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## COMPUTER-MEDIATED ARGUMENTATIVE INTERACTIONS FOR THE CO-ELABORATION OF SCIENTIFIC NOTIONS

### INTRODUCTION

It is now well recognised that argumentative interactions can be vehicles of collaborative learning, especially on a conceptual plane (see e.g. Andriessen & Coirier, 1999). Information and communication technologies such as Computer-Supported Collaborative Learning ("CSCL") environments can play an important role in such learning to the extent that they enable task sequences and interpersonal communication media to be structured in ways that favour the co-elaboration<sup>1</sup> of knowledge (e.g. Baker, 1996, 1999; Baker, de Vries, Lund & Quignard, 2001).

This chapter adopts a general perspective in educational psychology and technology according to which understanding the cognitive, linguistic and interpersonal *processes* of interactive learning is a primary basis for design of learning situations, together with the tasks and tools that comprise them. Such an emphasis on the study of interactive learning processes now crosscuts theoretical perspectives and currents as diverse as situated learning, social psychology, as well as Vygotskian and post-Piagetian psychologies of learning (e.g. Resnick, Levine & Teasley, 1991; Pontecorvo, 1993; Gilly, Roux & Trognon, 1999), in the general attempt to understand how understanding emerges from interaction (e.g. Roschelle, 1992). If we could gain better understanding of the processes by which different types of knowledge are elaborated in argumentative interactions, this could enable us to better design CSCL environments that exploit this learning potential.

Within this perspective, we present a case study analysis of a corpus of interactions that was collected in a situation where students used the "CONNECT" CSCL environment (Baker, de Vries & Lund, 1999; De Vries, Lund & Baker, 2002) to collaboratively solve a problem of interpreting a sound phenomenon in physics. CONNECT enables dyads of students to critically reflect upon and to collaboratively write texts across the Internet. As background for the analyses, we first sketch a theoretical approach to understanding the relations between argumentation, interaction and collaborative problem solving, out of which emerge a number of reasons why learning might occur as a result of engaging in an

argumentative interaction. We then briefly describe the CONNECT study and present illustrative analyses of the corpus that was collected during it. Our analyses emphasise the way in which the dialectical game of argumentation relates to expressed changes of attitudes towards solutions, and how the playing out of this game goes hand in hand with renegotiation of the conceptual background within which it is situated. In conclusion, we discuss potentials and limits of CSCL environments in relation to productive argumentative interactions.

## ARGUMENTATIVE INTERACTION, COLLABORATIVE PROBLEM-SOLVING AND COLLABORATIVE LEARNING

### *Argumentative interaction and collaborative problem-solving*

Understanding how argumentative interaction can lead to collaborative learning requires setting it in the context of collaborative problem-solving activity. Within such a research goal, we see argumentative interaction fundamentally as a type of *dialogical or dialectical game* that is played upon and arises from the ‘terrain’ of *collaborative problem solving*, and that is associated with *collaborative meaning-making*. Although negotiation of meaning is of course an integral part of any communicative interaction, our conjecture is that the interpersonal and interactive pressures imposed by the necessity to deal with conflicting points of view are particularly conducive to collaborative sense-making.

Although argumentation can occur with respect to any aspect of a problem space, as classically defined by Newell and Simon (1972), it will be convenient here to restrict our discussion to possible *solutions* to (sub-)problems in the task domain, that may be proposed by collaborating problem solvers. Let us term the task domain problem “*P*”, and name different possible solutions that are proposed for it *s1*, *s2*, etc. Suppose that a single solution is proposed and is mutually accepted; in that case, problem solving presumably proceeds without notable interruption. Argumentation can get off the ground in the case where either more than one solution is proposed, or else where a single proposed solution is not mutually accepted. We term the extent to which an interlocutor is willing to accept (believe, endorse, commit to, etc.) a solution its *epistemic status*, “*e*”, from the point of view of that interlocutor. The starting point for argumentation in collaborative problem-solving situations thus requires a certain degree of *diversity* — either in terms of solutions that are proposed for the task domain problem, and/or else in terms of the epistemic statuses of one or more solutions. The existence of such diversity creates a second level interlocutory problem, “*I*” (c.f. Quignard, 2000)<sup>2</sup>: which of the *s* for *P*, with their associated *e*, should be chosen? We assume that it is inherent in the problem-solving situation that either a single *s* must be chosen, or possibly that *s*’s should be ranked in order of their epistemic statuses<sup>3</sup>.

Thus far, an interlocutory problem *I* (i.e. one that rises in exchange between interlocutors) has arisen from a task domain problem, *P*. But how can *I* be solved? On the first level, the answer is clearly: by *transforming epistemic statuses of*

*solutions*, so that one appears more acceptable, believable, etc., than others. This intuition is in fact one of the bases of the classical *rhetorical* approach to argumentation (see van Eemeren, Grootendorst & Henkemans, 1996, for a modern account), according to which argumentation fundamentally aims at persuasion, or changing an auditor's point of view. But clearly, not all argumentative interactions are of this type; speakers' goals could be simply to decide which solution is to be preferred, without necessarily trying to impose their own views (Walton, 1989). Similarly, argumentation can take place in interaction with respect to several solutions proposed by a single speaker, whose interlocutor cooperates in helping to make a choice. To that extent, argumentation in collaborative problem-solving situations can often be seen more as a cooperative exploration of a dialogical space (Nonnon, 1996) than as an adversarial confrontation of well-elaborated and entrenched points of view.

But how can epistemic statuses of solutions be transformed, so as to decide which solution to prefer? We propose that there are two main and complementary ways: firstly, by *argumentation*, and secondly, by *negotiation of meaning*.

As a *discursive* activity, argumentation involves establishing specific types of (inferential or other) relations between the solutions being discussed, *s*, and other sources of knowledge, *k*, the establishment of which potentially influences the epistemic statuses of the solutions. An "argument" strengthens the epistemic status of a solution, and a "counter-argument" weakens it, from interlocutors' points of view. The sources of knowledge, *k*, must be different from the views to which they relate; they must *not* be understandable as developments, paraphrases, redefinitions, etc., of views (otherwise, the interaction becomes negotiation of meaning, or else explanation, in certain cases). A typology of (counter-)argumentation can be defined in terms of the nature of the inferential links, whether they are intended to strengthen or weaken epistemic statuses, and the nature of knowledge sources, *k*, drawn upon.

As a *dialogical* activity, argumentation involves somewhat more than linking in new knowledge sources to the ongoing discussion. Along its dialogical, or dialectical dimension, it is useful in the present context to theorise argumentation using certain elements of formal dialectics (Barth & Krabbe, 1982) and pragma-dialectics (van Eemeren & Grootendorst, 1984). Firstly, interlocutors' views with respect to epistemic statuses can become somewhat stabilised into *stances*, or *dialectical roles* — opponent and proponent — and the solutions under discussion then take on the form of *theses*. Although in formal dialectical models such roles must be stable (e.g. an opponent must be systematically *contra* all of the proponent's statements), in real students' interactions, positions can naturally shift in a more flexible way. Secondly, interlocutors must play the game of producing (counter-)arguments according to certain (usually implicit) *ground rules*. These ground rules are partly logical — e.g. logical contradiction will usually be pointed out, as will inconsistent expression of dialectical roles, such as being both *pro* and *contra* a given statement — and partly pragmatic or cooperative (in a Gricean sense). Pragmatic/cooperative rules fulfil the function of enabling the discussion to move forward to a determinate outcome: given the arguments that have been expressed as dialectical moves (attacks, defenses, retractions, etc.), which thesis has 'won out'? For example, arguing round in repetitive circles may be legitimately sanctioned, and

Arguing to Learn  
Confronting Cognitions in Computer-Supported  
Collaborative Learning Environments  
Andriessen, J.; Baker, M.; Suthers, D. (Eds.)  
2003, IX, 269 p., Hardcover  
ISBN: 978-1-4020-1382-9