Dialogic Learning :
Negotiation and Argumentation as Mediating Mechanisms†

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Abstract

An approach for analysing and modelling learning as the result of the interweaving of reasoning minds in verbal interaction ("dialogic learning") is described. It is argued that giving primacy to modelling dialogue in learning situations can establish requirements for Intelligent Tutoring Systems architectures and provide a means for understanding collaborative learning processes in humans and machines. Two specific and related types of dialogue are considered that are fundamental mediating mechanisms in learning : negotiation and argumentation. Modelling these mechanisms in learning dialogues show that a richer set of epistemic attitudes is required in order to understand cognitive change in students, and highlights metacognitive processes as means for coordination and control.

"Without negotiation the dialogue is transformed into monologue, the function of the interlocutor being reduced to that of a simple receptor of the message." (Moeschler, 1985, p. 176).

"... somebody corners me and proceeds to present me with an argument of great persuasiveness, of irresistible logic, step by step. I can think of nothing to say against any of the steps. I get to the conclusion and can think of no reason to deny the conclusion, *but I don't believe it* !" (Dennett, 1981, p. 308 ; [Dennett's italics]).

Introduction

This paper is concerned with analysing and modelling Dialogic Learning ("DL"). Given that the etymology of the word "dialogue" is a combination of "separation"/"through" (*dia*) and "reasoning"/"discourse" (*logos*), DL may be paraphrased as *learning through the interweaving of separate reasoning minds in verbal interaction.* It is therefore not the same as "interactive learning" : whereas the latter stresses an *actional* perspective, DL stresses *reasoning in dialogue*. Modelling interaction and dialogue has usually been a secondary activity in Artificial Intelligence and Education ("AI&Ed") research, and there are perhaps good reasons why this should be so. Intelligent Tutoring Systems ("ITS") designers have usually started from knowledge modelling and 'worked outwards' towards interaction mechanisms, believing that a natural language "front end" could always be added on later. Otherwise, dialogue models in ITS have been viewed as replaceable by graphical interfaces, or as unnecessary within "free discovery environment" and "situated learning" approaches. However, despite the fact that there is a reasonable and growing body of AI&Ed research on dialogue modelling (e.g. Collins & Stevens, 1983 ; Elsom-Cook, 1984 ; Baker, 1989 ; Cawsey, 1989 ; Petrie-Brown, 1989 ; Blandford, 1991 ; Winkels, 1992), and that nearly every ITS or learning environment must have some means for interacting with the student, modelling the interaction itself has rarely been considered as a (or the) primary problem.

For a number of reasons, I argue that, even admitting the alternatives above, *it is interesting for AI&Ed research to 'work inwards' from analysis and modelling of dialogues in learning situations towards models for knowledge as it is taught and learned*. Firstly, a dialogue model can not sqimply be added on to existing domain

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and student models : effective dialogue models establish their own constraints on other components of ITS architectures. In particular, I shall argue that ITS architectures need to be based on a richer epistemology (or doxology) - a claim that has implications for student modelling approaches based on "belief systems" (Huang et al, 1991 ; Self, 1992a). Secondly, many of the interactive functions performed in verbal interactions (such as turn-taking, focus and time management) have counterparts in graphical ones ; so it is worth studying the former as a key to the latter. Thirdly, AI&Ed research is now being widened to embrace the study of other kinds of learning dialogues, such as dialogues between learners and computer co-learners (Dillenbourg, 1991 ; Chan et al, 1992), and between students in computer-supported collaborative work (Behrend, Singer & Roschelle, 1988 ; Barbieri & Light, 1992 ; Blaye, 1988). However, it is within the "situated learning" paradigm that most emphasis has been made on verbal interaction as an essential factor in learning. I want to show that it is possible and interesting to develop *AI&Ed* models for some of these processes.

I shall consider two specific and related types of dialogue, and reasoning in dialogue, that have recently been claimed to play key roles in learning : *negotiation* and *argumentation*. They are related since one negotiation strategy is to try to argue in order to get the other speaker to accept what you propose ("adversarial argumentation"), and because some special types of argumentation ("critical argument") may be negotiative (the goal is to reach agreement by a common examination of reasons for and against different views). Despite the fact that researchers from a wide variety of theoretical perspectives have invoked the importance of these types of dialogue with respect to learning, further research is required in order to develop the kinds of models that would permit their incorporation in an ITS, and interpretation of experimental results concerning their possible effects on learning. After reviewing existing views on the roles of negotiation and argumentation in learning, the main body of the paper is concerned with summarising results of analysis and modelling these processes in learning dialogues.

Negotiation, Argumentation and Learning

Within ITS research, a 'new' theoretical framework called "Knowledge Negotiation" ("KN") has recently emerged (Moyse & Elsom-Cook, 1992). There are two main motivations for invoking negotiation with respect to ITS : firstly, "... to enable discusions about how to proceed, what strategy to follow, what example to look at, etc., in an attempt to loosen the tutorial control of standard ITSs ... " and secondly, "... to permit discussions about the viewpoints (i.e. the beliefs or the knowledge) themselves, on the philosophical grounds that one agent (the tutor) should not be deemed to have infallible insight into the 'correct' viewpoint." (Self, 1992b, p. 39). These two motivations are of course related, via a connection between *knowledge* and *control* : to the extent that knowledge to be taught and knowledge of the student's capacities in some domains (or parts of them) may be incomplete or uncertain, there may be multiple possible representations (viewpoints) and acceptable problem solutions, or justified belief rather than knowledge itself, this implies that control of the teaching-learning interaction should be shared. As in the case of Distributed AI research, a privileged mechanism for sharing knowledge and control is "negotiation". In line with this general 'epistemological weakening' of the teaching agent, 'knowledge' may also be *co-constructed* with the learning agent by means of "critical argument". Thus Goodyear & Stone (1992) describe how critical argument is the primary means for teaching-learning in social science domains, essentially characterised by diverging "schools of thought", and Baker (1989, 1992b) has integrated both negotiation and critical argument dialogue mechanisms in the "KANT" (Kritical Argument Negotiated Tutoring) system.

Many of the dominant themes of the KN approach find repeated echos in "situated learning" research (e.g. Seely-Brown, 1990 ; Lave & Wenger, 1989 ; Roschelle & Clancey, 1992). From a 'situated' perspective, negotiation is both a mechanism whereby individuals *coordinate* ("without deliberation", as Clancey, 1992 claims) with their physical environment and a conversational activity that enables individuals to engage in "peripheral participation" within "communities of practice" (Lave & Wenger, 1989). Negotiation and argumentation have also been invoked in empirical research on computer-supported collaborative/cooperative learning (from Piagetian and Vygotskian perspectives) as interactional variables that may be responsible for learning effects. For example, Barbieri & Light (1992) found that negotiations were significant predictors of efficacity in problem-solving of pairs, but only within the context of jointly constructed solutions. However, as Mandl & Renkel (1992) argue, "... the Piagetian and the Vygotskian theories that dominate the developmentally oriented research on cooperative learning are too global to allow proper explanation of the different empirical results found in this field." (Mandl & Renkl, 1992, p. 281). The work of Dillenbourg (1991) on the Vygotskian

idea of internalisation of interaction structures (in a human-computer collaborative learning system) is a step in the direction of more specific models.

In addition to research on the role of critical argumentation in the context of negotiation, a reasonable body of research exists on different aspects of argument and argumentation in relation to learning. Most research has taken some variant of the argument schema of Toulmin (1958) as a theoretical basis. For example, Voss and colleagues (Voss, Blais & Means, 1986 ; Voss & Means, 1991) have produced data on how subjects assess the strength of claims in relation to their supports. They argue that since "informal" argumentation is "a discourse conduit through which reasoning flows" (Voss & Means, 1991, p. 345), argumentation is a skill that can and should be taught. Argumentation has also been studied from the point of view of case-based reasoning (Bloch & Farrell, 1988), within a developmental perspective (Miller 1987), and a number of researchers have used representations of argument analyses on graphical interfaces as a means for teaching reasoning and explanation skills (VanLehn, 1985 ; Lesgold & Katz, 1993 ; Cavalli-Sforza et al, this volume). Nearly all research on argumentation in relation to learning has considered it in a *non-dialogic* context, apart from (to my knowledge) the work of Resnick et al (1991) and Pilkington et al (1992).

In summary, although negotiation and argumentation emerge as transversal themes in learning sciences, little research has attempted to develop specific analysis and modelling techniques in relation to dialogic learning. Some results and avenues of research in this direction are described in the next two sections.

Modelling Negotiation

In addition to the research described above, 'negotiation' is a key concept in a number of different disciplines, including language sciences (Kerbrat-Orecchioni, 1984 ; Edmondson, 1981 ; Moeschler, 1985 ; Roulet, 1993), Distributed AI (Bond & Gasser, 1988), agent theory (Galliers, 1989) and social psychology (e.g. Druckman, 1973). Common points emerging from these approaches are that negotiations are concerned with reaching *agreement* (accord, compromise, etc.) ; negotiations are often initially characterised by *conflicting attitudes* ; and that negotiating involves making offers or bids that may be accepted or rejected, in addition to using various strategies to gain acceptance (such as persuasive argumentation). As a first approximation, we can therefore define specific types or styles of negotiations in terms of : (1) goals and attitudes of agents, before during and after the negotiation, (2) types of things that are negotiated ("negotia"), and (3) strategies and communicative acts for achieving individual or joint goals.

In terms of (1), negotiations may be competitive (one or each agent wants their proposals to be agreed) or there may be a more impartial search for agreement. I would argue that "conflict" is not, as is often claimed, essential to negotiation : it is quite possible to want to achieve agreement with respect to something, with no initial (declared or not) conflict of goals or beliefs (this is commonly the case in cooperative learning studies). In terms of (2), we can make an initial division into *task-level* and *communication level* negotia. At the task level, the two basic types are "conative negotiation" (goals) and "epistemic negotiation" (beliefs, problem solutions etc.). At the communication level (a different kind of task), three main types occur (Moeschler 1985) : *interactional, meta-interactional* and *metadiscursive* negotiation. **Interactional negotiation** concerns the self-images that participants want to impose in the interaction (such as a seller "giving a good deal", etc.). This is important in dialogic learning, since in an ideal case, a student should be able to negotiate with a teacher with respect to his 'metacognitive' image of his own capabilities and the "student model" that the teacher is manifestly working with. **Meta-interactional negotiation** concerns the rights and obligations of interacting agents. For example, in a 'traditional' teaching dialogue (Bellack et al, 1966 ; Sinclair & Coulthard, 1975), teachers may have the right to make negative evaluations, whereas the student may not. Clearly, different rights and obligations may be negotiated (explicitly or implicitly)[4] by or in an interaction, they may be imposed, or they may be assumed to operate in a given social situation. I argue that *one* form of negotiable right is a defining feature of negotiation itself : the agents must have *symmetrical rights* to propose candidate negotia for agreement. I do not think that we would want to call an interaction in which one agent alone had complete right to impose what should be agreed a "negotiation" (!) However, as Rimmershaw (1992) points out, negotiations in teaching-learning contexts may often be more apparent than real : a teacher may 'pay lip-service' to a negotiative style whilst at the same time manipulating the interaction along a pre-determined path. Finally, **meta-discursive**

[4] "Implicit" negotiation simply means that a negotium is negotiated by performing some (communicative) action that is mutually understood to be *relevant* (Sperber & Wilson 1986) to it. For example, you can implicitly negotiate a different dialogue focus by changing the subject ("try it and see if it's accepted or not").

negotiation may be described as *negotiation of meaning*, where the latter term is understood in a broad semantic/pragmatic sense. As Clark & Schaefer (1989) have pointed out, specific interaction structures exist that have the function of negotiating shared meaning of utterances ("grounding") as a precondition for entry of expressed propositions into the "common ground" of dialogue. This has profound implications for varieties of computational speech act models (Cohen, Morgan & Pollack, 1990), since, as Edmondson (1981) claims, the meaning of speech acts may often be determined retroactively. Negotiation is therefore not an 'extra' in dialogue, it is viewed as *constitutive* of it (see quotation of Moeschler at the beginning of this paper), and is thus essential in dialogic learning.

Analysis of different kinds of learning dialogues has shown all of these forms of negotiation to be in operation (Baker, 1991, 1992b, 1993). For example, in computer-mediated teaching dialogues (in the domain of PROLOG), at least the following were negotiated, at the task and dialogue levels : *focus and problem-solving goals ; level of difficulty* of problems ; *time management /planning* of problem-solving (and 'time to think') ; *interaction and problem-solving style* ; *dialogue delimitation* (termination, continuation) ; *dialogue state parameters* (negotiator/speaker/topic) ; and *motivation /metacognition* (e.g., that a problem is not too difficult to be solved by the learner). It therefore appears that **almost any aspect of domain level and dialogue level tasks may be negotiated.** This has implications for the architecture of an artificial dialogic learning agent in that, for example, if negotiation mechanisms exist in learning dialogues for establishing joint understanding of the learner's problem, then the artificial agent may require less powerful student modelling capabilities. Secondly, negotiation at the dialogue level is in fact a form of *metadialogue*, or dialogue about dialogue. This implies that agents must have explicit awareness of the "state" of the dialogue, and of their processes for controlling it. With respect to negotiation processes in this type of dialogue it was shown that : explicit negotiations are most frequent at the beginning of dialogues, as participants "tune their violins" (Kerbrat-Orecchioni, 1984) ; subgoals of mutually accepted goals do not need to be negotiated ; and that negotiations of goals proceed from general to specific, with gradually increasing concreteness (eg. negotiate general topic, specific problem, interaction style, first speaker, etc.), this being a strategy designed to minimise conflict. These results confirmed to a large extent the hypotheses incorporated in the KANT system (Baker, 1989), where parameters of the dialogue state were explicitly negotiated, from general to specific.

Analysis of collaborative learning dialogues (Baker, 1991 1992a) has enabled a detailed model for communicative acts/functions (Gazdar, 1981 ; Bunt, 1989) in negotiations to be developed. Here the joint goal of achieving agreement is imposed (the students must produce a common solution). Negotiation therefore concerns the co-construction of *solutions themselves*, in addition to the negotia mentioned above. This analysis implies a specific view on what "agreement" is (the common goal of negotiation) : it is joint *acceptance* (Edmondson 1981) and not *mutual belief*, as would be implied by most computational speech act theories (Cohen, Morgan & Pollack, 1990). When students collaborate in problem-solving, their offered partial solutions are therefore not direct reflections of what they *believe*, but rather of what they *accept*. According to Cohen (1992), acceptance basically implies *willingness to use a proposition as a premise in reasoning* (dialogic reasoning in the case considered here). In a manner similar to the construction of the "joint problem space" of Beherend et al (1988), negotiations in these kinds of dialogue can therefore be modelled by charting the successive co-construction of a **Joint Acceptance Space**.

In collaborative problem solving dialogues, agreed solutions are not, however, co-constructed by a simple 'accumulation' of accepted propositions. What often happens is that ongoing common solutions are *moulded* or *refined* until agreement is found. One important additional phenomenon to be modelled is therefore the way in which students *relate their contributions to previous ones*. For specific domains and problems, I have described how a relatively small set of *relevance relations* between offered propositions can provide an informative model for collaborative problem-solving dialogues (Baker, 1993). For example, students may *elaborate* on solutions, they may *infer* new information, they may *generalise* or *particularise*, they may give specific values for variables, and so on[5]. Analysis on this level of detail can help us to answer some of the problems that have been raised with respect to collaborative learning (Behrend et al, 1988). For example, it can tell us when students are 'really' collaborating (relevance relations occur mainly between propositions offered by different speakers), and when students are largely problem-solving 'in parallel'.

[5] Such "relevance relations" resemble to some extent "coherence" (Hobbs 1982 ; Sanders, Spoore & Noordman 1992) and "rhetorical" relations (Mann & Thompson 1988) that have been developed for analysing texts. There are important differences, however, largely due to interactivity in dialogue.

Analysis and modelling of teaching-learning and collaborative problem-solving dialogues has therefore revealed how negotiation is a mechanism for (at least) : **determining the interaction type**, **controlling the interaction**, **establishing mutual understanding**, **establishing mutual agreement** and **co-constructing solutions**. To the extent that such functions may be fulfilled by specific dialogue mechanisms, this implies that other components of ITS architectures (such as student models) may reasonably be 'less than perfect'.

Modelling Argumentation

One type of argumentation that has received little attention in learning research is *argumentation dialogue* ("AD"). Whilst the "logic of argument" in texts or discourse is often concerned with defining legitimate transitions from sets of propositions to others, the "logic of argumentation dialogue" is concerned with 'rules of the dialogue game' that state when and how often competing views adopted by different interacting agents can be defended, conceded, accepted or rejected. As stated above, collaborative learning dialogues can fruitfully be viewed as negotiations that co-construct a 'Joint Acceptance Space'. When AD 'modules' occur in such dialogues, we can therefore pose the questions : "what is the role of AD with respect to individual cognitive change ?" and, "what is the role of AD with respect to evolution of the Joint Space ?" Clearly, we want to say that the two questions are related in that construction of the joint space may produce individual changes. Consider, for example, agent A1 who makes claim c1, which is not accepted by agent A2 ; A1 defends c1 and so an AD module is initiated. Supposing initially that an argumentation may be "lost", "won" or be a "draw", several hypotheses may be advanced :

H1 *Change in belief* : if A1 wins, then A2 'adopts' c1 and c1 is thus part of the joint space ; if A1 loses, then A1 drops belief in c1.
H2 : *Externalisation and reflection* : as a result of argumentation with respect to c1, both A1 and A2 externalise and reflect upon beliefs related to c1, which leads to changes in these beliefs (restructuration, etc.).
H3 : *Argumentation and disagreement* : as a result of conflict with respect to c1, A1 and A2 recognise that it is not part of the joint space (irrespective of winning or losing).

In order to validate these hypotheses we can draw on existing models for AD, such as "dialogic logics" (e.g. Barth & Krabbe, 1982). Whilst these are highly idealised models, they provide a set of technical terms and concepts with which to analyse students' argumentations, and thus a means for describing the extent to which they conform to this ideal. Dialogic logics consist of the following main elements : (i) *definitions of different types of conflict* ; (ii) *definitions of speaker roles* (proponent and opponent); (iii) *sets of legal locutions* ; and (iv) *plausible rules of formal dialectics* . The latter rules are designed to bring any discussion to *closure* by 'rational' means. For example, argument chains may be "won" when the opponent has lost or has no more "rights" in the discussion (essentially, when a speaker can make no further 'legal' move, such as a defense, since all defenses the speaker has available have already been used). There are two other possible outcomes : successful defense and successful refutation. A thesis is "defended successfully" if the proponent has won the last completed argument chain, and a thesis is "successfully refuted" if the opponent has won the last completed argument chain. These concepts (in addition to "winning", "losing", etc.) enable us to advance further hypotheses with respect to argumentation and cognitive change, in addition to those described above.

An important part of argumentation theory is that it is not concerned with 'private' beliefs, but with (joint understanding of) what has actually been *stated* or *externalised*. Armed with such theoretical tools, we can analyse and model students' arguments in terms of *commitment stores* (a list of statements to which they are each commited), rather than as sets of *beliefs*. I would conjecture that possible effects of argumentation on belief revision depend on at least the type of conflict concerned and the way it is resolved (rather than, for example, the incidence of "socio-cognitive conflict" - Doise et al, 1975). The following are some of the findings that emerge from analysis in these terms : even when a thesis (claim) is successfully refuted, this does not prevent the proponent from reopening several arguments in advance of the same claim later in the dialogue ; argument chains are often not 'closed' ; when students do not achieve closure within a few exchanges, they shift focus to a conceded statement ; students' understanding of argumentative relations between statements is often unclear ; and, in argumentation students often agree on more than they disagree (concessions).

These results suggest that, as in the case of negotiation, a 'theoretical wedge' needs to be driven between *dialogue attitudes* (attitudes towards what is said in dialogue) and *propositional attitudes* such as belief. To that extent, Hypothesis 1 above is ill-conceived, and hypotheses 2 and 3 become more probable by elimination. There clearly *is* some relationship between students' beliefs and their argumentations, but this seems to be more probably located in the benefits of metacognitive reflection (Hypothesis 2). Rather than attempting to model students beliefs directly from their utterances, I would therefore argue that an intermediary 'layer' of dialogue attitudes needs to be modelled, and that belief revision will be modelled in terms of a complex relation with this 'layer'. In these terms the foundational belief revision system of Doyle (1979) incorporates revision rules that are in fact closer to revision of *commitments* in AD rather than to beliefs (for example, one rule of AD is that a statement must be conceded if the speaker has no available defenses).

Conclusions

In this paper I have argued that beginning with modelling learning dialogues, in addition to 'building outwards' from domain and student models, is an interesting approach for AI&Ed. I have considered two specific related types of dialogue : negotiation and argumentation. With respect to negotiation, many researchers have hypothesised that it plays an important role in learning, but more detailed modelling of these processes is needed. With respect to argumentation, more research is required on its dynamic unfolding in dialogue in relation to evolution of students' beliefs. Analysis and modelling of both of these types of dialogue establishes that a richer set of attitudes (acceptance, commitment, opinion, ...), closer to dialogue phenomena themselves, is required for modelling dialogic learning : *belief is not enough.* Analysis of both negotiation and argumentation confirms the primary rôle of *metacognitive processes* as a means for controlling dialogic learning, achieving adequate coordination and enabling confronting points of view to evolve. Much further research is required in order to address some of the questions raised, particularly on integrating analysis of multimodal communication and action into analytical frameworks. Finally, I would claim that this research, conducted on the frontiers of pragmatics and learning theory, is AI&Ed research *per se* : the specific questions posed and analysis techniques described with respect to dialogic learning are not addressed by AI, linguistics, education or psychology alone. At a conference held two years ago on a similar theme to this one, the chairman (a well-known researcher in AI and language) raised the question "Where's the AI?", with respect to the development of multimedia learning environments. The answer given was "it's in the design". Posing the same question with respect to the work presented here, my answer is therefore "it's in the analysis".

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