (2014). Where is the evidence? A meta-analysis on the role of argumentation for the acquisition of domain-specific knowledge in computer-supported collaborative learning. *Computers & Education, 75*, 218-228.

Wecker, C., & Fischer, F. (2011). From guided to self-regulated performance of domain-general skills: The role of peer monitoring during the fading of instructional scripts. *Learning and Instruction, 21*, 746–756. doi:10.1016/j.learninstruc.2011.05.001

Wegerif, N., Mercer, N. & Dawes, L. (1999). From social interaction to individual reasoning: an empirical investigation of a possible socio-cultural model of cognitive development. *Learning & Instruction, 9,* 493-516.

Weinberger, A., & Fischer, F. (2006). A framework to analyze argumentative knowledge construction in computer-supported collaborative learning. *Computers & Education, 46*(1), 71-95.

Wells, C. G. (1999). *Dialogic Inquiry towards a sociocultural practice and theory of education.* Cambridge: Cambridge University Press.

Wentzel, K. R., Barry, C. M., & Caldwell, K. A. (2004). Friendship in middle school: Influences on motivation and school adjustment. *Journal of Educational Psychology, 96*(2), 195–203.

Wiley, J. & Voss, J. F. (1999). Constructing arguments from multiple sources: Tasks that promote understanding and not just memory for text. *Journal of Educational Psychology, 91*(2), 301-311.

Wu, X., Anderson, R. C., Nguyen-Jahiel, K., & Miller, B. (2013). Enhancing motivation and engagement through collaborative discussion. *Journal of Educational Psychology, 105*(3), 622-632.

Yackel, E., & Cobb, P. (1996). Sociomathematical norms, argumentation and autonomy in mathematics. *The Journal of Research in Mathematics Education, 27,* 458 – 477.

Yeh, K. Y. & She, H. C. (2010). On-line synchronous scientific argumentation learning: Nurturing students' argumentation ability and conceptual change in science context. *Computers & Education 55,* 586-602.

Zohar, A., & Nemet, F. (2002). Fostering students' knowledge and argumentation skills through dilemmas in human genetics. *Journal of Research in Science Teaching, 39,* 35-62.

Figure 1.

The three-node AFL framework: A systematic representation of research on argumentation for learning*

* *Note*: Boxes with dotted lines indicate the existence of research on types of discourse and learning outcomes that are outside of the scope of this review.

Figure 2.

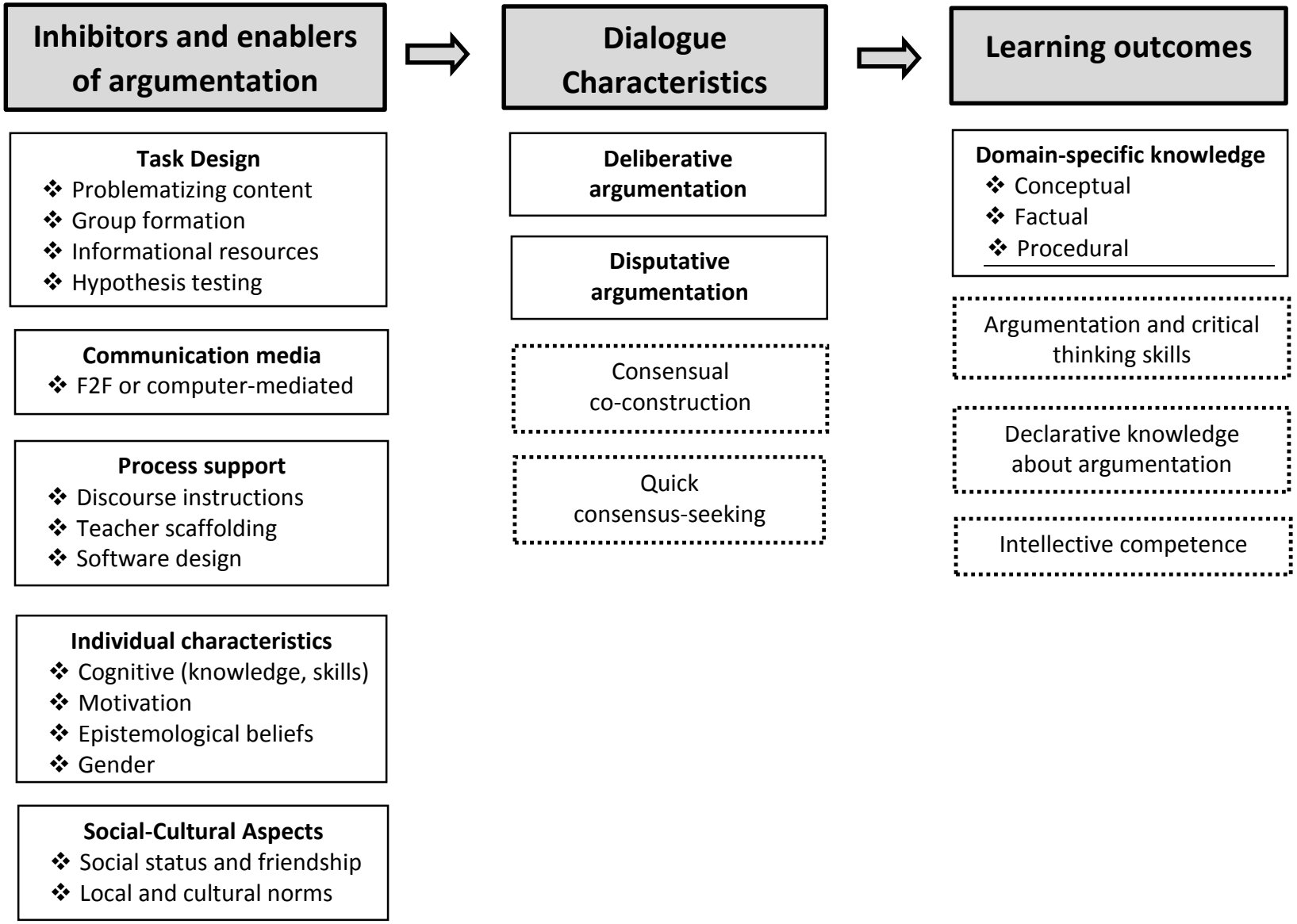
Dialogue protocol fragments showcasing three different discourse types*

Figure 3.

Goal instructions for deliberative and disputative argumentation (based on Asterhan et al., 2010)

Figure 4.

A cyclic representation of the AFL framework


Inhibitors and enablers of argumentation
Dialogue Characteristics
Learning outcomes
Task Design
❖ Problematizing content
❖ Group formation
❖ Informational resources
❖ Hypothesis testing
Communication media
❖ F2F or computer-mediated
Process support
❖ Discourse instructions
❖ Teacher scaffolding
❖ Software design
Individual characteristics
❖ Cognitive (knowledge, skills)
❖ Motivation
❖ Epistemological beliefs
❖ Gender
Social-Cultural Aspects
❖ Social status and friendship
❖ Local and cultural norms
Deliberative argumentation
Disputative argumentation
Consensual co-construction
Quick consensus-seeking
Domain-specific knowledge
❖ Conceptual
❖ Factual
❖ Procedural
Argumentation and critical thinking skills
Declarative knowledge about argumentation
Intellective competence

Deliberative argumentation fragment

Betty : If it is a matter of survival, then, uh, evolution would not occur, because swimmers, they don't need that for their survival. It's something that Nature feels that something has to happen, or the creature feels that something has to change for it to survive, only then that the change will take place. That's amazing!

Alice : The question is, uh, whether the change is biological or not? I mean, one survives and the rest does not, so one develops -

Betty: You mean like a mutation?

Alice: Because there are all kinds of animals. By chance, one kind is well adapted to the new situation and that kind survives and continues itself

Betty: Yes

Alice: I don't understand how he understood that - suddenly, he said that they developed webbed feet

Betty: So how do you think it happened? That it happened overnight?

Alice: That one by chance had something similar to webs. He survived, and the webs just evolved, became more sophisticated

Betty: And what if…

Alice: Not something out of nothing!

Betty: And if one of them had it?

Alice: Then they would not hae survived. How could they have survived?

Betty: Maybe they just developed it somehow?

Consensual co-construction fragment

Alicia: Okay. Do you have an idea?

Ah, yes. Because the area was flooded with water and those with legs that suited the water Ella:
actually survived.

Alicia: Humhum.

And then those that survived, developed and continued themselves. Ella:

Alicia: That is, that ducks developed webbed feet especially to survive/

/Yes/ Ella:

/in areas that Alicia:
once were dry and became flooded with water?

Alicia: Yes, that sounds reasonable.

Disputative argumentation fragment

It's like we saw in the movie, that they change according to the…environment. To the Avi:
weather. So they probably stayed in the water more and then developed…ehm…webbed feet.

I think that those who had webbed feet survived, and they produced more offspring that also David:
had webbed feet.

[short silence]

No, but it seems to me that before they did not have webbed feet at all. Avi:

But I think that they say that evolution it…it is not that an animal develops anything, but David:
that…that those that are well adapted to the environment survive. So, let's say that there were mutations of ducks with webbed feet…and…so those that had survived and produced more offspring, because they had an advantage.

No, but they also changed. It is not that-…The change was because of the environment. Avi:

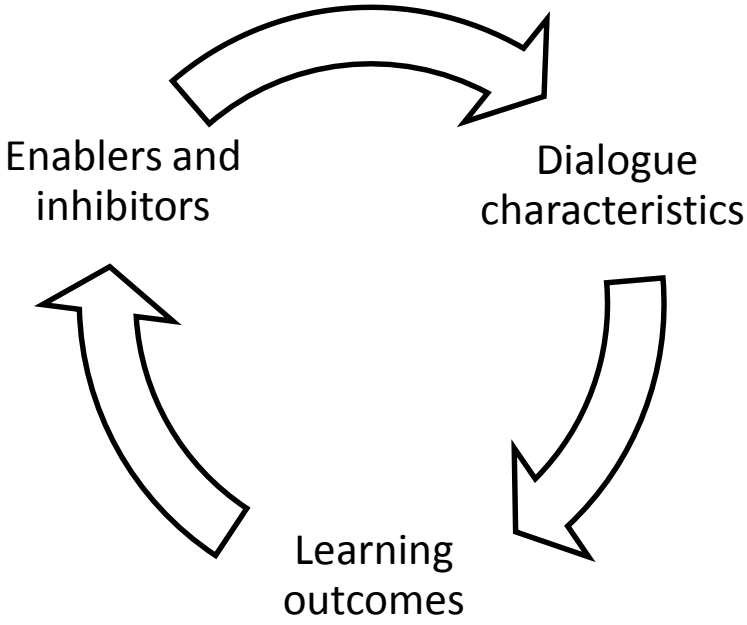
* The fragments are adapted from Asterhan (2013) and Asterhan and Schwarz (2009). In all discussion excerpts, students discuss the evolution of the webbed feet of Ducks, after having seen an instructional movie on natural selection.

Argumentation as deliberation

"The goal of a ‘critical discussion’ is to reach a better and deeper understanding of the topic under discussion, in this case: evolution. So, a good discussion is one in which both participants explore each idea and solution in depth, by providing adequate arguments and justifications. We should emphasize that a critical discussion will help both of you gain a better understanding of the topic. At all times during the discussion, try to discover the weaknesses and strengths in each solution and idea, whether it was proposed by yourself or your partner. At all times during the discussion, try to critically think about each idea or solution, whether it is logical or successful. To what extent do the justifications, evidence and explanation support the proposed solutions? Are there alternative solutions?"

Argumentation as dispute

"The goal of a ‘critical discussion’ is to convince one another of the correctness of one’s own solutions, in this case: to the questions about evolution. So a good discussion is one in which each participant criticizes the other’s ideas by providing adequate arguments and justifications that support one’s own ideas and weaken the validity of the other person’s ideas. We should emphasize that ultimately there can be only one winning side. At all times during the discussion, try and come up with arguments that could back up your solution and undermine your partner’s claims. How could you convince him (her)? What reasons and evidence could help you reach these goals? What are the weaknesses in the other person’s solutions?"


Enablers and inhibitors
Dialogue characteristics
Learning outcomes