Argumentation and reasoning

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1. Introduction: The resurgence of argumentation in education as a sign of ideological and cultural change

Writing a chapter on argumentation and reasoning at the beginning of the third millennium is not just an academic exercise. It is probable that 30 years ago, no chapter on this topic would have been written in a *Handbook of Educational Psychology*. One could say that at that time, research on psychological aspects of argumentation was still embryonic, largely due to technical limitations: since argumentation is a social activity, analysis of argumentation demands tools for recording and analyzing such data. But there is here more than technological developments, with cultural and historical dimensions. Each society has its own history, norms, tools, or institutions. The institutions of society carry with them prescriptions for skilled performance, or for ways of thinking and the use of particular technologies channels choices to favour certain means of solution or certain values. Differences among cultural groups in, say, performance on cognitive tasks, may be due largely to varying interpretation of what constitutes the problem that needs to be solved in the task and different values concerning the "proper" methods of solution (e.g., speed, reaching a solution with the minimum moves or redundancy, physically handling the materials versus "mental shuffling", original solution versus deference to authority, etc.).

The ways in which relations between thinking and communication are realized have to a large extent characterized cultures. Although Western culture is far from being uniform, common values are generally shared concerning the relations between thinking and communication. These common values can be discerned through the lenses of historical development. Western society has undergone interesting and profound changes that seem today, at the beginning of the 21st century, quite spectacular. These changes are visible through texts that are considered as canonical cultural assets and that have established standards for thinking and communication. For example, Plato's philosophy appears in the form of dialogues in which Socrates helps his interlocutor to reach eternal truths. Beyond the written word, a rich oral and direct activity is deployed in which not only knowledge emerges, but provocations, surprise, irony, and ultimately love between interlocutors. In addition, interlocutors challenge, elaborate, counterchallenge, ask questions or refute. The platonic dialogues blend then magnificently *dialogic* and *dialectic* moves. The topics of Platonic dialogues are varied, and many of them focus on the social and political order. Although Plato's Socratic dialogues pledge for an authoritarian state and an effort is made to preserve social and political order, Athenian rulers grasped the dialectical character of these dialogues as subversive (as appears in Socrates' trial in *Phaedon* and *Socrates' Apology*).

We claim here that the relation between dialogism and dialecticism that was quite balanced in Classic Greece considerably changed afterwards. While dialectical and rhetorical argumentative practices developed in Classical Greece become educational practices in the elite of the Western society, the dialogic erotic-philosophical
relationship present in Plato's dialogues, progressively vanishes in Western culture. Early Christian thinkers such as Gregory (6th century) still adopt this rich dialogic form to express their spirituality. Also, many thinkers continued adopting a dialogical form to express their ideas: Among the most celebrated Berkeley's *Dialogues between Hylas and Philonous* (1715), or Diderot's *D'Alembert Dream* (1769). However, dialogue is here an instrument through which ideas are presented rather than being essential, vivid. Some classical dialogues are vibrant, like the correspondence between Leibnitz and Arnauld on liberty or Spinoza's dialogues (e.g., between Erasmus and Theophile). However, dialogism is not articulated as a philosophy that conceives of an inter-subjective reality.

As opposed to the history of dialogism, the history of dialectics in Western culture is more complex, less monotonic. While early Middle Ages are characterized by the abandonment of classic argumentative practices, a strong resurgence of dialectical practices occur in from the 12th to the 14th century at the time of the Scholastic movement. The Scholastic dialectics developed in intellectual elites in first universities (Paris, Oxford) to find ways to accommodate patristic canonical texts with Aristotelian metaphysics. While types of argumentative practices are extremely rich at that time, they often look like logical and sterile games in which the anguish and the common search for truth that could be seen in platonic dialogues are replaced by a rhetorical form of intellectual dogmatism. Still, dialectical activity is not very well accepted by authority (see for example, the fierce attacks against Abelard in the 12th century) as it undermines accepted interpretations of canonical texts. Dialectic activities are treated as dangerous and are progressively abandoned as Monarchy and religious institutions become more established at the 14th century. Argumentative practices in universities are no longer targeted at producing knowledge but at training in rhetoric and in logic. It was with the development of *Absolute Realism* and one of its central players, Hegel, that dialectics resurged, not yet as an educational practice but as a philosophical method.

Hegelian dialectics is a philosophical method to grasp the fundamental aspect of reality (nature, history) in its complexity to tend to ideals. The *dialectical materialism*, Marx's "continuation" of Hegelian method helps grasping world stage and world history. Like in Greece, German dialectics discusses social and political order, but it is now to weaken established order. And if dialectical practices have always been considered as subversive and dangerous, in the 19th century and the beginning of the 20th century, they appear as utterly threatening and are not enacted in educational settings. At that time, dialogism has totally disappeared from philosophical methods and from almost all educational settings not because it is considered as dangerous but because it did not fit the ideal of reason as a solipsistic activity: Cartesian and Kantian philosophies favoured individual reasoning of the learner in a dual world. These philosophies gave the tone to educational practices that promoted intellectual abilities and autonomy.

At the beginning of the 20th century things changed: States became more democratic and permitted to hear the voices of the *demos*, of the people, and not only the authoritarian voices of the institutions. Philosophers began departing from pure dialectical methods to elaborate dialogical components; influential thinkers also pledged for blending dialectical and dialogical practices in education. Both philosophers and educationalists recognized the extraordinary power of dialectics for
instigating deep changes in society, but were aware that these changes may be destructive. Dialogical practices that add an ethical interpersonal dimension to thinking ensure the taming of dialectics as a tool for the sake of a societal constructive change of communication and thinking. Martin Buber has of course been a major instigator of the modern philosophy of dialogue. Buber considers the encounter between creatures instead of the apprehension of the individual as the essence of human spirituality. This encounter is both an event and an eternity. For Buber, the relationship constitutes the source for the construction of the self. In its daily, concrete deployment, the true relationship is reciprocity, presence, totality and responsibility. Several philosophers have been inspired by Buber’s philosophy of dialogue, among them Levinas.

As a philosopher whose theory is rooted in Kantian philosophy, Habermas certainly did not share Buber’s mystical philosophy of dialogue. However, quite interestingly, Habermas’ theory of communicative action (Habermas, 1972) shows many similarities with Buberian ideas. According to Habermas, the highest moral form of human endeavor is rational ‘communicative action’ oriented toward constructing a society in which truth, freedom, and justice prevail. In particular, the intellectual autonomy of the individual should be safeguarded from the coercive influence of arbitrary power exerted by self-serving competitive interests. Therefore we need to value social relationships that strive for achieving hermeneutic, or mutual and reciprocal understanding. Habermas identifies language as the vehicle for attaining this goal. However, language has an ideological dimension that can serve as a medium of power and oppression, especially in its role as the ‘reservoir of tradition’ which conceals and legitimates arbitrary power. Systematically distorted communication is inherent in ‘instrumental’ and ‘strategic’ actions. The former concerns actions that are oriented toward the control of impersonal problems (technical exploitation of Nature, efficient functioning of institutions, etc.); the latter concerns competitive individualism oriented toward achieving success and domination over others. Habermas’ theory of communicative action strives for counterbalancing instrumental and strategic actions by working towards the deconstruction of systematic distortions preventing mutual and reciprocal understanding.

In summary, both for Buber and for Habermas, communication is at the basis of changes in thinking. Although their perspectives are very different, they agree at a practical level to adopt dialogical methods to reach mutual understanding. Adherence to dialogism makes it possible to implement argumentative practices in schools that champion precedence of communication for mutual and reciprocal understanding over univocal rationalism. The approach proposed by Habermas suggests balance between dialogical and dialectical practices in education. The modern Western democratic state allows its thinkers and educators to blend dialogical and dialectical practices since they serve ideological values of equity, and of opportunities to learn in a sophisticated challenging world. And indeed, leading educators in several Western countries have begun implementing both dialectical and dialogical argumentative practices in schools, although they did not clearly spell out these principles. To cite a few, Lipman’s Philosophy for Children (P4C) (1991) and Dawes, Mercer and Wegerif’s (2000) Thinking Together project combined rational and dialogic ingredients. Also, Andrews (1995) brought the teaching and learning of argument to the centre of the curriculum, based on the understanding that argument is essential to
the development of thinking skills. He analyzes the function of argument from early childhood education to university study. He is explicit about the link between Democracy as a political system and the teaching of argumentation (Andrews, 1994). With Sally Mitchell, he compares between how people teach in Higher Education and how they should teach in more productive ways, which are argumentative. (Mitchell & Andrews, 2000). Other educational programs have been implemented in different countries. Also computer designers have developed new tools for communication that convey the Zeitgeist of a profound change in the role of communication in the society. Many tools are designed to foster collaborative work (CSCW) and collaborative learning (CSCL). In comparison with their technological ancestors that mediated individual cognitive training, communication here is reciprocal, personalized, and conveys social presence. These educational and technological initiatives do not mean of course that cultural changes indeed proceed in the direction suggested by the ideals of our society. The new interactive practices at school or at work may engender new problems, undesirable norms that could not be expected. However, argumentation is again at the foreground of our society with the hopes and dangers that it may engender towards a deep change in our society. Writing a chapter on argumentation and reasoning is then timely. Our role as educational psychologists is to study and to understand how the ethical comeback to dialogism and the trust in dialectical practices impinge on learning, whether new educational practices which are by definition rooted in old norms, and beliefs that are not compatible with dialogism and dialecticism be transformed in educational institutions. While many programs have been instigated to foster argumentation in classrooms, research on learning and teaching on argumentation in classrooms is not yet very developed. Our scope will then been limited to issues in Educational Psychology without referring to important educational projects for which systematic research has not been undertaken.

2. Argumentation: Some clarifying distinctions and definitions

The last two decades have witnessed an increasing interest in argumentation in the psycho-educational literature. It has followed a few decades of reflection in argumentation theory. But what is argumentation exactly? In everyday language the terms *argument* and *argumentation* are often identified with differences in opinion and quarrels, such as in the sentence: "They were having an argument". It is also often associated with rhetoric and debating, especially in countries where debating competitions are common. However, the definition of argumentation that theorists have articulated is not limited to human activities, such as interpersonal conflict or conflict management, nor to debating techniques, even though these may include argumentation.

A number of recent theoretical models of human thinking have emphasized the central role of argumentation in human thinking (e.g., Antaki, 1994; Billig, 1996; Kuhn, 1992). Kuhn (1992) for example, proposes that reasoned argumentation lies at the heart of human thinking (1991), whereas Billig goes even further by stating that thinking “(...) is a form of internal argument, modelled on outward dialogue” (1996, p.2, italics added). However, when the general aim is to study argumentation as a distinctive phenomenon and assess it when it happens, a more pragmatic approach is warranted. Our primary goal in this chapter is thus to identify argumentation when it happens and distinguish it from other social and (socio-)cognitive activities.
For this purpose we will, among others, rely on some definitions and distinctions that have been borrowed from argumentation theory. We do not intend to present an exhaustive overview of the different perspectives within this academic field (for more extensive overviews, see for example Perelman, & Olbrechts-Tyteca, 1958/1969; Van Eemeren, Grootendorst, Henkenmans, Blair, Johnson, Krabb, Plantin, Walton, Willard, Woods, & Zarefsky, 1996; Walton, 1997).

As a guiding line throughout this subchapter we will adopt the widely accepted definition of argumentation by Van Eemeren, et al (1996):

“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).

In the following sections we will dissect this definition piece by piece and highlight the most important distinctions with other (socio-)cognitive activities and processes.

2.1 The role of reasoning

Van Eemeren et al’s (1996) definition starts with the assertion that argumentation is an activity that involves reasoning. The distinction between reasoning and argumentation is an important one that is often overlooked in the educational and psychological literature: Argumentation is not a distinctive form of reasoning; it is an activity that involves reasoning. Therefore, we will start with a short consideration of the phenomenon of reasoning.

Within psychology, reasoning has traditionally been approached as a particular form of individual thinking and, as such, has been extensively studied by cognitive psychologists, mainly within the field of problem solving. The building blocks of reasoning are inferences (Walton, 2006). Moshman (1995; 1998) suggests the following distinctions between the constructs of inference, thinking and reasoning: He defines inference as those cases in which new cognitions are derived from prior information, whether these are prior cognitions or external data. One need not be aware of the prior information or the inferential process. In fact, many basic cognitive processes, such as for instance the interpretation of social information and the formation of concepts, occur without the individual being aware of the act or its nature.

Thinking is as an advanced form of inference, in which the individual deliberately coordinates one’s inferences to serve some purpose. The difference between inference and thinking is then two-fold: Thinking is always a conscious act and always has a purpose. When thought processes are being actively subjected to certain self-imposed standards of evaluation, an individual is said to engage in reasoning. Thus, reasoning is defined as “(...) epistemologically self-constrained thinking” (Moshman, 1998, p. 953). According to Walton (2006), such a conscious and purposeful act of inference involves the drawing of a conclusion from a given set of propositions called premises. Reasoning is then defined as the chaining together of such inferences (Walton, 2006).

According to both views, the quality of reasoning may be considered good or bad, since constraints may be applied in a correct, relevant and consistent manner, or they may not be. It is sufficient however that an individual deliberately constrains his/her thinking to certain epistemic norms and standards (Moshman, 1995; 1998) or inference structure (Walton, 2006) in order to define that person’s acts as reasoning. Vice versa, not all correct inferences necessarily constitute reasoning.
2.2 The goal of argumentation

Argumentation typically occurs when reasoning is used in goal-directed conversational exchanges (i.e., dialogues) (Walton, 2006). However, not all reasoning in conversation is necessarily argumentative. As we will show later on, reasoning may also be used when a person gives an explanation of a certain phenomenon to his/her conversational partner purely for informative reasons. Van Eemeren et al's (1996) definition shows that only when reasoning is used to decrease or increase the acceptability of a certain standpoint or solution, the participants are said to engage in argumentation. Thus, argumentation is first and foremost defined by the goal of the activity, which is the establishment of the epistemic status of one or more assertions (Baker, 2002a; 2003). As opposed to other forms of conflict resolution, such as for example physical coercion, participants attempt to reach this goal by engaging in verbal reasoning: They put forward reasons in support of or against a certain standpoint, claim or solution (Walton, 2006).

Argumentation may also be regarded from the perspective of persuasion. Voss and Van Dyke (2001) argue that one of primary goals of a participant in argumentation is persuasion. However, not every means of verbal persuasion necessarily constitutes argumentation: Appeal to the speaker's character (ethos) and appeal to emotions of the audience (pathos) may be effective debating tactics, but are usually not considered as valid forms of argumentation. In argumentation, persuasion is based on appeals to logic (logos) (Voss & van Dyke, 2001).

However, even though the goal of argumentation is often persuasion, this characteristic should not be limited to the inter-personal plane. Argumentation is characterized by the fact that different solutions or standpoints, not necessarily humans, compete with each other (Baker, 2002a; 2003). These claims may have been put forward and are defended by different speakers, but they do not necessarily have to be. This is, for example, evident in individual deliberation or in social situations in which two speakers collaboratively consider the advantages and disadvantages of two or more different perspectives.

2.3 Argumentation as a social and verbal activity

There seems to be general consensus among theorists that argumentation is in essence a social activity that presupposes the presence of an audience (Baker, 2002a; 2003; Leitao, 2000; van Eemeren, 1985; van Eemeren et al, 1996; Moshman, 1998; Walton, 2006; Zarefsky, 1995). As aforementioned, it typically occurs in dialogues between two or more interlocutors. Such dialogues may take the form of an oral or a written communicative exchange. In argumentative writing, the text may be directed towards a particular person known to the author, and may even be a part of an ongoing communicative exchange of writing in which different standpoints are attacked and defended by different persons. In argumentative monologues, such as oral lectures and written essays, the speaker or author does not expect a direct response from his audience. However, in such activities they present their line of reasoning such that it takes into account the potential standpoints and counterarguments that might have been forward by the audience. In other words, the argumentation in such cases is directed towards a virtual or a distant other (Leitao, 2000).

Even intra-personal deliberation may at times be argumentative in nature. Such deliberation may be externalized, such as when talking aloud or scribbling on a note. Internal intra-personal activities of argumentation are, for example, conducting a virtual discussion between two sides in one's mind or when an individual declaratively and consciously weighs the reasons for and against a certain line of
action, standpoint or solution. According to the views presented here, inferences that are arrived at without a conscious and verbalized attempt of reasoning and without the explicit or implicit consideration of a potential other are not considered acts of argumentation.

In light of our pragmatic approach mentioned at the start of this section it is important to carefully distinguish between internal argumentation and other forms of thinking. Independent of whether the activity occurs on the intra-personal or the inter-personal plane, the criteria for an activity to be classified as argumentation are identical, even if in some cases the audience may be virtual or distant.

2.4 Argumentation as a dialogical activity

The definition by van Eemeren et al (1996) states that argumentation is "(...) aimed at increasing (or decreasing) the acceptability of a controversial standpoint (…)". The use of the term controversial in this sentence seems to imply that argumentation is always dialectical in nature, that is: at least two different perspectives or solutions are competing with each another. Similarly, Leitao (2000) argued that reasoned conversation may be labelled as argumentative in nature only if it contains some element of opposition or divergence. Andriessen, Baker, and Suthers (2003), on the other hand, propose a definition that regards any chain of reasoned utterances meant to support a certain claim as argumentation. What is then the role of opposition and of dialecticism in argumentation?

For sake of simplicity, let us consider a dialogue in which two interlocutors discuss the legalization of marijuana. If one interlocutor is in favour of such legalization measures, the other opposes it and the two engage in argumentation to settle this difference in standpoints, then this situation is called a dispute. In a dispute the issue to be settled is which one of these opposed standpoints is better supported by argument (Walton, 2006). A slightly different situation is a dissent, in which one dialogue partner proposes a standpoint and the other only raises doubts and questions concerning that thesis (Walton, 2006). Even though in the latter case the interlocutors have not explicitly proposed two different theses, both situations are dialectical in nature, since at least two sides of a particular phenomenon have been considered in both: the first contained two explicitly articulated, opposed theses and the latter contained one explicitly articulated thesis that was both defended as well as criticized.

However, what if our two interlocutors were both in favor of soft drug legalization and proposed several reasons supporting their common standpoint? In this case, the issue is more complicated. They did not consider any different perspectives to their common standpoint and their conversation did not contain any form of opposition or divergence on the issue. Nevertheless, they clearly engaged in reasoning, since they proposed several assertions that were meant to increase the acceptability of their common standpoint. The question is then: Can or should this exchange be identified as argumentation or not? Many have defined argumentation as an essentially dialectical activity (Baker, 2003; Leitao, 2000; Walton, 2006). Accordingly, this exchange may not pass as argumentation.

However, the definition by van Eemeren, et al (1996) is more ambiguous with regards to this issue. On the one hand it does not include a clear criterion on the number of perspectives that have to be considered. On the other hand, though, it refers to the fact that the thesis discussed in the dialogue is controversial, that is: the perceived epistemic status varies among different individuals. Most importantly however, there is no specific mentioning of who these individuals are or ought to be; they may be the interlocutors that take part in the dialogue, or they may be fictive
personas. This point is pivotal. The very fact that one feels compelled to provide supportive reasons in favour of a certain thesis implies the awareness that there are always two sides to an argument. As observed by Walton (2006), "On the one side the reason is put forward as a reason to support a claim. On the other side, that claim is open to doubt, and the reason for giving the reason is to remove that doubt." Whereas in our third example these doubts are not even explicitly articulated, let alone represented by actual persons, the interlocutors provided reasons that were meant to increase the epistemic status of their thesis. This can only be done when they are aware of the possibility that their thesis may be contested by others and is as such controversial.

If we incorporate the third example in our view of argumentation, it perfectly fits the dialogic stance to which we adhered in the first section. Such a view of argumentation always presupposes a dialogue between two sides (Walton, 2006; Wegerif, 2007). Often these different perspectives are explicitly articulated and juxtaposed within the dialogue (dialectical argumentation), but sometimes their existence is only implicitly assumed. The latter manifestation of argumentation has also been referred to as one-sided (Asterhan & Schwarz, 2007).

2.5 Argument, argumentation and informal reasoning

Even though in the previous sections we already used the term argument here and there, we will further elaborate on its meaning in the present section. An argument is made up of statements called premises and a conclusion, where the premises give reasons to support the conclusion (Aristotle, 1924; Walton, 2006). The particular way in which the premises support the conclusion (i.e., the type of inference) defines the structure of arguments (Nickerson, 1996; Walton 2006). Walton (2006) distinguishes between three inference structures: deductive, inductive and presumptive.

A logical argument is one that makes use of deductive inference, in which one of the assertions (the conclusion) is implied by, or may be deduced from the other (the premises). If the premises are true, then the conclusion must be true (Nickerson, 1986). Inductive arguments, on the other hand, are based on probability and statistics, rather than necessity. With this type of arguments there is always a possibility that the premises could be true, but the conclusion is false, even when this is not probable. The third type, plausible argument, is based on presumptive inference. A presumption, according to Walton (2006) is "(...) a qualified, tentative assumption of a proposition as true that can be justified on a practical basis, provided there is no sufficient evidence to show that the proposition is false" (p.72). The premises are conditional, based on what would be normal in a familiar or known situation. If the premises are true, then a weight of plausibility is shifted to the conclusion. Thus, the conclusion is provisional, based on the data known and the situations we are familiar with and particularly sensitive to new evidence. Different types of arguments that are based on presumptive reasoning are, for example, appeal to expert opinion, argument from popular opinion, argument from analogy, and argument from consequence (Walton, 2006). The strength of supporting assertions is dependent on the criteria of evaluation that are applied. In contrast to deductive inference, there is no one set of absolute and field-independent rules of criteria (van Eemeren, et al, 1996; Toulmin, 1958). Instead, different fields have different agreed-upon sets of criteria, whether these are relatively well-defined, such as in Law and Science, or fuzzier, such as in moral dilemmas. The quality of an argument may also be evaluated on the basis of more general criteria in informal reasoning such as relevance, or acceptability (Means & Voss, 1996).
In the activity of argumentation, interlocutors propose arguments in favour or against a certain thesis. The chaining of these local arguments within the dialogue is expected to result in the settling of the central issue of discussion (Walton, 2006). From the point of view of the dialogue as a whole, a complex argument is constructed that usually represents at least two different standpoints and a number of supporting and refuting premises. Thus, at the dialogue level this global argument represents the inferential structure of the different assertions that were proposed during the dialogue. Whereas in an argumentative dialogue local arguments may at times be based on deductive inference, much of human argumentative discourse cannot be captured by rules of formal logic (Nickerson, 1986; Perkins, Farady & Bushy, 1991; van Eemeren, et al, 1996). Moreover, argumentation as an activity is not based on rules of formal logic, but characterized by informal reasoning: Participants in argumentation attempt to establish which one of the theses put forward is more or less acceptable (Baker, 2002a, 2003).

### 2.6 Argumentation and explanation

As aforementioned, not each text of discourse containing a sequence of verbal reasoning in a social context is necessarily argumentative in nature. The act of explaining, for example, often resembles argumentation, which substantially complicates the process of identification. They are both acts of reasoning and have therefore similar syntactic and formal structures: Both arguments and explanations 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. In addition, they often 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 intra-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 all these resemblances, acts of argumentation and explanation differ in 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. In argumentation, on the other hand, the proponent proposes reasons for the recipient to come to accept a certain thesis (Walton, 2006). Baker (2002a; 2003) 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. Then the distinction between argumentation and explanation should be made based on the context of the dialogue, both in a local and general sense.

Whereas, this distinction is sometimes easily made, lack of adequate information on the dialogue context and the speakers' intentions may substantially complicate the determination of a sequence of reasoning as argument or explanation. Take for example the following statement: "I am tired, because a mosquito kept me awake for most of the night". By itself, it could either be meant as an explanation or an argument. If the immediate dialogue context shows that the recipient of this statement had asked the proponent why (s)he was yawning, then the communication would have been an explanation, since it clarified the reason for his/her fatigue. However, it is
also possible that the statement was given in the following chain of collective reasoning between, for example, two spouses:

A: "I am so tired"

B: "You can’t be tired! I know that you turned in at eight PM!"

A: "I am tired, because a mosquito kept me awake for most of the night".

In this small exchange, spouse B contests the assertion made by spouse A, by providing reason against it. Spouse A, in turn, rebuts this counterargument by providing a reason that supports the original assertion. In this short exchange the central proposition is contested, not explained. Thus, the key test to determine whether a certain communication is an act of argumentation or explanation is to focus on the central assertion and ask whether the participants presume it is true or not (Walton, 2006). If they do and they do not contest its epistemic status, then they are engaged in explanation.

Both explanation and argumentation are considered valuable activities that are thought to improve understanding, declarative knowledge and reasoning skills. The importance of distinguishing between argumentation and explanation is not only a matter of epistemology. The two testify of potentially very different (socio-)cognitive processes each of which may prove to be beneficial for different types of learning. For example, explanation-driven discourse has been found to benefit learning (Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Chi, deLeeuw, Chiu, & Lavancher, 1994; Coleman, 1998; King & Rosenshine, 1993; Neuman & Schwarz, 1998; Okada & Simon, 1997; Van Boxtel, van der Linden & Kanselaar, 2000). However, recently Asterhan & Schwarz (submitted) found that only engagement in dialectical argumentative discourse was followed by radical conceptual change in evolutionary theory, whereas consensual processes of explanation construction were not.

3. How do we argue? A developmental perspective

Answering the question "how do we argue in natural settings?" is a necessary step for educational psychologists that aim at fostering argumentation in school. Developmental psychologists have studied the ability of children in contexts such as disputes or negotiations. In these contexts, children know how to argue very early. Three-year-old children know a lot about the form, content, and function of arguments in verbal interactions, and by the age of five are skillful negotiators with their parents, siblings and peers (Eisenberg & Garvey, 1981; Stein & Trabasso, 1985). Howe and McWilliam (2001) recorded the arguments held by 3-5 yr old nursery school children. Most children displayed sophisticated tactics, for example, justifying positions and selecting alternatives. However, sophisticated tactics were interspersed with rudimentary ones, for example physical force and bland assertions, and (even with activity context taken into account) the manner of interspersion was dependent on their economic status and their gender.

These findings about the natural propensity of children to generate sophisticated argumentative strategies conflict with very broadly cited studies by Kuhn (1991; 1992; 1993) and Nickerson (1986). In her 1991 study, Kuhn interviewed individuals from four age groups (teens, 20s, 40s, and 60s) about urban social problems (e.g., "what causes prisoners to return to crime after they're released?"). The interview consisted of eliciting and probing the subject's reasoning about these problems.
Subjects were elicited and probed to express their causal theories, to justify them by providing supporting evidence, to generate opposing theory, to evaluate presented evidence, and to answer epistemological questions regarding certainty and influence of the evidence on their own thinking.

This study and other studies by Kuhn and by Nickerson showed that people tend to provide theories with a single cause or with multiple parallel causes. Concerning evidence, people had difficulties differentiating between theory and true evidence to often express 'pseudo-evidence'. From a developmental perspective, teens and elderly persons have more difficulties to evaluate evidence, and their judgment is biased by their own standpoint. Also, all age interval samples – even adults, have difficulties in elaborating opposing theories. People in their twenties are the most skillful in this respect. Also there is a clear advantage for more educated persons. The superiority of educated persons was the most pronounced for epistemology (e.g., for identifying the source of their knowledge or for evaluating its quality). Another interesting finding is that the mastery of skills is quite stable over the social problems that were checked. Such stability confers to what Kuhn calls argumentive skills the status of a set of ‘general skills’ that develop in the life span.

In summary, Kuhn's studies (1991; 2001) showed that in the sixth- to the ninth-grade period, argument skills grew in children. After that, educational level made the difference, with college-educated people performing better than ninth graders, but with people without a college education performing at a level between sixth and ninth graders. Kuhn (2001) identified developmental differences according to a three stage development of epistemological understanding: absolutist, in which knowledge consists of facts, multiplist or relativist, in which knowledge is regarded as an opinion, and evaluativist, in which claims and support are acknowledged. The influence of Kuhn's studies on research in learning to argue has been substantial, since learning can be measured by the increase in argumentative skills scores and since the tools proposed are relatively simple to use (e.g., Zohar & Nemet, 2003).

Stein and colleagues (Stein & Miller, 1990; 1993; Stein & Bernas, 1999) provide theory and findings that help overcoming the contradictions between the natural propensity children have in engaging in argumentation and biases in argumentative skills. According to Stein and Miller, although argumentation skills emerge very early in development, knowledge about the function, form and content of argument "emerges out of a desire to ensure that personally meaningful goals are attained" (p. 101). Stein and Miller introduce emotion in argument contexts to assume that four components underlie the development of an argument: (1) the desire to achieve personally meaningful goals, (2) knowledge about the positive and the negative consequences of actions, associated with the attainment of these goals, (3) knowledge about obstacles that stand in the path of goal attainment and (4) beliefs about consequences of not attaining these goals. In that way, understanding the nature of personal goals allows predicting the thinking, reasoning and actions carried out during attempts to resolve conflicts. When children recognize that they have conflicting views, both willingly engage in an argument and both aim at settling it (by winning or by reaching an agreement).

The contradiction between the developmental studies undertaken by Kuhn and by Stein and Miller can also be settled through a different but complementary argument. This argument belongs to the methodological realm. When they checked how people argue, those scientists evaluated argumentative skills. In the two kinds of studies, the methodological tools were of very different nature. For Kuhn (and Nickerson) these were structured interviews or questionnaires, administered at
different ages. In these questionnaires or interviews, students are typically asked about social issues in order to assess their ability to give reasons, to produce evidence that corroborates them, to imagine challenges and to rebut them, etc. (e.g., Kuhn, 1991). In contrast, Stein and Miller directly observed children in natural settings while settling disputes or negotiating a decision. The ability to challenge or to counterchallenge was observed in situ, not in interviews in which an experimenter asked questions such as “Could you imagine how you could answer to somebody who does not agree with you? Give reasons” It is then clear from a theoretical point of view that the development of argumentation skills and their manifestation in a given situation is highly sensible to context. A reasonable interpretation of the numerous different educational studies that evidence “the acquisition of some argumentative skills” is that intensive programs in which students receive argumentative prompts turn to normative the enactment of argumentative practices in the specific context in which these practices are fostered and not necessarily in other contexts. This is the job of the educator to prospect useful contexts for argumentative activities.

The suggestion that argumentative skills can be differently enacted through manipulations that modify the goals of subjects has been confirmed in a recent study by Glassner and Schwarz (2005). Glassner and Schwarz investigated what they called the antilogos ability, an argumentative skill that consists of critically evaluating whether information presented actually supports a given claim. The antilogos ability was tested for different variables: age group (Grades 8 and 10), direction of information (one text was presented as supporting a claim and the other was presented as opposing the same claim), whether or not a personal argument is constructed before critical evaluation, and whether or not a worked-out example is provided before critical evaluation. The study indicated that a) antilogos develops during adolescence; b) it differs for different directions of information; c) the combination of expressing personal argument before critical evaluation and being provided a worked-out example improves antilogos performance in Grade 8 students; d) personal standpoint can be neutralized during critical evaluation. This study indicates both a developmental trend and the fact that context can considerably modify the manifestations of this skill. Glassner and Schwarz conclude that the fact that manipulations can so easily increase performance may suggest that dispositions rather than skills govern antilogos.

In sum, the studies reviewed here reveal that: (a) people have a natural propensity to argue; (2) people show difficulty to engage in argumentation in contexts where goals are not evident; (3) between–subject differences are particularly linked to age and education; and (4), the potential to manipulate situations so that they foster argumentation. Important educational implications can be drawn on the role of school to foster argumentative skills. School should be sensitive to providing adequate contexts for argumentation. In general, the effort of the educator should be put on (1) designing situations in which the personal goals of the students (implied by the design) will help them engage in situations with educational value, (2) help students in identifying the goals of all participants. Another insight is that the explicit teaching of argumentative skills is often valueless: since students acquire basic argumentative skills very early, what is more needed is to contextualize these skills in educational settings. Schwarz and Glassner (2003) have described the asymmetry between everyday life and scientific argumentation through personifying everyday argumentation by a blind person and scientific argumentation by a paralytic person: The blind – the everyday arguer, can operate argumentative moves (can walk) but the result of the negotiations is often unclear – he/she does not know exactly where to go;
the results of his/her discussions are useful in daily activities but they are generally not accumulative. The paralytic – the scientific arguer, receives principles, laws, theories; he/she can see them, but is not able to move on with them, to use them in discussions. It is then the educator's responsibility to design activities and to provide tools with which the natural propensity to engage in argumentation could be capitalized for scientific issues and educational goals (see section 5 in this chapter).

4. Argumentation and Learning

In section 1 of this chapter, we outlined the ideological reasons why argumentation has been largely untapped in modern education until two decades ago. In the previous section we explained the great potentiality as well as the pitfalls of argumentation as an educational tool, in the light of developmental research. In the current section we review the literature on argumentation and learning. It can be roughly divided into two different related strands of research: Those that investigate how children can be taught and elicited to engage in argumentation, and those that focus on the role of argumentative practices in different group and individual measures of learning. In the former case, the creation of productive argumentative practices is the aim since researchers investigate the conditions and settings that elicit productive argumentation in educational settings. Section 5 of this chapter is dedicated to the topic of argumentative design. In the latter case, however, the creation of productive argumentative practices is a prerequisite for studying the role of argumentation in learning. This is the focus of the present section.

Argumentation as a classroom practice or an instructional intervention can take many forms: argumentative essay writing, exercises in argument evaluation, argumentative discussions in small groups or with the whole classroom, they can be teacher- or student-lead, computer-mediated or in face-to-face mode, to name a few. In addition, researchers and educators may be moved by different motivations to implement argumentation in learning activities. Consider for example the difference between the following two questions: "Does participation in argumentative interventions improve individual critical thinking skills?" and "Can participation in group argumentation lead to changes in personal attitudes towards abortion?" Whereas the former question focuses on its benefits on individual skills, the latter refers to the role of argumentation in personal belief change.

Our review of the literature on learning and argumentation will therefore distinguish between the following fields of investigations: (1) individual belief modifications; (2) reasoning and thinking; and (3) subject matter knowledge. The dividing lines between these three fields are not always apparent, since the constructs involved do not exist nor evolve independently of each other. In learning how to argue, for example, individuals learn and practice how to argue about something, thus also improving their knowledge on that subject. Vice versa, having a deeper understanding and more knowledge on a certain topic enables a person to be able to construct more qualitative and complex arguments on that same topic. The differences

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1 "The blind and the paralytic" is no more than a metaphor to render the very different ways people participate in collective argumentation, depending on context. The way we identify informal daily discussions with the paralytic, blind – unable to see more knowledge, is quite Platonic, but we highly value the importance of informal discussions.
Participation in argumentative activities in the classroom is also likely to convey and instil norms of conduct, expectations and scripts for what a qualitative discussion should be like. One of the more prevalent reasons for teachers to implement argumentative discussions in their classroom may in fact be motivated by expectations that these activities will teach their students to become civilized, rational and empathic discussants. Unfortunately, however, such effects of argumentative discussions have yet to be investigated and we therefore limit our discussion of the literature to the three fields mentioned above.

4.1 Argumentation and modification of beliefs and of attitudes

Historically, argumentation has been used to convince in the public area, and although we focus here in argumentation and learning, it is more than natural to begin this section by what research has yielded on modifications in attitudes/opinions during and after an argumentative activity. The answer to this question during argumentative activity is simple: Tools for scrutinizing modifications in attitudes and opinions in interaction have still not been developed and research has exclusively focused on tests after argumentation. The timing for checking these modifications is diverse: from immediate tests to tests after several weeks. The types of tests range from simple expression in multiple choice items to the argumentative writing of essays. The argumentative writing is preferred because it uncovers the considerations of the individual and the reasons he/she invokes. The argumentative writing of essays is problematic though, since the biases and weaknesses in content and structure of written arguments may be attributed more to the difficulty to engage in the argumentative writing process itself than to shortcomings in the participation of students to a previous argumentative activity. Also, gains from argumentative interactions may stem from the writing process itself that demands to a very rich cognitive activity. In spite of these caveats, written arguments are nevertheless used to measures gains from previous argumentative activities (Kuhn, Felton & Shaw, 1997; Schwarz, Neuman, Gil, & Ilya, 2003; Sandoval & Millwood, 2003). This kind of methodology is justifiable though, if the researcher keeps in mind that the written argument is the product of two activities, the argumentative interaction, and the writing process.

These methodological precisions and caveats being made, we can turn now to the empirical findings that stemmed from tests given after argumentative activities. Kuhn, Felton and Shaw (1997) investigated the effects of dyadic interaction on argumentation (what Kuhn calls argumentive reasoning). They showed that if adolescents or adults are prompted to find consensus or to understand differences of opinions in successive interactions, argumentive reasoning progresses. The progresses were measured in written essays six weeks after interaction through identification of the number of arguments, their quality (non-functional to functional), whether evidence was used, and holistic evaluation of structure of arguments (from one-sided to two-sided arguments). Kuhn et al. study showed interesting results: first the fact that the arguments in the final texts were more two-sided. Also, although opinions did not change, they turned to be more moderated among adolescents than among adults. Also, among subjects that changed from a one-sided to a two sided argument, the adolescents used meta-cognitive statements while the adults did not. The theoretical
interpretation of this study is problematic, since Kuhn and colleagues recognized that in most of the dialogues, no conflict model dominated and that peers agreed in the course of their discussion. The term 'effect of dyadic interaction' is then quite fuzzy. The types of processes during interaction are diverse, and some of them only were really argumentative. In spite of its problems, this study is valuable if instead of dealing with effects of dyadic interaction on argumentive reasoning, one interprets it as the study of argumentative characteristics of texts after dyadic interaction.

This interpretation is adopted by Schwarz and colleagues (Schwarz, Neuman, Gil, & Ilya, 2003) to show how triadic interactions improved the quality of argumentative texts written by Grade 5 students invited to write arguments on the issue of experiments on animals. The experiment comprised multiple stages in which students wrote arguments individually or collaboratively. At one of the stages, triads were presented short texts representing arguments pro or con the issue. Schwarz and colleagues showed that collective essays were of the highest argumentative quality and that the Grade 5 students did not use texts in their essays. In contrast with Kuhn and colleagues, Schwarz and colleagues concluded that knowledge about experiments on animals was co-constructed in argumentative activities (and not that argumentive reasoning increased). To illustrate their conclusion, Schwarz and colleagues analyzed some protocols to show the argumentative processes that led to changes in written texts. Like in the Kuhn et al. study, the processes showed more consensus-seeking than adversarial dialogues. In summary, the 'effect' in both studies did not measure a correlation between a type of dialogue and quality of individual text writing but between a very general set of conditions – dyadic interaction, and instructions to seek consensus or understand disagreements, and individual text writing. The set of conditions can be called an argumentative design, as it is hypothesized to provide constraints and affordances for argumentative activity although actual argumentative processes are far from being guarantied.

In school, there are several domains in which personal opinions are discussed. The main ones are Civic education and History. In Civic education, research has not been investigated to observe how argumentative activities modify opinions, but in History, pioneering studies have already shown interesting results. Societal and ideological changes concerning autonomy and authority in modern society have led educationalists to favour a critical-argumentative approach in history education. They developed new kinds of activities such as evaluation of historical sources, discussion of multiple texts, or argumentative writing. As Baker (2003) claims on such activities, argumentative activity turns accounts into stands held by protagonists in historical action and participants in historical-graphical debate.

Empirical findings on the effects of this reform on historical reasoning are still rare but encouraging. For example, Perfetti, Britt, Rouet, Georgi, and Mason (1994) showed that historical problem solving argumentative activity may influence narrative, attitudinal and argumentative characteristics of student’s writing: in a well

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2 We do not insert in this subsection on changes in beliefs and attitudes, the case of Science and Mathematics although the personal views children hold in these domains are certainly resources that teachers use to help students learn scientific concepts. However, the rules of the game are quite different. In Science or Mathematics, children are more inclined to change their minds if they understand the teacher or the results of an experiment. Personal opinions are not at stake, at least at the same degree, as compared to History for which discussions may involve ideological or political issues. Our decision not to include the case of Science and Mathematics is also based on the fact that literature on these domains is rich and we wanted to keep the length of the chapter reasonable.
designed experiment based on the critical reading of conflicting sources, they showed that opinions turned to more two sided. They also pointed to relations between changes in empathy and in argumentative level of text writing and the use of information from historical sources – a clear indicator of historical learning.

Goldberg, Schwarz and Porat (2007) undertook another study based on argumentative activities. They obtained similar results concerning the improvement of argumentative writing. A major difference between the two studies is that in the Perfetti et al. study, the issue was quite neutral (the history of Panama) while Goldberg and his colleagues designed a study in which the researchers focused on the effect of the vitality of historical issues in collective memory on students’ history learning processes and products. Forty 12th grade students of different ethnic background participated in two historical problem-solving learning tasks. The historical issues were found to differ in their vitality in collective memory as signified by students’ consensus, certainty, and reference to the present. These differences defined vitality as expressed in living and dormant collective memories. Findings showed effects of vitality on narrative and argumentative change, and on the relation of historical source evaluation with narrative change. An interaction was found between issue vitality and ethnicity in the source evaluation: more vital collective memory narratives were more resistant to change and more prone to ethnic identity bias. In the case of living collective memory, two groups representing two different narratives were involved in argumentative activities. Goldberg and his colleagues showed that when the debate is in the context of inter-group relations it heightens awareness of in-group membership, “making social categories salient”. Thus, on the one hand the preconceived collective narrative of the past is more open to change, and on the other hand it arouses social identity motivating its change. Argumentative strategies and historical sources serve as resources for social identity needs.

The fact argumentative improvement relates both to stability and change of attitude shows that historical argumentative activity does not simply free learners from the influences of their subjective preconceptions into the realm of unbiased critical thinking. The motor and motivator of argumentative change is still the individual’s fundamental attitudes and needs, often stemming from social identity. Argumentative activity and the critical encounter with diverse historical sources somewhat loosens the hold of collective memory and widens the scope of narrative choices for the individual.

Although promoting dialectical-dialogic activities in History classes appears as a very promising direction in History education, it raises difficult ethical and pedagogical problems: "Is the teacher entitled to attempt modifying personal narratives?", or "Is the preference of one narrative over another one, an issue of reasoning or of ideology?" are some of the tough questions that educators that choose to adopt a dialectical-dialogical approach in History classes have to answer. A new alternative to this approach has been brought forward by Coffin (2006). As a linguist, Coffin identified how texts are written in History textbooks. She used functional linguistics to identify how central components of texts in History textbooks, such as temporality, causality or judgment/valuation are encoded in those texts. Coffin showed how linguists collaborated with teachers to help them listing the requirements necessary for writing a text and to commit students to comply with these requirements in their writing assignments. To a large extent, this approach is conservative: students are trained to imitate the different genres of historical texts they read. Although the outcomes of their writing should often be a polished argument, it is not necessary for
the writing activity to involve argumentation. Rather, Coffin's linguistic approach brings to consciousness (both for teachers and students) the way in which History texts are linguistically structured and shaped and the way in which writers draw on grammar and vocabulary to create different communicative effects. We personally think that Coffin's approach is more adapted for dormant issues for which narratives are not vivid. In such cases, changing opinions is only a matter of having more information at hand.

4.2 Argumentation and the improvement of reasoning and thinking

The most profound reasons that led thinkers and educationalists to bring forward argumentation in school are also the most difficult to study. And indeed, many new educational programs in which argumentation serves as a tool to improve reasoning have been developed but systematic research has rarely been conducted to study the impact of these programs on reasoning. The achievements consist in the implementation of these programs, and on the popularity that they gain among teachers and students. These educational programs generally do not put to the fore the promotion of 'critical thinking' rather than the fostering of argumentation, although scrutiny over but their implementation heavily depends on the instilment of argumentative practices. One of the most celebrated programs dedicated to critical thinking is Lipman’s 'Philosophy for children' (P4C) (Lipman, 1991) in which students are presented issues with a (folk) philosophical character and that are relevant to society. According to his ideology, critical thinking concerns understanding and not skills. The understanding is realized through dialogues among students, and dialogues between students and the teacher. Several studies have been undertaken to evaluate the impact of P4C. To measure success of the program, several researchers used tools for assessing critical thinking skills before and after the program. It is not surprising that results are not conclusive: the program focuses on understanding rather than on the acquisition of skills.

Another appraised program, Perkins' Point Zero, explicitly focuses on the acquisition of thinking skills similarly to an apprentice that acquires craft in a workshop. And indeed, students are coached to express argumentative skills which are generally considered as meta-cognitive skills in a cognitive apprenticeship setting. This program led to more conclusive results. However, it is difficult to be convinced that such a program conveys dialogic ideas. The same approach is adopted by Zohar (Zohar & Nemet, 2003) in a program on genetics and ethics in which a teacher scaffolded argumentative skills through explicit prompts during enquiry in well-structured tasks. Zohar and Nemet showed that the acquired argumentative skills could be applied in near transfer and far transfer tasks on similar scientific issues. Here again, instruction is structured and directed and although the teacher prompts the production of reasons supported by evidence, or the rebuttal of arguments through experiments, the dialogic dimension present in P4C is missing.

In contrast to the programs above, the 'Thinking Together' program (Dawes, Mercer, & Wegerif, 2000) is centred on dialogue. It is does not focus on skills or on understanding but on fostering dispositions for dialogue: Students are invited to comply with ground rules about what they call 'exploratory talk' (and which could be called also critical reasoning). Examples of ground rules are: 'give reasons to your claims' or 'refer to arguments raised by others'. These rules are spelled out by the teacher but students must enact them during classroom discussions. The role of the teacher is to sustain collective talk according to such ground rules. In an interesting
It seems, however, that the creativity of educationalists such as Lipman, Perkins or Mercer in developing with their colleagues exciting educational programs is by far bigger than the creativity researchers used to assess these programs. Direct reports on the kinds of dialogues that develop during the programs are more convincing and show unusual interactions that are not exclusively teacher-centred. They show norms such as the need for justifying claims, and to challenge views that are established in classrooms. Such reports are important although insufficient: The shift to dialogism in programs to promote critical reasoning challenges evaluation. The Argumentative Group at the Hebrew University tries to face this challenge. The group developed since 1996 the program 'Kishurim' (Schwarz & Glassner, 2003; Schwarz & de Groot, 2007) for fostering argumentative practices in schools. In this program, students are invited to comply with ground rules similar to those in Thinking Together. They are trained to evaluate the structure of arguments and their goodness. They are also trained to enact dialogical-dialectical practices (brainstorming, critical discussions followed by reflective teacher-led discussions, etc.). Environments in the Kishurim program include graphical tools for argumentation in e-discussions. Instead of using ready criteria for measuring the impact of the program on reasoning, the researchers first spelled out the pedagogical principles on which the program was based (autonomy, collaboration, commitment to reasoning, ethical communication, procedural mediation, etc.). Schwarz and de Groot showed that these principles are compatible with dialogism. In the process of finding proper criteria to evaluate the program and to improve it, they showed that the criteria of coherence, decisiveness and openness are appropriate for evaluating the program since they stem from pedagogical principles of the program. They then focused on one history teacher who implemented the program in his class during a period of 7 months. Schwarz and de Groot showed that the History course was successful according to those criteria, but not successful according to other more traditional criteria. To measure coherence, decisiveness and openness, Schwarz and de Groot used argumentative maps collectively constructed by discussants.

In light of the present shortcomings in evaluating the quality of reasoning in classes where argumentative practices are fostered, our opinion is that descriptive methods are the best to render the processes that develop in educational programs. For example, in science education, the descriptions undertaken by Sandoval (2003; with the SenseMaker system), or by Osborne, Erduran and Simon (2004) show activities in which argumentation is at the service of epistemology in their reasoning: students ask for source of knowledge, check evidence, raise hypotheses and try to co-construct coherent explanations.

In summary, several programs with different pedagogical approaches that advance dialogical thinking have been developed in different countries. In some of these programs, direct observation of activities show genuine reasoning processes supported by argumentative practices. However, methodological steps to grasp systematically these reasoning processes are still modest. New criteria and methods should be developed to fit the dialogic stand that characterizes change in education.
4.3 The role of argumentation in knowledge construction and revision

It is clear from the previous two sections, that the role of argumentation in belief modification and reasoning has been given relatively much attention in the empirical literature. In contrast, empirical research seldom focused on the benefits of argumentation on concept learning, and even less so in the sciences (Duschl & Osborne, 2002), in spite of the fact that argumentation is often associated with the activity of knowledge construction (e.g., Andriessen, Baker & Suthers, 2003). One of the reasons may be that collaborative knowledge construction is often regarded as a consensual process in which peers build on each other's ideas. Argumentation, on the other hand, is often seen as a conflictive situation in which peers contest each others' ideas. However, as aforementioned, a disparity in views does not necessarily have to reflect an interpersonal conflict; in contrast, peers can collaborate to dialectically explore different perspectives of a certain dilemma. Moreover, according to (neo-)Piagetian notions of learning, intra-personal conflict may be an important instigator for conceptual knowledge revisions (Mugny & Doise, 1978).

Research into the effects of argumentation on conceptual knowledge

First indications that argumentative dialogue may improve content knowledge were reported by Teasley (1995) and Jimenez-Aleixandre (1992). This claim was further supported by evidence from qualitative analyses and field studies (e.g., Baker, 2003; Fernandez, Wegerif, Mercer & Rojas-Drummond, 2001; Mason, 2001; Schwarz, 2003; Schwarz & Linchevski, 2007; Schwarz, et al., 2003; de Vries, Lund & Baker, 2002). For example, Schwarz, Neuman and Biezuner (2000) conducted a study on the effect of pairing children with different misconceptions concerning decimal fractions. The pairs were then instructed to solve a set of decimal problems together. Their dialogue analyses found that pairing children with different misconceptions can indeed lead to conceptual gains, provided that the two engage in an argumentative discussion.

Whereas descriptive data may provide insights into processes of emergent learning, they cannot provide conclusive answers to questions concerning causes for 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 better understanding, as suggested by Means and Voss (1996)? To answer such questions experimental designs are needed. However, such an approach presupposes that argumentation can be manipulated as an independent variable and isolated in order to study its effect on learning. A priori, this does not make sense: One cannot command people to argue or to refrain from arguing. One possibility is to compare the effects of different designs hypothesized to foster argumentation. Such an approach does not focus on effects of argumentation but on the effects of eliciting argumentation. Such an approach is justified if the designs are proven to elicit more argumentation than control conditions. It has been adopted in the three following studies:

In an investigation into the effects of different writing instructions, Wiley and Voss (1999) found that undergraduates who were instructed to write an argumentative essay on an historical topic achieved better conceptual understanding than those who received other instructions (narrative, summary or explanation). Interestingly, however, they did not necessarily have better retention of factual information.
Asterhan and Schwarz (2007), on the other hand, focused on the effect of dyadic, oral argumentation on conceptual understanding in evolutionary theory. They also treated argumentation as a condition: In a first experiment, undergraduates were assigned to dyads and collaboratively tried to explain an evolutionary phenomenon. Half of the dyads were instructed to engage in argumentative dialogue on their respective explanations and received some written examples of argumentative moves; the other half was merely instructed to collaborate. Individual evolutionary understanding was assessed on three separate test occasions: Prior to, immediately after and a week following the intervention. When controlled for pretest performance, delayed post-test explanations of students in the argumentative condition were found to testify of better conceptual understanding than those of control students. Furthermore, the pattern through which this advantage was attained revealed that students in both conditions improved their conceptual understanding immediately following the intervention. However, students who were merely instructed to collaborate lost this temporary gain, whereas students in the argumentative condition retained the same level of performance at the delayed post-test.

The advantage of argumentation observed in collaborative dyadic situations was replicated in a follow-up confederate study in which experimental subjects were elicited to engage in monological argumentation directed at and prompted by a peer confederate (Asterhan & Schwarz, 2007). Similar to the dyadic study, students who were instructed to engage in monological argumentation on their own and another person's solution showed immediate gains that were retained a week later. Control students, on the other hand, did not show conceptual gains on any of the test occasions.

A third experimental study on the effect of argumentation on conceptual understanding was conducted by Nussbaum and Sinatra (2003). They focused on the effects of a task design according to which individual learners were elicited to consider and justify alternative explanations: 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 (i.e., the correct solution). Participants in both experimental and control conditions were shown a simulation of the correct solution before moving to the next item. Whereas no difference was found in the accuracy of their predictions, the explanations of experimental subjects showed more attention to key aspects, such as gravity and momentum.

In sum, independent of the particular way in which argumentation was elicited (written/oral, computer-mediated/pen-and-paper, individual/collective) the combined conclusion from these three studies is that the engagement in argumentation improves conceptual understanding. Further research is needed to clarify whether this conclusion can also be generalized to other argumentative designs, populations (in particular school populations) and different subject matter.

These findings also raise important questions concerning the mechanisms through which argumentation leads to learning gains in conceptual knowledge. Systematic research into such mechanisms is still at a very early stage. However, insights from first findings allow for the formulation of educated hypotheses concerning these mechanisms. Moreover, the activity of argumentation encapsulates several social and (socio-)cognitive processes that have been investigated in the psycho-educational literature and found to foster learning. These issues will be discussed in the next section.
Exploring the mechanisms behind conceptual gains through argumentation

A quick glance at the aforementioned literature shows that many of the studies on argumentation and declarative knowledge adopted an instructional design paradigm based on notions of cognitive conflict. This paradigm is based on Piagetian conceptualizations of learning (e.g., Piaget, 1985), according to which intra-personal cognitive conflict leads children to seek equilibrium and, hopefully, to accommodate their pre-existing conceptions into new ideas. Researchers in conceptual knowledge revisions have attempted to apply Piaget's descriptive notions of learning to design learning tasks that rely on creating conditions in which students' naïve conceptualizations are confronted with anomalous data or contradicting views. This design paradigm has generally been referred to as the cognitive conflict paradigm (e.g., Limon, 2001).

Tasks that are designed within this instructional design paradigm are cognitively very demanding. It is expected from learners that they will: (1) become aware of and articulate their initial (mis-)conception; (2) understand the new information presented to them; (3) become aware of the contradiction between the different pieces of information; (4) compare and evaluate them, and (5) adapt their naive conceptions or construct a new one (see also Posner, et al, 1982). Therefore, participation in such tasks does not necessarily guarantee conceptual change. For example, Chinn & Brewer (1998) have shown that ignoring, rejecting, excluding, reinterpreting and expressing uncertainty about the validity of anomalous data are common responses among undergraduates. To engage in such tasks, students will need to be highly motivated and engage in, what has been referred to as, "deep processing" (Dole & Sinatra, 1998). Not surprisingly, results from empirical studies that have applied the cognitive conflict paradigm in instructional strategy are, overall, rather disappointing (Limon, 2001; Driver, Newton & Osborne, 2000; Tolmie, Howe, McKenzie & Greer, 1993).

The cognitive conflict paradigm has also been implemented in peer collaboration settings (socio-cognitive conflict) by pairing students with different initial conceptualizations or by presenting collaborators with contradictory information (e.g., Amigues, 1988; Howe, Tolmie & Rodgers, 1992; Jensen & Finley, 1996). Theoretically, collaborative task designs seem to be more promising for concept learning within this paradigm than individual settings: According to (neo-)Piagetian theory, the confrontation of different cognitions in combination with the equality in status are considered to induce high levels of cognitive conflict which are thought to be crucial for the occurrence of conceptual change (e.g., Damon, 1984; Mugny & Doise, 1978; Piaget, 1985). The interaction with an equal-status peer is also thought to cause learners to engage in explanatory activities, such as the consideration of alternative ideas (Okada & Simon, 1997). In addition, having (a) partner(s) may reduce the cognitive load as a result of the combination of individual resources and the distribution of task-related cognitive demands among the participants (Dillenbourg, 1999).

However, as the literature on peer collaboration has extensively and repeatedly shown, simply putting two people together is not sufficient (e.g., Coleman, 1998; King, 1990; King & Rosenshine, 1993; Teasley, 1995). Even the creation of heterogeneous groups according to personal beliefs and performance does not ensure productive peer collaboration. An increasingly large body of research seems to indicate that for collaborative task designs to be effective, more than anything else, participants have to engage what has generally been referred to as shared thinking (Rogoff, 1990). This means that they have to actively engage in and transact on each
Collective argumentation involves a specific type of shared thinking that may be particularly beneficial for concept learning, especially in tasks that are based on the creation of (socio-)cognitive conflict: Argumentation explicates and brings to the surface many of the aforementioned steps that are thought to be crucial for assuring and solving the hypothesized cognitive conflict and lead to conceptual gains. Accordingly, the activity of argumentation may be conceptualized as a tool, or a scaffold for dealing with (socio-)cognitive conflict in a more efficient or successful manner.

As a culturally embedded activity, argumentation comes with a certain set of norms, expectations and rules of conduct that are part of argumentative scripts (e.g., Kollar, Fischer, & Slotta, 2005; Nussbaum, 2005; Nussbaum & Kardash, 2005; Weinberger, Ertl, Fischer & Mandl, 2005). Such social scripts assure that discussants will actually engage in those steps that are thought to lead to progress through cognitive conflict, such as the need to explain oneself, the need to give justifications for claims proposed, the need to hear and understand alternative views and the need to formulate relevant counterarguments. Each of these actions has by itself been shown to be beneficial to learning in general and concept learning in particular:

First of all, argumentation as a group activity is thought to reduce the extensive cognitive load involved in concept learning, especially in demanding tasks such as those that involve cognitive conflict techniques. Instead of having to represent the different views in one’s mind and to elaborate, evaluate and integrate them, an argumentative group discussion enables the objectification of perspectives and their representation by actual persons defending them (Baker, 2003). Empirical findings from recently conducted research support this conjecture: Protocol analyses of dyadic dialogues revealed that repartition of ideas between discussants distinguished between those interactions that lead to subsequent radical knowledge transformations (i.e., conceptual change) and those that did not (Asterhan & Schwarz, submitted).

Secondly, the mere generation of an argument, whether in solitary or group format, causes a person to consider explanations that justify solutions, opinions or attitudes, and requires him/her to express them in verbal, explicit communication. This act of justification alone combines a number of potentially beneficial aspects:

First of all, generating explanations to oneself (self-explanations) while learning declarative knowledge from an expository text has been shown to significantly improve students’ conceptual and procedural understanding on that topic in, for example, physics (Chi, Bassok, Lewis, Reimann & Glaser, 1989), biology (Chi, de Leeuw, Chiu & Lavancher, 1994; Chi, 2000) and mathematics (Neuman & Schwarz, 1998; 2000). This phenomenon has been referred to as the self-explanation effect. The generation of an argument (i.e., a claim supported by a reason), whether in solitary or group format, causes a person to ponder explanations that justify solutions, opinions or attitudes, and requires him/her to express them in verbal, explicit communication. Such an act taken in isolation serves as a self-explanation, and, as such, is likely to lead to similar gains as those through the elicitation of self-explanations.

Argument generation in interpersonal argumentation conveys more than an explicit verbal articulation of theories and their reasons per se. 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. In fact, research on
accountability effects (e.g., Tetlock, 1992) has shown that even the mere anticipation of an unknown audience that might require explanations or justifications has been found to improve the quality of one's thinking.

Wiley and Voss (1999) propose that the difference between producing an explanation and an argument may be found in the fact that the latter is perceived as more personal: Instead of having to explain what happened, one is asked to explain why (s)he thinks it happened. This is thought to lead to higher levels of motivation and personal investment, as well as a perception that theories and opinions have to be defended and justified, which in turn produces better retrieval and relating of different pieces of information (Wiley & Voss, 1999).

However, whereas processes of consensual explanation and elaboration may be beneficial for certain types of learning, they may not be sufficient for changes in particularly robust misconceptions. In a recently conducted investigation, Asterhan and Schwarz (submitted) compared protocol analyses of dyads of which following the interaction at least one of the dyadic partners achieved radical conceptual change in evolutionary theory, to those of non-gaining dyads. They distinguished between dialogical moves that testify of critical-dialectical engagement in ideas (i.e., reasoned challenges, oppositions, rebuttals, and concessions) and those that testify of consensual development and validation of explanations (i.e., reasoned support, agreements, and elaborations). The results showed that dialogues of gaining dyads contained a larger number of critical-dialectical moves, but that gaining and non-gaining dyads equally engaged in consensual knowledge building. These intriguing findings open a new venue of research into the effects of explanation and argumentation on learning. The literature on explanation- and elaboration-based dialogue has extensively shown its benefits on learning (Chi, et al, 1989; 1994; Coleman, 1998; De Leeuw & Chi, 2004; King, 1990; King & Rosenshine, 1993; Neuman & Schwarz, 1998; Okada & Simon, 1997; Van Boxtel, van der Linden & Kanselaar, 2000; Webb, Troper & Fall, 1995). However, these studies did not focus on scientific concepts that have been particularly resistant to instruction and may require a radical reorganization of conceptual knowledge, or radical conceptual change (Chi, in press; de Leeuw & Chi, 2004). Thus, further research is needed to explore the potentially different roles of consensual co-construction of explanations and dialectical argumentation in concept learning.

In contrast with one-sided reasoning, dialectical argumentation requires by definition the examination and coordination of different perspectives. This means that discussants have to consider objections to their personal theories and assumptions, to attempt to understand alternative positions and to formulate objections and/or counter-objections (Stein & Miller, 1991). The integration of findings from several different sources seems to suggest that these activities lead to superior cognitive processing:

First of all, providing counterarguments on why a certain explanation or viewpoint is incomplete or incorrect not only allows one to propose convincing arguments to refute that position in a discussion, but is also likely to deepen the understanding of the correct concept in the process. As argued by Kuhn (1992), "only by considering alternatives – by seeking to identify what is not – can one begin to achieve any certainty about what is" (p. 164).

Secondly, both Asterhan and Schwarz (2007) and Wiley and Voss (1999) found that the instruction to engage in argumentation led to gains on measures of conceptual understanding, but not necessarily improved performance on more superficial measures of learning. In the Wiley and Voss (1999) study, for example, students who were instructed to write argumentative essays gained a better
understanding of the historical subject matter, as expressed in the number of inferences and underlying principles of the subject matter they identified correctly on post-tests. They also wrote more qualitative essays, using more causal connections and transformed sentences from the original texts. In contrast, however, narrative writing tasks yielded better retention of factual information of the historical texts they read. In the Asterhan & Schwarz study (2007), undergraduates that had engaged in dyadic argumentation showed superior mental models of evolutionary understanding than control subjects, but did not use a larger number of correct Darwinian propositions in their answers. Thus, the gains from dyadic argumentation were reflected in students' mental models of evolutionary change, not in the explicit naming of these propositions.

Moreover, in this same study, mentioning the "right" answer (i.e., the Darwinian account for evolutionary change) during the discussion was not found to predict subsequent individual learning gains. Similar findings have also been reported by Howe and colleagues (Howe, McWilliam & Cross, 2005; Howe, et al., 1992). For example, in a study on the effect of peer collaboration on primary school children's conceptual understanding of motion down an incline, Howe et al (1992) found that correct solutions that were mentioned in the group interaction phase were not correlated with individual conceptual progress. They concluded that the experiences created conflicts to be resolved rather than solutions to be remembered.

In addition, implementation of instructional designs for dialectical argumentation has also been shown to foster robust learning gains: In a field study on two Spanish high school classes, Jimenez-Aleixandre (1992) tested the effectiveness of two different teaching strategies intended to cause conceptual change from a Lamarckian to a Darwinian explanation of evolution. In the experimental classroom pupils compared their own personal misconceptions with Darwinian accounts in teacher-led dialogue and subsequently evaluated the difference between these two individually. In the control classroom, students engaged in a teacher-led classroom discussion on the difference between Lamarckism and Darwinism. She not only found that the experimental classroom outperformed control subjects on an immediate post-test, but also that this advantage was preserved on a re-test including different items that was taken a year later. Similarly, Asterhan & Schwarz (2007) found that even though "regular" collaborative learning setting led to gains immediately following the interaction, these gains disappeared after one week. In contrast, dyads that participated in similar conditions but had been instructed to engage in argumentation consolidated their immediate gains and showed similar levels of conceptual understanding at the delayed post-test.

Finally, argumentative dialogue entails more than the "mere" transaction on each others' ideas. It's unique structure of linking premises, conclusions, conditions, rebuttals and so forth is also thought to considerably improve and extend the organization of knowledge, which leads to better recall and understanding on subsequent test occasions (Means & Voss, 1996). This claim is further supported by current theoretical models that regard human thinking and the organization of knowledge presentations as primarily argumentative in nature (e.g., Antaki, 1994; Billig, 1996; Kuhn, 1992).

The literature reviewed here touches upon a number of possible mechanisms that may explain how argumentation can lead to learning gains in conceptual understanding of subject matter. Whereas they provide some first answers with regards to the mechanism of learning through argumentation, more than anything else they outline future directions that are particularly worthy of further empirical
research. Additional research is also needed to identify the types of learning for which argumentation may or may not be beneficial and to extend the scope of subject matter topics investigated.

5. Argumentative design
In contrast with argumentation in informal settings (conversations during family dinners, disputes between siblings or friends), argumentation in educational contexts about ‘scientific knowledge’ rarely occurs spontaneously, and is difficult to sustain. It is then imperious to design activities in which participants are expected to engage in argumentation. We call this effort ‘argumentative design’. Argumentative design concerns the design, by a teacher, researcher, or educational professional, of collaborative situations in educational contexts in which participants take on productive argumentation. We mean that argumentation is productive when: (1) several arguments are raised or challenged during the discussion, and (2) participants capitalize on the arguments that emerge during the discussion in subsequent activities. In educational situations, argumentative design is an arrangement that includes the presentation of a discussible issue, but that leaves the precise nature of the discussion to the participants. According to the (socio-) cognitive conflict (neo-) Piagetian idea, one might have envisaged that simply confronting students with data that challenge their views or with other students with different views would trigger productive argumentation. However, as mentioned previously, research has shown the relative failure of such interventions to lead to conceptual learning (Limon, 2001). The few successes and the many failures in adopting the cognitive conflict paradigm support the importance of a meticulous design. Argumentative design is then a very difficult task. Although the articulation of clear principles on argumentative design is still premature, we review here several studies which allow us suggesting some directions.

5.1 Conditions for productive argumentation
Argumentative design concerns at the first place an arrangement set in advance – conditions for productive argumentation, then the structuring of argumentation itself. We are not exhaustive and limit ourselves to the role of shared understanding, of initial cognitions and of disagreement among discussants.

The role of shared understanding
Converging on shared understanding about the task is crucial for teacher-learner interactions. Both teacher and learner need to talk and engage in joint activity about the resources of their common knowledge and common interests or goals. Talk is the principal tool for creating this framework, and by questioning, recapitulating, reformulating, elaborating and so on, teachers are usually seeking to draw pupils into a shared understanding of the activities in which they are engaged. This shared understanding functions as a dynamic frame of reference which is reconstituted constantly as the dialogue continues, so enabling the teacher and learner to think together through the activity in which they are involved. If this shared understanding is successfully maintained (through grounding actions), misunderstandings are minimized and motivations maximized. The teacher will be able to help the learners transcending their established capabilities and to consolidate their experience. If the dialogue fails to keep minds mutually attuned, however, the scaffolded learning grinds to a halt. Shared understanding is a mutual achievement, dependent on the
interactive participation and commitment of both teacher and learner and on negotiation of common goals; but a teacher must take special responsibility for its creation and maintenance.

**The role of initial cognitions in fostering productive argumentation**

Of course, people cannot participate in a discussion if they are not minimally knowledgeable on the issue at stake. But what is the meaning of this 'minimal knowledge'? Depending on the task at stake, researchers have pointed at the importance of having a mental model or strategy of their own for the task at stake, without which discussants cannot deploy any explanatory frame in their discussion. For example, Glachan and Light (1982) showed that students without any strategy to tackle the 'Hanoi towers' game could not gain from interaction with peers in solving the game since they did not provide reasons in their interactions with peers. A promising direction concerns differences in initial strategies or mental models. Such differences may naturally lead to the articulation of different arguments and to the emergence of new arguments agreed upon by the parties. This is what happened in the study on the Hanoi towers conducted by Glachan and Light (1982) and by Schwarz, Neuman, and Biezuner (2000) with the mathematical concept of decimal fraction. Pairing in heterogeneous dyads led to conceptual learning. Post-hoc analyses showed that students engaged in productive collective argumentation.

**The role of disagreement in fostering productive argumentation**

Different initial cognitions is often translated in a state of disagreement between discussants. However, this is not necessary: discussant may develop different perspectives and reasons that reflect their personal views without reaching overt disagreement. In fact, disagreement should be treated cautiously: disagreement by itself may lead to polarization. For example, Lord, Ross and Lepper (1979) presented arguers with written sources of which some confirm and some contradict their personal standpoint; the arguers tended to be progressively more one-sided. Moreover, when two disagreeing arguers aim to win, the quality of their arguments may tend to decrease (Stein & Miller, 1993).

The role of disagreement seems then both beneficial and detrimental concerning the 'productivity' of collective argumentation. On the one hand, the fact that conflicting arguments are stated in the discussion may lead to learning (Mugny & Doise 1978). Such arguments risk to be one-sided though. However, disagreement also brings social inhibition that may hamper learning. For example, Asterhan and Schwarz (2007) confronted students with different mental models on evolutionary theory to solve a problem. The experimenter presented to the dyad a model of dialectic argumentation that favoured the challenge of conflicting ideas. In this context, many dyads that began their discussion by disagreeing continued it by considering together the conflicting views and trying to accommodate them. Thus, these students dodged the social inhibition that disagreement may create. The students that did not express overt disagreement while discussing a problem involving evolutionary theory progressed in their explanatory schemes. The students that adopted an adversarial style in which disagreements were overt, did not progress in their evolutionary theory. Thus, in spite of the potentiality of the arrangement of different initial cognitions, and of subsequent disagreement among peers, this disagreement may inhibit learning gains. Discussants may avoid this by collaborating to jointly accommodating different perspectives. Another way to avoid pitfalls linked to social inhibition concerns the use of external resources.
5.2 The role of resources in structuring argumentation
Like for the subsection about conditions to trigger productive argumentation, this subsection is partial. We focus on the role of hypothesis testing devices in structuring collective argumentation as a special case of feedback in this endeavor. Also we limited ourselves in considering the role of texts in structuring argumentation and did not include the more general role of libraries.

The role of hypothesis testing devices in fostering argumentation and learning
Among the resources that may foster productive argumentation, hypothesis testing devices are central, especially in science education. These resources include measurement instruments (balances, meters, etc.) and simulations in computers. Even in the case students check their own hypotheses through the device and find they were wrong, they are very often inclined to overlook the data the device provides. This is the case with individuals confronted with outcomes that contradict their conclusions (Tolmie & Howe, 1993). However, Howe and colleagues (Howe, Tolmie, Duchak-Tanner, & Rattray, 2000) have shown that the reason why individuals do not gain from hypothesis testing is that dialogue is needed to resolve the conflict. And indeed Howe and colleagues (Howe et al., 2000) showed that when students worked in small groups and were asked to 'reach consensus' on a problem in physics, hypothesis testing led to conceptual change. A quantitative analysis of the dialogues showed that change was accompanied by productive argumentative activity (i.e., the dialogue itself contained several arguments, and they were challenged in some way). Schwarz and Linchevski (2007) showed similar results that led to productive argumentation and subsequent conceptual change in the realm of conceptual reasoning: dyads could capitalize on a hypothesis testing device to deploy productive argumentation and subsequent conceptual change. Schwarz and Linchevski showed that the design of the task was tailored to lead to disagreement among peers and conflict with the results of the measurement. The peers were then motivated to settle these disagreements.

The role of (multiple) texts in fostering argumentation and learning
Texts seem another natural candidate for eliciting productive argumentation. In fact, as noticed by Schwarz (2003), collective argumentation around multiple texts representing divergent views has been an important practice adopted in the past by intellectual elites (e.g., by Scholastics and Talmudists in the middle Ages). For different reasons, this practice has almost vanished for several centuries. Its adoption is now considered positively in schools, but as a practice, it is still uncommon, even in universities. Obviously, cautious design is the rule of the game to trigger productive argumentation. Questions such as whether to ask students their initial reasoned opinion or not, whether to discuss texts before discussing the issue or not, whether to present challenging texts in the middle of a discussion, etc. are important issues whose answers should be adapted to the age of the students, the content to be learned, and the initial knowledge of the students.

Many studies have focused on learning from texts or on extracting arguments from multiple texts (e.g. Wiley & Voss, 1999). However, these studies have not focused on argumentation itself but on subsequent gains only. This neglected issue seems important for learning scientific knowledge: Since students have huge difficulties to engage in argumentative talk around scientific issues, studying when and how texts are incorporated in argumentative talk, is an important issue. A few studies have concentrated in this very issue, though. For example, de Vries, Lund and Baker (2002) provided a text on acoustics to dyads of students and asked (through a
software) about their agreement or their disagreement for each sentence of the text. When peers did not agree, the system proposed them to discuss their disagreement. Even in this very structured setting, students had a very hard time to deploy productive argumentation and generally did not advance their conceptions in acoustics.

The intuition on the role of texts to enhance argumentation according to which texts make public common opinions about issues, therefore provide resources for students to operate argumentative moves needs specification. In a case study, Schwarz (2003) showed that providing texts at the beginning of a discussion between students is too complex if the reading of the texts is not structured. Baker (2003) presented electronic texts to dyads and invited them to discuss the texts. The reading was highly structured: for each statement, students were asked whether they agreed, and disagreed and to propose reasons for their (dis)agreement. When students disagreed in their judgment, they were asked to settle it. In another study, Schwarz, Neuman, Gil, and Ilya (2003) proposed to elementary school students multiple short texts that provided resources pro and con a moral issue – whether to perform experiments on animals. The students read and commented the texts together, then discussed the issue under consideration. While, in this case, argumentation was found productive – the study showed that reading the texts promotes further the quality of argumentative writing in individual essays, although it was difficult to identify pieces of information 'included in the texts presented' that the students used. Rather the reading of the texts triggered quite associatively productive talk. Such a use seems appropriate for moral issues but does not seem to fit for discussing scientific issues.

Another untapped research direction concerns the form and content of the texts. Two main forms of texts seem to have potentialities for learning. The first one is a narrative form. A narrative form can more easily be appropriated, but it is not easy to incorporate in the elaboration of a well structured argument. On the other hand, providing texts in the form of arguments can leave the reader indifferent. Concerning content, providing texts that present conflicting or completing arguments (or multiple texts) seems to be of great potential for learning. If we take into consideration the possible arrangement of initial cognitions of the students (see above), the encounter of students with completing or conflicting multiple texts opens a very interesting direction in research.

5.3 On designing interactions to promote productive argumentation

So far, we presented argumentative design as a series of factors, or arrangements anterior to argumentation. However, argumentation risks remaining unproductive if exclusively left in the hands of the learners. Sustaining the argumentative process is often a necessary action. However, it is an extremely hard task. As a first step in this endeavor, it is natural to look at teachers when animating discussions in their classes. Yackel (2002) analyzed several protocols of teachers that mediated collective argumentation. She showed that in order to help in the emergence of arguments, teachers needed to have both an in-depth understanding of students' conceptual development and a sophisticated understanding of the concepts that underlie the instructional activities being used. Since this enterprise is very difficult to sustain, a first simpler step in coping with the design of interactions has been to focus on prompts, isolated actions that may promote productive argumentation.

The first important step in this direction was to recognize that offering an explanation may not always be the best kind of prompt. Palincsar and Brown (1984) were one of the first who suggested that for learning to be meaningful, rather than
offering an explanation, it is often better to lead students towards further inquiry. There is some empirical evidence, for example by Pilkington and Parker-Jones (1996), supporting the idea that by adopting an inquiry style, by prompting the students’ reasoning, justification of conclusions, or stating implications from data, a tutor can increase their understanding by reflection. Ravenscroft and Pilkington (2000) report research on tutor strategies and speech acts that are likely to be important in productive educational dialogues. Among all argumentative prompts, it is useful to differentiate between moderating and mediating ones. Moderation concerns prompts encouraging participation, answering challenges, clarifying, focusing on topic or even giving reasons. Mediation concerns the very constructing of arguments by pointing at contradictions, bringing new data, challenging an argument. Both kinds of prompts are useful. However, while teachers can learn quite easily the techniques and prompts for moderation, mediating argumentation seems extremely difficult.

Another way of prompting for fostering productive argumentation consists of feeding discussants with useful information in the course of their discussion. For example, Asterhan and Schwarz (2007) provided a part of a protocol featuring two disagreeing discussants proposed reasons for their views about a problem on evolutionary theory and challenged each other. This argumentative prompt was given in the middle of the discussion between peers and changed the characteristics of the discussion to more argumentative and led to resilient conceptual gains.

Mercer, Wegerif and their team propose a dialogic approach for promoting collective argumentation that differs from the prompting approach in the sense that the teacher's interventions are not isolated and linked only to specific goals but belong to a culture that the teacher instils in classroom talk. It consists of encouraging students to implement rules of exploratory talk (called ground rules) in their talk. In Exploratory Talk, partners engage critically but constructively with each other's ideas. Relevant information is offered for joint consideration. Proposals may be challenged and counter-challenged, but if so reasons are given and alternatives are offered. Agreement is sought as a basis for joint decision-making and action. Knowledge is made publicly accountable and reasoning is visible in the talk. The teacher’s role in instilling ground rules consists of including ‘reasoning words’ such as ‘what’, ‘how’, ‘if’ and ‘why’ as the children are lead through the activity. The teacher accepts and discusses challenges made and respects them. The children are given a demonstration of how to consider the validity of alternative suggestions. The teacher invites children to speak so that as many people as possible feel able to join in the discussion, and ensures that an agreement is sought and reached. In this way, through careful modelling of the ground rules for talk, the teacher is demonstrating to the children how effective collaboration can be as an integral element of intellectual activity. The children are engaged in the discussion, their points of view are sought, they have some influence on the discussion and the actions that are taken. And by being engaged in a dialogue in which Exploratory Talk is modelled, they are being prepared to use it when they continue the activity in small group discussion. We already mentioned that in this context argumentation turns to be very productive as general thinking skills were promoted (Wegerif, Mercer & Dawes, 1999).

In the Kishurim program, Schwarz, Glassner and de Groot (Schwarz & Glassner, 2003; Schwarz & de Groot, 2007) adopted a similar, dialogic approach. However, the project proposes additional ways to design and structure argumentation. The first way concerns arranging successive activities for transforming arguments according to the goals in these activities. A typical succession of activities includes the presentation of a dilemma, individual argumentation in a written essay reflecting
a personal opinion, brainstorm argumentation in a teacher-led discussion, round of turns argumentation in which the teacher controls a pre-established order of asking for arguments and all students have time to express their viewpoints, round of turns counter-argumentation in which the teacher orchestrates another controlled round of turns to figure out the reasons an opponent could raise and each student attacks his or her previous argument, small group dialectical argumentation in which small groups of students collaborate to construct their arguments, preparing the defence of an argument, in which students collaborate to design a multimedia representation based on their small group dialectical argumentation, and defending an argument in which students use their presentation to convince their audience (the whole classroom) that they are right. There are many variants of such practices, but the idea behind sequencing different activities is that arguments and argumentation should be adapted and transformed according to specific goals and that the discussants should be aware of the need for these transformations. A second important specificity of the Kishurim program is that argumentation is structured by using a computerized tool that represents graphically dialogues as they develop. The advantages and drawbacks of various electronic tools in structuring argumentation are reviewed in the next subsection.

6. The missing end: argumentation in a changing world

The philosophical and political changes that shook our society during the 20th century brought to the fore changes in education. The forms of reasoning that are favoured in educational program are progressively more social, without losing a critical character, naturally bringing argumentation to the fore. We could see that such a direction is very promising and can lead to substantial learning gains such as conceptual changes or reasoning skills. However, it is difficult for students, teachers, thus to designers. Argumentative Design, is a bridge between the intentions reformers have about change and practice, and as such is a new and extremely complex task. It involves multiple choices on varied social and cognitive arrangements and new kinds of resources (e.g., various conflicting or completing texts). Recently, designers have begun developing new modes of communication and their structuring, as well as new tools for sustaining collective argumentation. These very rich developments are far beyond the scope of the present chapter. We will only mention that the designers often belong to the Computer Supported Collaborative Learning (CSCL) community, and that the environments they design are identified distinctly as Computer-Supported Learning Argumentation (CSCA) tools. The aforementioned sensitiveness of students to scripts or instructions to engage in argumentation (Nussbaum, 2005, Nussbaum & Kardash, 2005; Weinberger, Ertl, Fischer & Mandl, 2005; Weinberger, Fisher & Stegmann, 2005) is even more crucial with CSCA tools: Scripts are covertly conveyed in the ontologically different conversation moves imposed onto the discussion: discussants typically have to use pre-defined dialogical constraints, such as for example "claim", "evidence" and "reason", when conducting an on-line conversation. Discussions are asynchronous or synchronous, and their representation generally combines graphical and textual elements. These new tools involve then varied scripts, modes and representational specificities. It would be unfair to summarize this extremely rich new direction of development and of research in several lines. The volume Arguing to Learn: Confronting Cognitions in Computer-Supported Collaborative Learning environments edited by Jerry Andriessen, Michael Baker and Dan Suthers (2003) presents some interesting results in this direction. A recent publication by Andriessen and Schwarz (in press) on Argumentative Design
gives a special place to CSCA tools and to the role of the teacher in structuring argumentation. The diversity of new aspects and methods we presented in this chapter on Argumentation and Reasoning is another sign of the profound educational change towards dialogism integrated with dialecticism, which follows an ideological revolution bringing to the fore better and deeper communication between people. And at the time of revolution, excitement sometimes prevails on reflection.

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