Educational dialogues and computer supported collaborative learning: critical analysis and research perspectives

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Abstract

We present a critical perspective on the current state of research on educational dialogues within and without Computer Supported Collaborative Learning environments, in order to propose research perspectives in the intersection of these two domains. Our main proposal is that in order to integrate different types of human or machine analysed data over different timescales, it is necessary to do so within a theorisation of the object of study and its units of analysis. Standpoints on the nature of the object of study, conceived as the development of collective thinking in and by dialogue, on the importance of different timescales and broader units of analysis such as collaborative learning platforms, form the bases for these proposals. We also call for broadening and integrating theoretical perspectives on (educational) dialogue itself, beyond a purely logocentric vision.

Keywords: dialogue, CSCL, timescales, units of analysis, collective thinking, platforms

The state of play and changes in the game

In the interdisciplinary field of Computer Supported Collaborative Learning (CSCL)[1], with design and analysis of learning settings being at its core, almost all research aims to improve (our understanding of) the quality of educational dialogues. This is hardly surprising: in the absence of pre-existing perfect common ground, in evolving situations, collaboration reposes crucially on dialogue between participants as a means for working together and learning. It may well be that achieving common ground based on people's *lifeworlds* has become even more complex, given a broader range of experiences via social media and increasingly multicultural societies – in which case the importance of dialogue in bridging between experiences and between cultures is

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[1] See the new CSCL handbook edited by Cress, Oshima, Rosé & Wise, 2021, for an overview of the CSCL field.

growing considerably. The specific question for CSCL is how situations can be designed that provide technological and pedagogical tools whose collective appropriation will enable the emergence of constructive/productive dialogues in and across knowledge domains and lifeworlds.

In comparison with dialogues in the everyday classroom — or at least what has up to the recent present been considered as "everyday", i.e. students and teacher in the same room — CSCL environments constitute what might be termed "game changers" for research on educational dialogues, involving such a broad range of new mediating means that they cannot be considered as simple additions to or variants of existing practices. Without claiming to be exhaustive, a list of such game changing features would include: interactive semiotic tools such as diagrams used in collaboration at a distance, structured communication in educational settings (on-line and in classrooms), automatically generated guidance, representations of the dialogue itself for real-time reflexion, interactions that are channelled or scripted in diverse ways, automatically recorded computer-mediated dialogues that can be used as objects of study and evaluation, tools for teacher orchestration of groups in whole classrooms, … all of which have all contributed to the establishment of a challenging new research agenda on the nature of understanding and knowledge that emerges from such dialogues, and the processes by which it does so. The cultural context in which this new dialogue game is played has changed too: students come to the CSCL classroom with their everyday Internet and social network communicative practices, and schools and social media come with different knowledge structures and knowledge taxonomies (Crook, 2012), which create new challenges for educational dialogues.

And yet, the vision of dialogue in CSCL that we have just sketched has its limits: it stems from an apparently obvious aspect of CSCL research, which is that it mostly focusses on specific studies (experimental, qualitative, design-based) of the use of specific suites of tools. However, it may also be useful to step up to the study of another level, that of *infrastructures*, platforms, and how they create new societal and institutional conditions for educational dialogues (Bygstad & Øvrelid, 2020; Zuboff 2019; Ludvigsen & Steier, 2019). In educational systems around the globe the use of platforms is increasing rather rapidly. Many of the platforms connect what students and teachers do, content resources related to curriculum, communication tools (synchronous and asynchronous), with many types of data being collected and transformed through APIs to larger databases. The implications of such *platformization* have hardly been studied, as conditions for educational dialogue or collaborative learning, or else as conditions for pedagogical approaches and the monitoring of students' progress over time. Within such platforms, other game changing aspects concern the sheer variety of 'levels' of data on educational dialogues that can be collected — detailed behavioural traces, and some researchers even add physiological measures, in addition to messages exchanged — and the possibility of dialogues over broad spaces of time on social networks and forums. Similar issues have been raised by Reimann (2021), in his editorial notes in ijCSCL, that contain an interesting conceptualisation of socio-technical configurations for productive talk. He also proposes that there is a need to connect studies with a small and a large *N*. An important question is therefore: *how can such diverse data sets, over multiple timescales, involving a combination of automatic and human analyses, be combined in a meaningful way?* As will be discussed in more detail throughout this paper, we propose that finding the beginnings of an answer to this question requires a deeper or more appropriate theorisation of educational dialogues in CSCL.

Preceding, and in parallel to, work in the field of CSCL, research on educational (or "classroom") dialogues *per se* has had its own development. Modern research on educational dialogue can be dated from the publication in 1975 of Sinclair and Coulthard's seminal work, based on a type of hierarchically structured discourse grammar of interactions between the teacher and children in the classroom, comprising the famous IRF (Initiation, Response, Feedback) structure. Over the years that have ensued, research on educational dialogue has burgeoned and deepened, leading on one hand to a multiplicity of analytical models or "coding schemes" and on the other, to

attempts to bring these together, in the form of comprehensive analysis methods (for example, "SEDA": Hennessy et al., 2016). Concomitantly, the types of dialogues and phenomena analysed have become more varied in terms of the teaching domains considered, moving from apparently already formalised domains in STEM, to more exotic areas such as civic education. New dimensions, phenomena and genres of discourse and dialogue have come salient objects of study, such as argumentation, emotion and multimodality. The ongoing exploration of these dimensions is in part influenced by the new forms of educational dialogue enabled by technologies.

These new and extremely varied forms raise the issue of including educational dialogues in one category: educational dialogue can be seen as an empirical *hic et nunc* communicative exchange, or else as a goal in itself, an abstract ideal horizon to be aimed for (see below). Such dialogues may also be referred to as "talk", "conversation", "interaction" (verbal, communicative, multimodal) or even "discourse", where choice of the term used is situated within different (theoretical) frameworks/stances, such as social anthropology, conversation analysis, behavioural interaction analysis, or interactional linguistics. The term "dialogue" is often misused, however, and it is necessary to define frontiers beyond which the talk/conversation/interaction ceases to be an educational dialogue.

In this paper, we cope with diversity in the fertile intersection of CSCL and educational dialogues by identifying and proposing new research directions based on a range of analytical approaches, and that are relevant to a broad range of tools, and mediating means, available on different levels in CSCL situations. In contrast with this encompassing turn, we delineate educational dialogues as specific forms of talk/conversation/interaction, and partly root their study according to a Bakhtinian approach.

Some of the main questions raised here are: "What is the nature of the object of study for research on educational dialogues and CSCL?", "To what extent do certain automatic, linguistic, behavioural or physiological analyses and the phenomena to be studied pass each other by?", "How can meaning making processes be studied on different timescales, beyond the micro to macro levels?" and "To what extent is it possible or desirable to reconcile alternative theoretical approaches to understanding dialogue?"?

The main argumentative thread (together with its sub-threads) and rationale of this paper can be summarised as follows:

- Research on educational dialogues, within and without CSCL environments, currently witnesses a broad diversity of dimensions of study, objects of analysis and analysis methods.

- In addition to hand-done qualitative-quantitative analyses, important currently used methods in CSCL include various techniques for (behavioural, linguistic, physiological, …) automatic analysis.

- Such analysis techniques are often purely empirical or algorithmic (for example, in identifying recurring patterns and clusters) in a sense that is rarely based on theories of dialogue and cognition.

  — Caveat: recent research on learning analytics does in fact make links between "e-data" (e.g. from group artefacts, speech and groupware logs) and specific higher-order constructs such as symmetry of action and transactivity in collaboration (e.g. Martinez-Maldonado et al., 2021), but these constructs, as well as initial data analysis, need to be situated within and guided by more general theories of dialogue, cognition and collective activity.

- It is important to integrate automatic analyses with human analyses, in order to account for complex behaviours over long periods of time, involving appropriation of pedagogical and technological tools and very large data-sets.

• In order to promote such integration, it is necessary to return to the fundamental theoretical and methodological questions concerning the nature of the object of analysis — what are or should we be trying to analyse? — and with what units of analysis?

— Given arguments that reject the individual communicative act and thinking as possible objects of analysis of dialogue, we propose that the object of analysis is the development of collective thinking in dialogue, and that the units of analysis are, on the smallest level, the exchange, the highest levels that of culture, with a proposal for a new meso-unit, that of the (collaborative learning technological) "platform".

The major part of this paper is therefore concerned with theoretical issues relating to the definition of the object of study and its units of analysis, in research on (CSCL) educational dialogues. Within such an argumentative thread, "along the way" we also deepen the discussion of certain concepts underlying it, such as thinking, cognition, dialogue, temporality, development and complexity, with a view to evoking related ongoing academic debates.

This paper is structured as follows. In the next main section we address theories of the main object of study for research on educational dialogues: dialogue, thinking, and thinking-in-dialogue. We develop the idea that this corresponds to collective thinking in dialogue, corresponding to the dialogue structure of the "exchange". We also discuss current foundational debates on the very nature of dialogue, as conceived in educational settings. The main section that follows, "Timescales and development", moves up from the level of dialogue to that of collective activity, how it needs to be considered on different temporal levels, building upwards from the micro-level of particular dialogues. We then, in the section "Digital infrastructures and platforms", propose a meso-level unit of analysis, between the dialogic exchange and institutional, social and cultural contexts, arguing for its particular relevance for CSCL research. The last main section of the paper discusses contemporary questions relating to validation of analyses. In conclusion to this paper, we recapitulate, reformulate and further develop its main arguments and conceptual discussions.

To conclude this introductory section, the reader is warned that this text is closer to an exploratory path weaving its way across a conceptual landscape than to a cartesian logical structure. It does and can not constitute a treatise based on an exhaustive survey of research. We focus on what we consider to be the main issues and questions at stake today and in the future, selecting aspects of previous research that are most relevant to these aims.

The object of study: dialogue and thinking

In the midst of burgeoning contemporary research on educational dialogue, it is still useful to ask what are we trying to understand or analyse. We propose that the (most basic or fundamental) object of study is: *the development of collective thinking in and by dialogue*. Each of the terms just used — dialogue, thinking, development — will be further discussed below.

Before beginning to discuss dialogue and thinking in more depth, a number of preliminary issues need to be dealt with. Firstly, the very question of the relation between dialogue and thinking is difficult to formulate, since *by definition*, "dialogue" *means* collective thinking. Dialogue, in the sense of *dia-logos* ("dia" – through, via; "logos" – discourse, word, speech, reason, principle) simply means — to make an audacious simplification — reasoning (a form of thinking) that is exchanged between people in discourse. This is what distinguishes the term "dialogue" from conversation and interaction, and makes it particularly appropriate when applied to educational dialogues. Furthermore, to engage in dialogue means to make thinking *evolve* together, which is also, by definition, a form of learning. Dialogue requires some kind of *interdependent change* in what is said and exchanged, an example of a non-dialogue being an endless exchange of unchanging statements and rejections ("It is", "It isn't", "It is …").

Thus defined, the object of study might seem intangible, in that it involves emergent properties of interactive processes, over time. This may be compared with what has been termed (Dillenbourg et al., 1995; Koschmann, 1996; Stahl, Koschmann & Suthers, 2006) the "interactions paradigm", where the goal is to search for "productive" types or patterns of interaction that are correlated with learning outcomes. In this direction, statistical methods have been devised for identifying recurring sequential patterns in codes of units such as the conversational "turn" (Chiu & Khoo, 2005) and for modelling them cotemporally using epistemic network analysis (Shaffer, Collier & Ruis, 2016). However, there is no necessary contradiction here, since defining the object of study, the unit of analysis in a meaningful way as a process of thinking together in dialogue provides a means for applying the interactions paradigm, basing it on a more principled way of conceiving the building blocks of the dialogue.

Secondly, focussing research on *thinking* such as reasoning, conceptualising and problem-solving in dialogue may seem paradoxical, given to the broadening range of phenomena that are now studied, such as interpersonal relations, and regulation of emotions, as mentioned above. However, our primary concern here is with *educational* dialogues that, by definition, are oriented towards learning in and across knowledge domains as defined in educational systems. Whilst education can, of course, concern learning to manage interpersonal relations and emotions in groups, we nevertheless consider these to be secondary means to primary ends, i.e. those of facilitating the development of students' thinking in specific taught knowledge domains. Notwithstanding this point, since emotion and cognition are inseparable, or emotion is a mode of thinking (Picard et al., 2004), analysis of emotion can be seen as, in an indirect sense, as contributing to the analysis of cognition.

A third preliminary issue to the dealt with concerns multimodality. To speak of thinking and meaning is of course an abstraction; but, from our point of view, it is an abstraction over the full behavioural multimodal palette of communicative interaction — aspects of the vocal channel such as timbre, intonation, accent, the whole body, including gesture and posture and inseparable dimensions of cognition such as emotion. We think with the whole body (embodied cognition), or with our bodies, interacting together. But the behaviours, the emotions, although involved in thinking, are not *the* thinking, the meaning *itself*, in a more abstract sense: for expressing that, amongst other things, the human species developed language. Notwithstanding recent tendencies to focus on identifying — either automatically or else by hand-done coding — clusters and patterns of behaviours, we see these as having a useful heuristic value for analysing thinking, whilst not constituting an analysis of thinking *per se*. We therefore adopt — "unashamedly", we might say — a linguistic, semiotic and logo-centric approach.

The written modality has always been favoured as a channel for dialogising, especially amongst highly literate persons. New technologies (including CSCL technologies) have democratized written dialogues, but at the same time have changed the very nature of educational dialogues, that have become potentially more reflective, and possibly more exposed to disjunctions (Wise & Schwarz, 2017). Furthermore, an important pedagogical contribution of CSCL is that it tends to promote the blending of multiple modalities in consecutive or parallel channels, a fact that characterises the change in the nature of educational dialogues. In addition, computer-mediated dialogues bring new forms of synchronicity in which oral rules of adjacency and non-overlapping are violated (Herring, 2001). Ontologies — types of dialogic/argumentative moves — can be displayed, and awareness tools (Schwarz & Asterhan, 2011) allow discussants as well as teachers to participate in dialogues that are often productive, and always different from oral dialogues. The study of educational dialogues, in particular in CSCL situations, is thus challenging since its object is a moving target.

(Educational) dialogue: a brief yet in-depth discussion of foundational issues

Two meanings of "dialogue" currently subsist in the educational literature, that we shall term the philosophical and the empirical (notwithstanding the fact that the "empirical" approach is also highly theory-laden). The philosophical meaning conveys the idea that dialogical accountability exceeds a Humanist's reflexivity since it acknowledges, through the notion of *transgredience* (Bakhtin, 1919–1921), that the individual cannot ever have either transparent or complete self-understanding and moreover, that such independence is illusory. Each person is an actor oriented to others (Buber, Levinas), and the distinctive features of utterances (such as tone, genre, lexical choice) are context-specific choices made from multiple possibilities available at that moment (Davies & Renshaw, 2013). According to Bakhtin, every utterance is related to another utterance, true to turn-taking in which the conversational norms are followed in order for a conversation to have a cohesive flow in which individuals respond to one another. Bakhtin's enterprise, and in general the philosophical view of dialogue is a critique of the monologisation of the human experience that he perceived in the dominant linguistic, literary, philosophical, and political theories of his time (Linell, 1998; Baxter, 2006). This position opposes a reductionist appraisal of the material and sociocultural worlds. On the other hand, the empirical enterprise is often reductionist, in seeking a minimal lexicon ("codes") and syntax (their relations or patterns) of segments of dialogue. This reductionist idea does not fit Bakhtinian *dialogism,* and in general the philosophical stance towards educational dialogues.

The gap has not been bridged between the philosophical perspective on dialogue, that points at an ideal educational goal, and the empirical one, as a *hic et nunc* communicative exchange involving several people, oriented towards knowledge (*logos*) elaboration. We contend that this gap should continue to subsist, since we consider that dialogue is central to the process of education — *e-ducere*, the bringing out from students what they are capable of — that is potentially unending, at least during life.

Dialogic Theory (the philosophical stance), intuitively seems natural and unproblematic for coming to grips with actual educational dialogues. However, Dialogic Theory is a domain in which the two trends of Critical Theory are dissonant with each other. In their fierce attack of positivism, post-modernists have argued that there are no sustainable norms of rationality, that educational discourse is or should be political discourse, and should enfranchise certain groups of interest from others. Teacher authority takes significance against an insidious backdrop of relations of domination. Some theorists have even questioned the desirability of dialogue, and others contrast it with what they call the dialectic—an inexorable imposition of rationality (Matusov, 2011; Wegerif, 2011).

However, some dialogists that follow Habermasian ideas (1988) of social rationality see Dialogic Theory as bridging between a socio-cultural stance and Critical Theory. In *Voices of the Mind*, Wertsch (1991) incorporates Bakhtin's key ideas of voice and dialogue to expand Vygotsky's arguments about the mediation of human activity by signs. Dialogue emerges in the context of mediation, which triggers social and psychological insights (Wertsch & Kazak, 2011). Wegerif (2007, 2011), who holds a radical post-modernist stance, is critical of Wertsch's position, since (as antimodernists would claim), dialogue cannot be imposed on learners. His alternative account of 'education into dialogue' aims at liberating learners beyond mediation (Wegerif, 2011), through tensions between differences. Wegerif embraces a new form of dialogue, one that avoids any sameness, any consensus. However, in contrast to his antimodernist and seemingly defeatist ancestors, he proposes a practical vision of what he sees as dialogic. With Mercer, he had contrasted exploratory talk (Barnes, 1976) from cumulative and disputational talk (Mercer, Wegerif, & Dawes, 1999), exploratory talk being a mode of discourse in which "partners engage critically but constructively with each other's ideas" within a process of reasoning through 'interthinking' (Mercer, 2000). The teacher is very central in sustaining exploratory talk. It seems that Wegerif's radical theoretical stance (Wegerif, 2011) does not coincide well with its practical

counterpart — the analysis of actual educational dialogues — or with the research program developed by Mercer and colleagues (e.g. Littleton & Mercer, 2013). Many researchers committed to dialogic education do not follow Wegerif's radical position and reconcile the dialectic and the dialogic in the form of collaborative argumentative activities, including dialogue (e.g., Schwarz & Baker, 2017; Schwarz & Shachar, 2017). The merger of ideas from socio-cultural stance and Critical Theory could then provide a path forward.

What would be the most appropriate theoretical and methodological approach to analysis of educational dialogues? We shall argue that the answer to the question turns crucially on the definition of the object of study. One possible candidate would be Conversation Analysis (CA), which has been applied to interactions in classrooms (e.g. McHoul, 1990; Macbeth, 2004). CA focuses on sense-making in talk and social interaction, seeking to elucidate the underlying *apparati* through which we construct turns at talk, correct misunderstandings, build conversational sequences, and so forth (Koschmann, 2013). The proper role of "ethnographic background" in CA, such as past history, the roles of the participants, cultural roles and expectations, etc, is essential. Schegloff (1992) argued that the role of context in meaning-making, rather than being a given, should be the very matter under investigation.

However, two aspects of CA render its application to educational situations involving dialogue at the very least problematic. Firstly, CA eschews all considerations of participants' psychology, of their thinking, in the broadest sense, and how it evolves in the social interaction. Some CA researchers might say that, in a sense, the thinking is 'in' the dialogue, but it is not made clear how or where. Therefore, *if* the research goal is to study how people manage their social relations in interaction as such, and co-create meanings for localised discourse objects, including in educational situations, *then* CA may be the appropriate approach. However, *if* the aim is to study the evolution of students' collective thinking, concerning the learning issue at hand (a form of learning), as we propose here, then CA is not appropriate to this task. Secondly, CA studies are examples of case-based inquiry, often being restricted to a few turns of talk and are not made for grasping issues of sequentiality beyond microgenetic studies. As we argue below (the section on Timescales and Development), it is necessary to integrate different temporal levels in the study of collaborative learning, to understand how the microgenetic fits into larger timescales of learning. In sum, it is not at all clear what is a CA position with respect to (collaborative) learning, within and across social interactions. Finally, the gap between CA and the philosophical stance with respect to educational dialogues is immense.

Thinking in and through dialogue

What is it that we are aiming to do, analyse, when we analyse educational dialogues? Several answers to this question have been discussed above. They include seeking to identify forms of interaction that are productive with respect to learning outcomes, analysing the main communicative functions to be supported by CMC interfaces and trying to understand *how students think together*. This latter possibility can be understood in two main ways. The first sees dialogue between students as a type of *method* for studying their "conceptions" (for example, of heat in physics, or justice in civic education), in which case, only those statements that bear on these issues will be considered, as expressions of each student's conceptions. The second involves trying to understand *how students think, together, in and by dialogue*: this is the aim that we shall consider, briefly, here. Let us state at the outset that (of course) not *all* thinking occurs in dialogue, as we understand it, i.e. as a communicative exchange between flesh-and-blood people, oriented towards knowledge elaboration. It is also quite possible to think whilst alone, reading a book or taking the bus (cf. the Vygotskian notion of thinking as "inner dialogue", developed in Fernyhough, 1996).

What is it that we are analysing when we are analysing the processes of thinking between people, students, teachers, engaged in dialogue? Let us first reject a possible answer: we are *not* analysing

individuals' thoughts as they are expressed to other individuals. Such a rejection is supported by a broad range of theoretical and empirical approaches. For example, social psychologists designed a carefully constructed series of experiments on Piagetian conservation tasks, and concluded that "it is no longer possible to decide *a priori* if a competence is purely cognitive or also involves the social competence of displaying that behaviour. Intelligence, then, can be considered as intrinsically a sociability" (Perret-Clermont, Perret & Bell, 1991, p. 55). Within a discursive psychology approach, Edwards (1993) rejected the question "what do children really think" as essentially misguided: the thoughts that are expressed in children's dialogues are situated, contextualised in the interactive situation. In sum, participants in dialogue shape their utterances to the interactive context, shaping each other's contributions. Is knowing what people 'really think a realistic possibility for research, for the persons themselves or for others? Could we get closer to what people 'really thought' in a dialogue, by interviewing them afterwards? We would say no: this does not break out of the 'circle of dialogue', even though a mixed-methods approach of this kind may help to elaborate a fuller picture, or "thick description" (Geertz, 1973), that describes the broader context, but as said, not the dialogue itself.

There are more radical critiques of the idea that meaning, language, dialogue should be understood in terms of the expression and reception of individuals' thoughts, of which we shall evoke only two. The first stems from Wittgenstein's *Philosophical Investigations* (1978), that constitute a long and compelling argument against meaning in dialogue being a matter of expressing individual and "private" thoughts. The second originates in Bakhtin's (1927/1977) model of language and communication, discussed above, according to which our discourses are essentially reformulations of other discourses in the language community, not expressions of solipsistic thoughts.

The adoption by the CSCL community of the theoretical idea that solipsistic thoughts are not expressed in our language which is essentially dialogic, led to an insidious confusion: the term "educational dialogue" does not point at any specific type of discourse/talk/communication, although the Bakhtinian theory would call it dialogic, however it is deployed. The idea of dialogue points at a specific form of talk/communication/discourse that conveys ethical values such as tolerance, or empathy. As such, there are forms of talk/communication/discourse that are not dialogues: those that flout ethics as well as evolution as a function of taking the other into account (as discussed above). The distinction of what is dialogic from what is not, is an educational rather than a theoretical issue. This issue is important since education is based both on normative and empirical issues. This issue is largely neglected, but our position is that the first step in analysing educational dialogues is to delineate their frontiers, from any kind of behavioural, communicative exchanges.

Moving back to the question of the object of study obviously relates to the question of analysing different types of data, with the exchanges in collaboration and dialogues as one point of fixation. For example, automatic analysis of videos of student groups shows that looking at the shared task materials and looking at each other (Cukurova et al., 2017) correlates with collaborative learning. A deeper analysis of this would look at what the students were thinking together at points where dense clusters of behaviours occur and would integrate the findings of automatic analysis with existing theories of collaboration (e.g. Roschelle & Teasley, 1995; Dillenbourg, 1999) that already postulated a shared task focus and a sufficient degree of mutual attention/understanding (Baker et al., 1999; Barron, 2003) as necessary conditions for collaboration. The sharedness of the tasks cannot be taken for granted it need to be developed as part of the educational dialogue/collaboration (Dillenbourg et al 2016; Rasmussen & Ludvigsen, 2010).

The basic unit of analysis

Having rejected the idea of dialogue as a 'window on the individual mind', and having delineated the frontiers of educational dialogues, we return to the question stated above — what are we

analysing? — and try to formulate the beginnings of an answer. Assuming that we do have a psychological orientation, what we are — and can only be — analysing in educational dialogues is *collective thinking,* the thinking that people do together, involving thinking about the thinking of the other. Yet, the term "collective thinking" covers several phenomena: (1) an individual's thoughts, that are, nevertheless, contextualised in dialogue; (2) the 'space' of mutual understanding (i.e. what is *grounded*: Clark & Schaefer, 1989; Baker et al., 1999); and (3) the 'space' of what is mutually understood and agreed (including agreement on what is disagreed), (4) specific genres of talk that become invoked in institutions and educational settings. The word 'space' is in scare-quotes here since its ontological status is not clear.

This has implications for the *basic unit of analysis* of thinking-in-dialogue, which is the *exchange*, not the individual turn, speech act, message or behaviour. The exchange is basically a ternary structure, of a presentation, followed by a reaction to that presentation, followed by a ratification of the previous two turns (see Moeschler, 1985, and Clark & Shaefer, 1989). Each of the three basic units can of course be expanded into hierarchical structures, for example by clarification questions, that once replied to enable the basic exchange structure to be pursued. Dialogue comprises (thematically) interlinked sequences of exchanges. The exchange is the unit of *negotiation of meaning*, represented by Sorsana & Trognon (2005) as follows (Figure 1), where A and B are participants in dialogue:
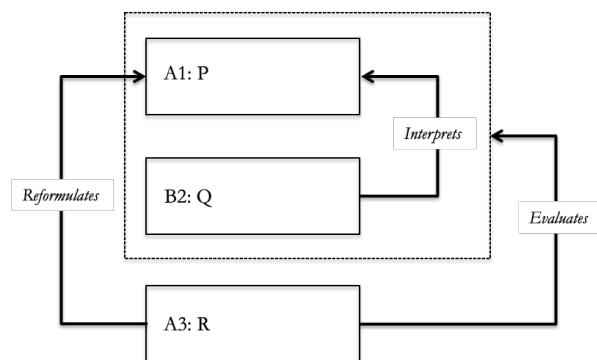

Figure 1. The basic structure of negotiation of meaning in an exchange structure (redrawn from Sorsana & Trognon, 2005, p. 33).

In intervention 1, A expresses a proposition, P, that is replied to by Q in intervention 2 by B. In so doing, B makes manifest an interpretation of P. In intervention 3, A evaluates this interpretation and reformulates A1. The third intervention is also commonly divided into an evaluation followed by a ratification by B. This is the basic structure, the unit of analysis, of negotiation of meaning, of collective thinking. An important corollary of this, is that the individual conversational *turn* is not a relevant unit of analysis: the relevant unit is the *intervention*, or *move*, that may straddle several turns (Roulet, 1992). "Turn-taking" is a phenomenon of sharing of the communication channel, given human psychological limitations with respect to many people trying to speak and hear all at once. It is not a semantic unit of analysis, of collective thinking, that enters into hierarchical structures of dialogue.

This is the ternary structure of communication in dialogue, oriented towards co-construction of a shared discourse and mutual understanding of its meaning. But in the field of the learning sciences, other types of triadic structures also need to be considered, notably the mediational triangle, where the mediating tools between subject and object are CSCL environments in the present case, the triangle of ego-alter-object (where the object of discussion is considered as a type of inanimate 'actor' in the discussion, influencing its course). It is intriguing to speculate on

the direction that theory of educational dialogue might take should these three "triads" (of communicative exchanges, of subject-mediation-object and alter-object-ego) be combined.

To return to the negotiation of meaning, it is possible to distinguish what might be termed 'routine' or minimal negotiation of meaning, when all goes smoothly in the dialogue (understanding what the others said, on a surface level, satisfying minimally Clark and Shaefer's, 1989, "grounding criterion"), from 'deeper' dialogical thinking (understanding the meaning of key concepts). This has been called pragmatic versus semantic grounding (Baker et al., 1999). Harré and Gillet (1993) made a distinction between *cognition* and *thinking*: cognition is all that happens in the individual from perception to action; thinking is that part of cognition for which the subject is able to produce an *account*. In our view, such 'deeper', semantic thinking can occur when the course of seamless joint action and thinking in dialogue comes across an *obstacle*: the task for whose achievement the dialogue occurs is blocked in some way; objects that are manipulated behave in surprising unexpected ways; the participants realise that there is a misunderstanding; the participants recognise that there is a disagreement, and are motivated to resolve it. In each of these cases, more intense thinking together may be stimulated: renegotiation of the meaning of the task, explaining phenomena, explaining oneself, explaining to each other, constructive argumentation, corresponding to the types of obstacles just mentioned. This points to focussing design and analysis of educational dialogues on those that involve such deeper collective thinking, most probably in dialogues that address concepts underlying the topic of discussion, involve explanation and collaborative argumentation (Schwarz & Baker, 2017). The presence (or the absence) of collaborative argumentation can be seen as relating to the frontiers of what counts as educational dialogue, and to the measure of its quality.

To conclude this rapid discussion of research on dialogue and thinking, we perceive it as facing a basic dichotomy: *either* the individualistic and untenable "dialogue as a window on the mind" approach, inherited from the extrapolation of cognitive psychology from the individual to the group, *or* the disappearance of thinking and the psychological subject as an object of scientific research, in conversation analysis and situated learning theory. We have sketched out a possible path between these extremes, that basically involves abandoning the idea that an analysis of (educational) dialogue is an analysis of the thinking of individual students, embracing the concept of collective thinking in and by dialogue (cf. also Allwood, 1997) and considering *the exchange as the basic unit of analysis*. Or rather, the exchange is the *smallest* relevant unit of analysis of thinking in dialogue. In order for such an analysis to be meaningful, beyond the local level, exchanges need to be situated within broader activity structures over *time*, as we discuss below. Finally, it is obviously possible to analyse individuals' contributions to a dialogue: our point is simply that such an analysis could not be of individuals thoughts, in a way that is separable from the interactive context.

Timescales and development

Our discussion so far, of the object of study and the unit of analysis for research on educational dialogues, has been limited to exchanges in particular dialogues. To what extent is this relevant for the study of collective learning activity as it unfolds over broader timescales?

The view that there is no primary pure and naked reason that might secondarily don linguistic clothing leads to bestowing a Janus-face on dialogue: claims transcend any local context and at the same time, they are raised here and now and are *de facto* recognized as bearing on agreement with respect to participation in interaction for effective collaboration (Habermas, 1987). Mercer's (2008) claim in "Seeds of Time" that educational dialogue needs to address the temporal dimension, conveys the additional idea that in-depth learning takes a lot of time and effort. These understandings raise the necessity of considering timescales of collective activity in CSCL (e.g., Ludvigsen & Arnseth, 2017; Stahl 2015). Without these timescales, the dialogue and, thereby,

the learning processes can become fragments of talk without a deeper understanding of why and how they emerge.

In "Across Scales of Time", Lemke (2000) focuses on the interdependencies between different timescales. Every action is dependent on previous actions and needs to be understood as part of larger social structures or institutional activities such as schooling. Temporality can be concerned with a millisecond of neuro-reaction or else with historical phenomena that took place hundreds of years ago. Connecting timescales in a unit of analysis is of course not a trivial issue, and given the platformization of education (see below), it is a very urgent issue for the CSCL field. Some CSCL scholars have, to a certain degree, addressed issues of time and used concepts like learning, interaction, or participation trajectories (Furberg el al 2013; Damşa, 2014) to capture how dialogue and learning emerge over time. The smallest unit of analysis of educational dialogue, at a level that is related to meaning for the participants involved, is what we have already called the exchange.

Beyond the nuclear focus of the exchange, temporality is deeply connected to spaces and communicative events (Hymes, 1972; Hennessy et al., 2020). Hymes (1972) described the hierarchically three-nested level of communication. Communicative acts are the micro-interactions that take place, while communicative events are the meso-level in which one can identify participation, purpose, tasks, and broader orientations, while communication situations can be seen as macro-level in which structural aspects and institutional arrangement can be identified. It is important to note here that Hymes and others who take such an approach conceptualize the levels as intertwined and interrelated. Norms for how to take part in dialogue can be observed at all three levels. These three levels are used in many of the stances that study educational dialogue in natural contexts (see for example, Mercer, 2008; Baker & Schwarz, 2019; Sande Van De. & Greeno, 2012; Furberg et al 2013). In CSCL, computational artifacts are treated as part of the unit of analysis, which means that location and space must be seen as part of the time-space configuration. Computational artefacts become used as part of the educational dialogue, and the artefacts come with certain design features. Data can be collected about which actions become performed, or what we label "behavioural traces" - the structures of the actions performed.

Therefore, development, especially when participants capitalize on CSCL environments, is not just change over time, such as accumulation of knowledge or increase in efficiency in task performance. It is a qualitative change in the system involving the subject of learning, from the individual to the group, the organisation and society. Engeström (1987) described development as "learning by expanding": like the Baron von Münchhausen, who pulled himself, and the horse on which he was seated, up and out of the mire by pulling upwards on his own hair, people change their ways of seeing the situations in which they find themselves, by 'lifting up' their ways of conceiving them. In CSCL situations, multiple dimensions develop whilst mutually influencing each other, including qualitative change in the group discourse, interpersonal relations, roles, emotional climate and mutual understanding; gradual appropriate by teachers and students of a new pedagogical approach, a technology, platform; institutional practices accommodating to collaborative approaches to learning.

CSCL situations can thus be understood as complex systems (Arrow, McGrath & Berdahl, 2000), involving bi-directional influences and limited predictability beyond a time window relating to the "growth factor" (here, the intensity of changes and emergence of new ideas and understandings). Methodologically, this means that the point in time in which development is 'sampled' will be important. It also suggests that, in order to apprehend the broad sweep of development, the notion of "trajectory" (Dreier, 1999; Furberg & Ludvigsen, 2008) would be promising and trajectories can be studied through behavioural traces, patterns and meaning making in new digital platforms.

Digital infrastructures and platforms

So far, we have discussed micro- and meso- units of analysis of collective thinking in educational dialogue. The highest units of course correspond to societies, cultures. But what units of analysis are relevant, between the lower and upper extremes? Specifically with respect to the study of CSCL situations, we propose that a possible macro-level unit and new line of research could be to understand *digital infrastructures* as communicative situations, with the digital environments as communicative events, whilst communicative actions become played out with other participants and digital tools. The interdependencies of these three levels — digital infrastructures, specific digital environments and communicative situations — are what constitute *platformization* and conditions for educational dialogue. Platformization often helps having a retrospective view upon dialogues (for example by scrolling up and down written dialogues), displaying argumentative maps, and awareness tools. These traces transform communicative events into multiple time scale events. The simple reflection on a digital dialogue through the decomposition and evaluation of its components is a common practice in dialogic education (Slakmon & Schwarz, 2019). Looking at traces in new CSCL platforms can then tell a lot about development across educational dialogues.

Platformatization goes hand in hand with the use of computational methods to look for fine-grained patterns that might never be detected 'by hand'. Even if we knew where to look, a manual point-by-point examination of the data is unlikely to produce useful insights with respect to these higher-level phenomena. Computational approaches can also extend manual analyses by allowing us to look for the presence of detailed patterns previously identified by hand across many more instances and contexts. For example, Social Network Analysis has been helpful in showing patterns of distributed versus dominated communication (Brooks et al. 2014), the uptake of ideas across a distributed community over time (Suthers 2015), and finding noteworthy collections of interactions within a large network that merit the intensive time needed to study meaning-making activities in-depth via qualitative approaches (Wise et al., 2017). As language is often a central (though not necessarily the only) mechanism through which learners communicate, the use of natural language processing (NLP) technologies is of particular interest to the CSCL community. For example, it can be used to scale up (and speed up) the process of content analysis by letting the machine learn from a sample set of human coded messages (Rosé et al. 2008; Mu et al. 2012). Computational approaches can both be applied to the kinds of data long-used in CSCL research (e.g., the content of student utterances as they collaborate in a face-to-face or textually mediated environment) and also allow for new forms of data (e.g., eye gaze, gesture, location, biosensors). An embryonic but very promising direction in the use of NLP techniques is the identification of argumentation components in dialogue (e.g. Habernal & Gurevych, 2017). Such a direction may help in the mediation of (multiple) educational dialogues. Another area in which computational methods offer a particular advantage is in the study of self–/co–/socially shared regulated learning in collaborative contexts. Regulated learning is a complex metacognitive and social process that is cyclical and involves adapting thinking, motivation, emotion, and behaviour (Järvelä & Hadwin, 2013). Currently, limited methods exist for making these processes and accompanying social and contextual reactions visible, and those that do are time-consuming, expensive, and often reliant on subjective self-reports. New physiological and technology-assisted data collection can simultaneously trace a range of parallel and overlapping cognitive and non-cognitive processes. These multimodal data can be used to identify markers that characterize successful Self-Regulated Learning and learning progress. This, in turn, can help us to better understand the interactions between different facets of regulation and how small-scale situated adaptations and regulation of situated challenges contribute to large-scale adaptation during collaborative learning tasks (Hadwin, Järvelä & Miller, 2018).

With all these possible methods and techniques it becomes more important than ever to develop theories and models that capture and connect different levels of granularity and scale in the

analysis. If we do not develop them, we run the risk of fragmenting the idea of learning in educational dialogue as the phenomenon, which is at the core of what we want to understand and explain. One solution might be that we can (as we do here) identify a point of fixation as start and end point for the analysis. This could create a more advanced cumulative path for CSCL research.

The contextual sensitivity of the dialogue cannot be understood from the digital traces collected in platforms, alone, though. We still need methods — that analyse sequentially as unit of analysis, and levels of description — that include participants' meaning-making over time. Why is this so important? Educational dialogue is seen, as part of learning, reasoning, and argumentation, as knowledge and skills that all students need to develop. To understand how and why dialogue emerges, we argue that exchanges should be defined as the smallest possible unit of analysis. In the triadic exchanges one can capture what the participants try to contribute with and what they achieve. Each utterance can be conceptualized as multidimensional, and which aspects that the listener and other speakers choose to select are part of how the dialogue emerges. In schools, it can spark emotional, cognitive/epistemic, or social responses — or what often can be observed, aspects of all three but with emphasis on one or two. And uptake and responses and new contributions (and in many forms of dialogue) are rather complicated to describe and analyse. The context sensitivity emerges through multidimensional signs (verbal, physical, and digital) that are not formalized and part of a direct observation in small sequences. The meaning for the participants becomes generated over periods of time-based multiple types of resources.

Validation of analyses

Any proposal concerning an analysis approach must obviously be linked the question of how it can be validated, not only scientifically, but also educationally, by other social actors or stakeholders.

As any other human activity, analysing has its addressees. And as a pervading form in the world of education, educational dialogues serve diverse functions directed to very different audiences. SEDA is an obvious example of this multifunctionality. Howe et al.'s findings (2019), that show through SEDA that dialogical practices predict cognitive and social outcomes, address the concerns of policy makers with respect to the implementation of dialogic practices. Another group of addressees is teachers, for whom training to enact SEDA categories of actions helps in improving the quality of the educational dialogues – according to the SEDA categories.

Reliability testing is a common concern amongst developers of coding schemes, who attempt to minimize inference levels and maximize the chances of two or more coders applying the same category to each unit of analysis. A number of indices are available for checking reliability, with Cohen's Kappa being most commonly used. The value of reliability testing is questioned by some (e.g. Lefstein et al., 2015; Sedova et al., 2016), especially the implicit expectation that researchers unfamiliar with the context can code reliably using a scheme that they have not developed. In addition, requiring agreement between coders who are not experts in interaction analysis would seem, in some cases, to lead to the simplest and possibly least interesting codes being retained. Nevertheless, if the analysis scheme is intended for general use, especially by practitioners, it is important that it can be communicated. In practice, levels of success vary with classroom dialogue and achieving high reliability is difficult and time consuming. The finer grained a coding scheme, the less reliable it is likely to be, simply because there is more room for discrepancy and error. There is thus a tension between reliability, *qua* validity, of analyses and their depth, with respect to the object of study.

Researchers employ various strategies to maximize reliability, including tightening up and illustrating definitions, coding at cluster level, and using sequential, hierarchical structures of

decision making. For example, Transactive Discussion (Berkowitz & Gibbs, 1983) begins with a distinction between orientation towards self or other and then breaks down those categories.

Unlike reliability, construct and content validity are very rarely addressed in this field. Researchers seem to presume knowledge of productive dialogue when formulating schemes to analyse it. The variation in definitions and markers used across studies (Howe & Mercer, 2016; Kim & Wilkinson, 2019), indicates that further work is needed. One approach is theoretical triangulation, whereby the same transcript of discussion is analysed from different theoretical perspectives, yielding deeper, complementary insights from each (Clarke, 2001). van Drie and Dekker (2013) related the perspectives of teacher, students and domain to each other by, respectively, analysing interactivity of the discourse, conceptual level raising and historical reasoning, and integrating the outcomes. Comparison of coding schemes has also been made on occasion. Hennessy (2020) applied three different schemes to the same transcript to explore their affordances: SEDA, Accountable Talk (Michaels & O'Connor, 2015) and Transactive Discussion (Berkowitz & Gibbs, 1983). There was strong overlap between the coding outcomes from the perspectives of the three schemes, plus some interesting, nuanced differences. Likewise, Mayer (2018) found that SEDA and Accountable Talk moves could be roughly mapped onto her own Framing-Developing-Evaluating analysis of the history knowledge construction process, but a new category of "Asking for observations" was proposed. In the CSCL literature, some of the same discussion is part the history of the field. For example, Jeong, Hmelo-Silver and Yu (2014) and Jeong et al (2017) have analysed the use of research design, methods and analytics techniques in CSCL and suggested frameworks and categories that can be used in order to create a more cumulative path for CSCL.

Finally, on the issue of methodology, as we mentioned in introduction, there have been various attempts to propose general, standardised and widely used analysis methods (e.g. SEDA – see above). The motivation for this may well be derived from areas of psychology where standardised tests are the goal and the norm, enabling comparisons between studies. Is analysis of educational dialogues like that? "Not quite", we would say. An extended interaction analysis method is never neutral with respect to its purpose, the phenomena that it is designed to capture, or not. And as we have discussed, such purposes, research goals and theoretical perspectives, are very diverse in the area of educational dialogues and the interdisciplinary field of CSCL. General analysis frameworks (structured ensembles of codes) could be of some use to researchers who share exactly the same goals and research questions, or could at least provide sources of inspiration for researchers who might want to adapt existing methods to their own aims.

Concluding discussion

What do our overall arguments lead to? As we promised (or warned) the reader at the outset, this text reports several intersecting pathways across a complex research landscape, that is not in any sense stabilised. We shall now try to summarise the main ideas expressed above.

We sketched a portrait of research on educational dialogues, within and without CSCL systems, in terms of diversity — diversity of theoretical approaches, diversity of methods, of types of data of dimensions of dialogue, with the coexistence of analyses performed by researchers and analyses performed automatically. This 'diverse diversity' can be seen as a sign of the vigour of the research domain, and yet it may also signify its dispersion and fragmentation. In the belief that attempts at integration, even if localised, can be of use, we propose to revisit the fundamental questions of the theoretically-defined object of study — what are we trying to understand, analyse? — and the main units of analysis — how is the object to be understood?

Following this direction, we defined the object of study as *the processes of development of collective thinking in and by dialogue*. Meaning-making is a part of this; but so are also the processes of development of interpersonal relations in the group, of appropriation of new

pedagogical approaches and, in CSCL situations, of appropriation of the technological artifacts. In part, this choice of object of study was motivated by arguments that we presented, originating in a broad variety of theoretical perspectives, that reject the expression of individuals' thoughts in dialogue as objects of analysis. It must be said that it was also motivated by the main theoretical perspectives underlying the views expressed in this paper, that are both socio-cognitive and socio-cultural[2]. We also delved into the theoretical complexity of the multiple contemporary theoretical perspectives on the nature of dialogue itself, where the gap is still not bridged (if, indeed it should be) between theories of dialogue as an empirical phenomenon and as an abstract theoretical horizon.

With this in mind, we moved on to defining the basic unit of analysis as the ternary structure called the *exchange*, whereby whole dialogues are recursively embedded structures of communicative acts and iterations over evolving discursive objects. This minimal unit of analysis needs to be articulated with units working over much broader timescales (societal, historical), in order to avoid the pitfall of the decontextualization of microscopic sequences of dialogic exchanges, being presented as beautiful illustrative "gems" of collective thinking, which have no past or future.

Between the micro and macro temporal levels of activity, we proposed an intermediary unit of analysis, based on a phenomenon that is now an important part of CSCL research, that of the *platformization* of technology-supported educational settings. Indeed, the analysis of platformization of educational settings is historically new in the CSCL field, despite the presence of some CSCL scholarly work with multi-levels analysis, when understanding educational dialogue is the aim. We claim that the phenomenon of educational dialogues varies as a part of contextual and deep cultural changes. However, how humans choose to speak and talk is still a foundational/classical humanistic and social science issue. Through the use of various platforms, it is possible to collect millions of data points. Unfortunately, the CSCL analysis will be less cumulative if the minimal unit of analysis and the fixation of the phenomenon are not shared. Platformization also raises basic issues of social equality within schools, regions, cities and countries as well as part of the globalization of education. We must engage in the types of platforms that create conditions for collective thinking and in-depth learning in all school subjects and in a variety of educational settings. This includes the development of generic skills, such as the capacity to take part in argumentative practices and dialogues (about values, norms, democratic issues etc).

Our main conclusion is thus that it would be fruitful for research to develop approaches that deal with multiple levels involved in a CSCL environment that are based on digital platforms and have educational dialogues as the analytic unit to be understand and explained. The CSCL field needs a new conceptualization in the form of 'models' for qualitative and quantitative analysis of interactional encounters, integrating behavioural traces collected automatically over extended periods of time (Oshima & Hoppe, 2021). The most important issue here is to establish the connections between types of data and how the multiple levels involved can become connected.

Both thick and thin behavioural data could be of importance. The specificity and sensitivity in the analysis is performed in part by a human analyst in combination with automatic analysis, and this is based on carefully selected variables that give deeper insight in dialogues (oral and written). We can conceptualize this as the collective intelligence of the analysis. When performing such analysis, one should connect the levels and types of data that are able to be connected. Connecting data of neurotransmitters or eye-tracking to social practices is not feasible or productive since the phenomena that one collects data about are too different, and measure

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[2] In the new CSCL handbook, these and other conceptual positions are described in more detail (Ludvigsen, Lund & Oshima, 2021).

different phenomena. Each analysis could be of high quality, but analyses need to be connected in models that do not leave "big black holes" within the model.

We do not argue that all CSCL studies need to involve "all" levels in each single study, but we need to be able to conceptualize and synthesis how multiple dimensions influence and affect educational dialogue. This could mean that studies should take the smallest unit of analysis (the exchange) as a starting point and include what is needed in order to explain how dialogues emerge as part of digital platforms/socio-technical infrastructures. In addition, data such as log files can give structural insights about how interaction and collaboration emerge, as foundation for detailed analysis of the dialogues.

As we said at the outset, CSCL environments are game changers for educational dialogue, given the new range of semiotic means of interaction and the attendant possibilities of recording, displaying and analysing many different kinds of data. Such complex tools need a considerable amount of time in order to be appropriated into educational institutions. Overall, the *leitmotif* of this short paper has been that of the need to *combine in meaningful ways*: to combine types of data, analysed by hand and automatic qualitative and quantitative analyses, preserving the meaning of the analysis in terms of a clear vision of its object and units.

Finally, we suspect that the days are gone when the promulgation of "dialogue" in educational practice could be conceived within a purely neutral, rationalistic and classically democratic approach, in abstraction from issues of politics and power (Nasir et al., 2021). Our object of study — dialogue in education — appears to be constantly elusive, as it evolves with our (globalised) societies and with our attempts to study it. CSCL research may be at an important juncture in this respect.

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