'Dialogic scaffolding': Enhancing learning and understanding in collaborative contexts

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ABSTRACT

In this paper we present a system of analysis for characterizing 'dialogic scaffolding', i.e., the way scaffolding processes are enacted through the dialogic interactions among teachers and learners. The system employs tools from Socio-cultural Discourse Analysis (Mercer, 2010) and the Ethnography of Communication (Saville-Troike, 2003). We also illustrate the application of the system with selected data from a study on the role of teacher–student dialogic interactions in enhancing understanding in collaborative contexts. Following a socio-cultural perspective for understanding learning and developmental processes, the system seeks to create bridges between conceptualizations of 'scaffolding' and 'dialogic approaches' to studying these processes in classroom settings. Results show the system's potential for providing fine-grained accounts of how adult–children dialogic interactions serve as scaffolds to enhance the latter's understanding and learning. We discuss the theoretical and practical contributions of this work for comprehending and promoting teaching and learning in school contexts.

1. Introduction

1.1. Learning and development as apprenticeship

In this paper we follow a socio-cultural perspective for conceptualizing processes of development, teaching and learning. Inherent in this perspective is the notion that, if we are to understand the nature of thinking, learning and development we need to take account of the intrinsically social and communicative nature of human life. Socio-cultural theory posits that learning and development are achieved partly through dialogue, and that education is enacted through the interactions between teachers and learners. These interactions reflect the cultural and social practices of the communities in which educational institutions exist (Cole, 1996; Daniels, 2001; Lave & Wenger, 1991; Mercer, 2000; Rogoff, 1990; Wertsch, 1985).

Rogoff (1995) proposes to analyze socio-cultural activity in general, and learning and development in particular, on three mutually constituting planes: a) *participatory appropriation* (PA) is the personal process by which individuals learn through their active engagement in social activities; b) *guided participation* (GP) refers to the interpersonal processes through which people become involved in culturally valued activity; and c) *apprenticeship* (AP) involves people participating in community activities that have as part of their purpose the development of mature participation by less experienced individuals. According to Rogoff (1990), guided participation involves children and their caregivers in the collaborative processes of a) building bridges from children's present to new knowledge, and b) structuring children's participation in activities with dynamic shifts over their

degree of responsibility. The author further argues that guided participation implies that 'both guidance and participation in culturally valued activities are essential to children's apprenticeship in thinking' (p. 16). Within these interactive processes, 'scaffolding' takes place when such guidance falls within the 'zone of proximal development' (ZPD). That means that the aid of more expert others is sensitively adjusted to the novice's current level of expertise ('real level'), while at the same time stretching this level so that the novice can achieve a more advanced performance that he or she could not yet display alone ('potential level') (Vygotsky, 1978; Wertsch, 1985; Wood, Bruner, & Ross, 1976). Scaffolding is temporary, gradually transferring more responsibility to novices so as to promote eventual appropriation of knowledge and abilities, as well as self-regulation. This allows novices to progress from 'legitimate peripheral participation' to assuming a more central role as competent participants in their communities of practice over time (Lave & Wenger, 1991). In Fig. 1 we depict the way scaffolding can be understood within the framework of Rogoff's three analytical planes.

Recently, Van de Pol, Volman, and Beishuizen (2010), after a thorough review of current literature, propose that scaffolding involves three key characteristics: a) *contingency*: refers to responsive, tailored or adjusted support; b) *fading*: refers to the gradual withdrawal of this support over time, and c) *transfer of responsibility*: refers to the eventual handing over responsibility for the performance of a task to the learner. They further identify eleven scaffolding strategies that teachers commonly use in interaction with students in diverse educational contexts. These are defined in Table 1. In the present work we adopt this proposal, focusing specifically on the first key characteristic, which we term 'responsiveness'.

Since the concept of 'scaffolding' was first introduced by the pioneer work of Wood et al. (1976), it has been widely used to explain diverse learning processes such as distributed cognition (Cole & Engeström, 1993); a wide variety of knowledge domains such as literacy (Palincsar & Brown, 1984; Rojas-Drummond, Hernández, Vélez, & Villagrán, 1998), and various educational contexts, including whole classroom and small-group interactions (Elbers, 1996; Renshaw & Brown, 1999; Rojas-Drummond & Mercer, 2003). (See Lin et al., 2012; Van de Pol et al., 2010, for comprehensive reviews of the literature in the field).

These and other contributions have advanced significantly in conceptualizing and empirically grounding the concept of 'scaffolding' in diverse educational contexts. However, not many studies have analyzed with ample detail the role played by the dialogic interactions among the participants in providing scaffolds to promote learning and developmental processes.

1.2. The role of dialogue in fostering learning and development in educational contexts

Recent research in the field of educational practices has emphasized the key role played by the dialogic interactions among teachers and students in supporting children's development, reasoning and learning (e.g. Littleton & Howe, 2010; Mercer & Littleton, 2007). This research has explored two functional aspects of these interactions. The first is teachers' use of dialogue as a
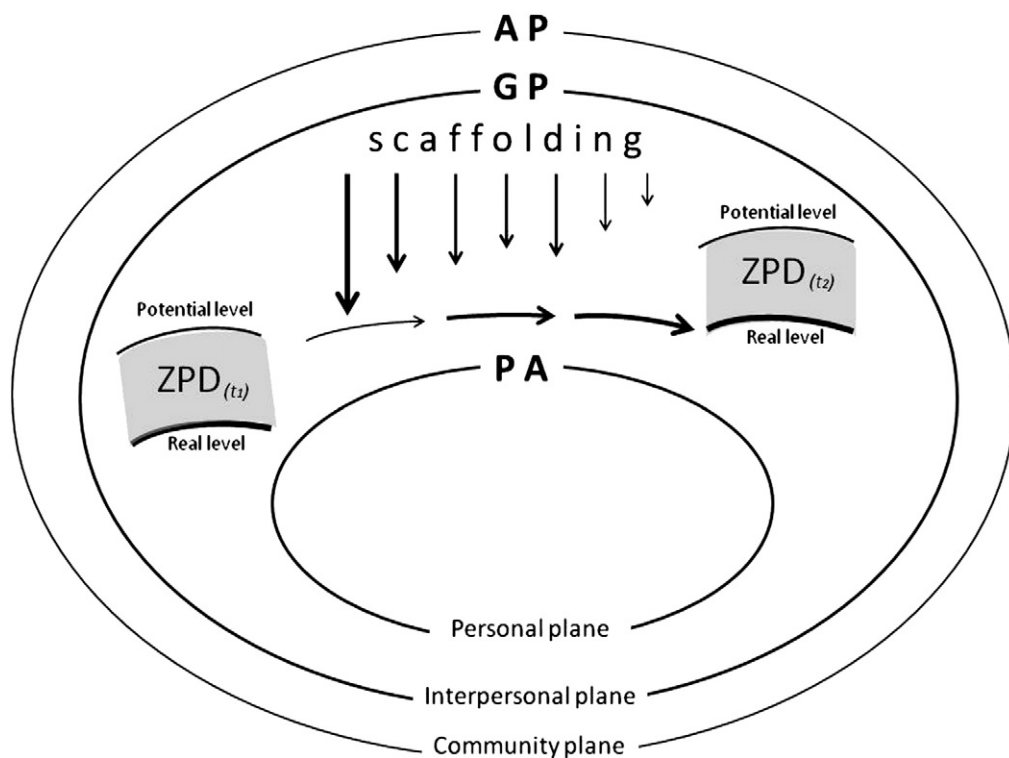

Fig. 1. Situation of scaffolding processes within Rogoff's (1995) three planes for analyzing socio-cultural activity.

Table 1
Array and definition of scaffolding strategies[a].

A) Intentions		B) Means	
1. Direction maintenance	Refers to keeping the learning on target, enabling the learner's pursuit of a particular objective.	6. Feeding back	Involves the provision of information to the student regarding his/her performance.
2. Cognitive structuring	Involves promoting – by different means of assistance – that students organize or structure information.	7. Providing hints	Entails the provision of clues or suggestions to help the student move forward.
3. Reduction of degrees of freedom	Entails taking over those parts of a task that the student is not yet able to perform, simplifying the task for him/her.	8. Instructing	Involves telling the students what to do, or explaining them how or why.
4. Recruitment	Refers to getting students interested in a task and helping them adhere to its requirements.	9. Explaining	Refers to the provision of detailed information or clarification about a subject matter or an activity.
5. Contingency management/ frustration control	Involves facilitating students' motivation through recognizing their achievements or minimizing frustration.	10. Modeling	Involves the demonstration of a particular skill or activity to the student.
		11. Questioning	Involves asking students to respond to an inquiry by the teacher.
		12. Marking critical features[b]	Involves accentuating certain features of the task that are relevant.

[a] Adapted from Van de Pol et al. (2010).
[b] Strategy 12 was added, taken from Wood et al. (1976).

means for 'scaffolding' children's learning and development (Mercer & Littleton, 2007; Rojas-Drummond & Mercer, 2003; Wells, 1999). The second is the potential value of peer group interaction and talk as another means of supporting these processes, but in a more symmetrical environment (Fernández, Wegerif, Mercer, & Rojas-Drummond, 2001; Howe, 2010; Rojas-Drummond, Littleton, Hernández, & Zúñiga, 2010).

In the work reported in this paper we analyze the way scaffolding is enacted through what both teachers and students do and say as part of their communicative interactions. This work follows recent developments that endorse 'dialogic approaches' to investigating learning and teaching in educational contexts. According to Alexander, dialogic interactions are conceived as those that 'harness the power of talk to engage children, stimulate and extend their thinking, and advance their learning and understanding'. These interactions are *collective*, *reciprocal*, *supportive*, *cumulative and purposeful* (Alexander, 2008; pp. 37–38).

Through dialogic interactions participants can create 'dialogic spaces' (Wegerif, 2007) which maintain an open, critical and constructive posture towards the exploration, confrontation and negotiation of different ideas. When opinions differ, participants may contrast their perspectives using argumentation, seeking eventual consensus. There is also an orientation towards inquiry
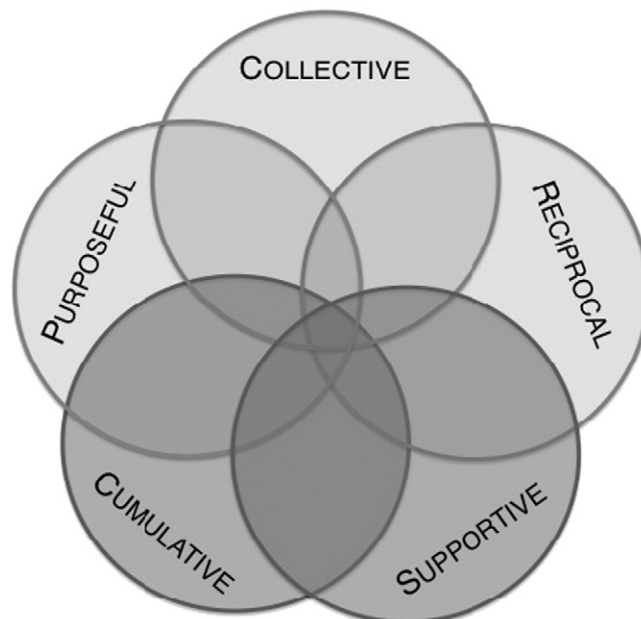

Fig. 2. Dimensions of analysis of 'Dialogic Teaching-and-Learning' (DTL).

Table 2
Analytical system for characterizing 'dialogic teaching-and-learning' (DTL).

CA representing 'Dialogic Teaching-and-Learning' (DTL)		CA representing 'Dialogic Scaffolding' (DS)	
Dimension	Communicative Acts (CA)*	Scaffolding strategies	Key characteristic of scaffolding
A) Collective Teachers and students address learning tasks and solve problems together, whether as a group or as a class, and participate as a learning community. Teachers (or students) orchestrate various forms of participation, including the planning and organization of activities, as well as the assignment and taking of turns.	1. Teacher manages turns by shared routines [rather than through high-stakes competitive bidding]. 2. Teacher distributes turns evenly among students. 3. Teacher combines the routine and the probing when assigning turns. 4. Teacher and students participate in carrying out the task or solving the problem. 5. Teacher and students plan or organize the activity together.		
	6. Teacher employs a questioning strategy of *extension* (staying with one child or theme) [rather than *rotation* (questioning round the class or group)].	11- Questioning	Responsiveness
	7. Teacher gives students thinking and talking time, [instead of pressuring them to provide instant responses]. 8. Teacher gives turns to less able, quiet or compliant students. 9. Students ask questions and/or provide explanations [not just the teacher].		
	10. Teacher encourages students to engage in collective activities	4- Recruitment	Responsiveness
B) Reciprocal Teachers and students listen to each other; exchange and share ideas; negotiate meanings and perspectives; consider alternative viewpoints, possibilities and hypotheses; and make reasoning explicit to achieve common understanding. Ground rules are invoked and used during discussions. Teachers encourage students' participation, as well as pupil-pupil dialogues.	Communicative acts of talk among teachers and students: 1. Teacher and students make ground rules for communication explicit. 2. Teacher encourages the expression of different view points from students.		
	3. Teacher invites students to expand on an utterance (e.g. by 'what is?', 'why?', 'what might be?' questions).	11- Questioning	Responsiveness
	4. Teacher provides arguments.	9– Explaining	Responsiveness
	5. Teacher asks students to justify their opinions.	11- Questioning	Responsiveness
	6. Teacher and students negotiate meanings and perspectives. 7. Teacher and students compare different perspectives or alternative views. 8. Teacher encourages the expression of different possibilities, using words such as "perhaps" and "might". 9. Teacher and students consider different alternatives before arriving at a solution. 10. Teacher or students acknowledge when they change their mind. 11. Teacher and students make decisions or arrive at solutions jointly. 12. Teacher and students talk about talk. 13. Teacher encourages pupil-pupil dialogues.		
C) Supportive Teacher and students create a positive atmosphere where everybody articulates their ideas freely. Teacher promotes scaffolded dialogues that guide and prompt, reduce choices and expedite "handover" of concepts and principles. Teachers promote understanding and learning through modelling, guided participation, dialogic enquiry and aided discovery.	1. Teachers encourage students to express their ideas freely, without fear of embarrassment or retribution. 2. Teacher asks students to express their interests.		
	3. Teacher makes students' achievements explicit to them and/or to others.	5- Contingency management	Responsiveness
	4. Teacher models productive ways of communication (e.g. by showing how 'think aloud'; how to explain; how to argue by providing reasons, justifications and evidence; how to hypothesize).	10- Demonstration/ Modelling	Responsiveness
	5. Teacher provides aid which reduces degrees of freedom, so as to allow pupils to concentrate on certain key aspects of the task.	3- Reduction of degrees of freedom	Responsiveness
	6. Teacher uses 'retreat and rebuild' exchanges (repair processes where pupils' mistakes are used to reconstruct knowledge).	12- Marking critical features	Responsiveness
	7. Teacher highlights or explains the process of arriving at a solution.	9. Explaining	Responsiveness
	8. Teacher uses cued elicitations to encourage students to 'discover' new knowledge or ways to solve problems.	7. Giving of hints	Responsiveness
	9. Teacher reformulates, elaborates, recaps and/or reviews learning with pupils.	2. Cognitive structuring	Responsiveness
	10. Teacher promotes that students solve a problem by themselves (withdrawing support when students demonstrates competence).	-------------	Fading -transfer of responsibility
D) Cumulative Teachers and students build on their own and each other's ideas, and link them into coherent lines of thinking and enquiry. Knowledge is jointly constructed, integrated, extended, elaborated and/or	I. Questioning: 1. Teacher asks questions which explore pupils' levels of understanding.	11- Questioning	Responsiveness
	2. Teacher asks open questions (rather than invitations to guess the one 'right' answer).	11- Questioning	Respo nsiveness
	3. Teacher asks questions which challenge students' statements or assumptions.	11- Questioning	Responsiveness
	II. Feedback: 4. Teacher provides informative feedback on which pupils can build (instead of positive, negative or non-committal judgement, or mere repetition of the respondent's answer).	6- Feeding back	Responsiveness

Table 2 (*continued*)

CA representing 'Dialogic Teaching-and-Learning' (DTL)		CA representing 'Dialogic Scaffolding' (DS)	
Dimension	Communicative Acts (CA)*	Scaffolding strategies	Key characteristic of scaffolding
transformed through spiral chains of questioning, responding, discussing and/or providing feedback. Emphasis is given to the temporal development of learning.	5. Teacher provides elaborated feedback on a pupil's response, which explains why it is adequate or inadequate.	6- Feeding back	Responsiveness
	6. Teacher uses praise discriminatingly (filtering out the habitual "good", "excellent", "fantastic", "brilliant", etc.)	6- Feeding back	Responsiveness
	III. Emphasis on the temporal dimension of learning:		
	7. Teacher builds knowledge from one to another student in a chain (using the responses of previous pupils to direct the interactions with subsequent pupils).		
	8. Teacher and/or students link prior knowledge (from outside or inside the classroom) to the current topic or activity.	2- Cognitive structuring	Responsiveness
E) Purposeful Teachers plan and steer classroom talk with specific educational goals in view. Goals and intentions are made explicit and guide problem solving and learning. Teachers promote metacognitive reflection on the purposes, significance and/or usefulness of what is learned. Learning is contextualized, situated and projected into the future.	1. Teacher or students make explicit shared purposes of talk.		
	2. Teacher or students make explicit the demands or purposes of an activity.	1- Direction maintenance	Responsiveness
	3. Teacher or students share their intentions with others.		
	4. Teacher or students plan courses of action or ways to solve problems.		
	5. Teacher or students create links between what is being learned and a wider context (outside of the classroom or the school).	2- Cognitive structuring	Responsiveness
	6. Teacher and students evaluate the extent to which they have achieved their goals.		
	7. Teacher encourages students to evaluate their own learning processes and/or outcomes ('what did I learn?', 'how did I learn it'?, 'what do I need to improve my learning?').	------------	Fading -transfer of responsibility
	8. Teacher invites students to reflect on the importance and/or usefulness of what is learned ('why do I need to learn x?'; 'how/where can I apply what I learned'?).		
	9. Teacher makes the learning trajectory visible (e.g. by explaining how certain knowledge will be useful in the future).		

*CA that are shadowed correspond to diverse *scaffolding strategies*.

and the joint construction of knowledge (Hennessy, Mercer, & Warwick, 2011; Mercer & Howe, 2012; Mercer & Littleton, 2007; Rojas-Drummond et al., 2010; Wells, 1999).

In spite of recent advances in the field, we still need further theoretical and empirical work to increase our understanding of how scaffolding is enacted through the dialogic interactions among participants in diverse educational contexts, and how these processes enhance children's development and learning. In addition, we lack sensitive methodological tools to analyze in detail these interactive processes. In the work reported in this paper we propose a system of analysis that enables fine-grained accounts of the ways in which dialogic interactions among teachers and students scaffold the unfolding of children's understanding and learning. This proposal attempts to create most needed bridges between conceptualizations of 'scaffolding' and those emerging from current 'dialogic approaches' to understanding teaching and learning. We next present the methodological grounding of this analytical system.

1.3. Methodological framework

The system developed to analyze dialogic interactions among teachers and students employs tools derived from Socio-cultural Discourse Analysis (SDA, Mercer, 2010). According to Mercer, SDA seeks to understand the function of communicative exchanges, framed in their socio-cultural context. It further purports to explain how participants in conversations construct shared understandings and common knowledge, throughout different time scales. Within this framework, the initial focus of our analytical work is the process we term 'dialogic teaching-and-learning' (DTL). This involves the communicative interactions among teachers and students that enable them to construct shared understandings and common knowledge in classroom settings. To capture the dialogic nature of this interactive process, we have deepened the original definitions of Alexander's five core 'principles', that, according to the author, sit at the heart of what is meant by 'dialogic' (see above). We view these five core principles as 'dimensions of analysis' that overlap and complement each other. The convergence of these five dimensions represents the essence of DTL (see Fig. 2).

Table 2 presents the system of analysis for characterizing DTL, which includes the extended definitions we propose for each of the five analytical dimensions. At the same time, we followed methods derived from the Ethnography of Communication in order to establish units of analysis systematically, starting from continuous strings of conversational turns (Hymes, 1972; Saville-Troike, 2003). In particular, we employed the system of hierarchical and nested units of analysis these authors propose to investigate conversations among participants, consisting of 'communicative acts' (CA), embedded in 'communicative events' (CE), which are
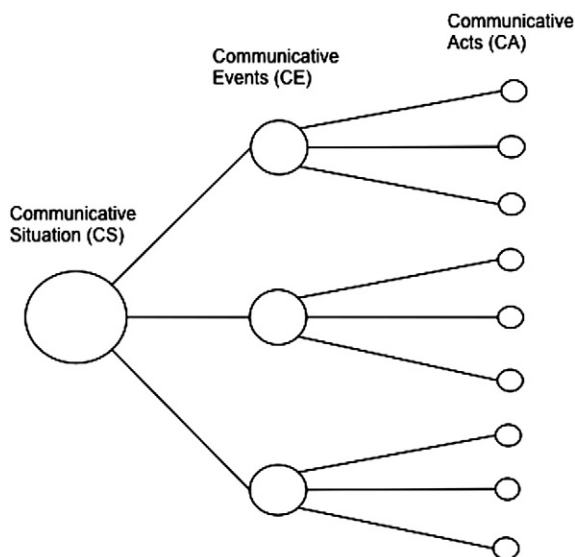
Fig. 3. Hierarchical and nested categories from the Ethnography of Communication.

in turn part of broader 'communicative situations' (CS) (see Fig. 3). Briefly, CA are identified by their interactional function. They get their status from the social context as well as from the grammatical form and intonation, and can be constituted by more than one utterance. CE are composed of a series of turns in the conversation where participants share a common purpose and general topic. Lastly, a CS is the general context within which communication occurs (see Rojas-Drummond, Mazón, Fernández, & Wegerif, 2006).

Our system of analysis defines a series of CA that can be displayed by teachers and students, in terms of what they do and say during dialogic interactions. These CA are distributed across, and constitute, each of the five analytical dimensions. The establishment and definition of these CA were initially based mainly on Alexander (2008) and Mercer and Littleton (2007) and Hennessy et al. (2011) and Wells (1999), as well as our own line of research for the last decade (Rojas-Drummond, 2000; Rojas-Drummond, Pérez, Vélez, Gómez, & Mendoza, 2003; Rojas-Drummond et al., 2006; Rojas-Drummond et al., 2010). The categories have been consecutively refined as data analyses progress, in a 'top–down' and 'bottom–up', cyclical and iterative fashion.

Starting from this wider system, we further defined a sub-system of those CA that may account for how adults scaffold children's understanding and learning through the dialogical interactions among participants. In order to identify these categories systematically, four expert judges compared each of the 50 CA of the DTL system against the definitions of the 12 scaffolding strategies in Table 1, looking for overlap between categories. Besides identifying these categories, the judges further established which key characteristic of scaffolding each CA represented. These analyses yielded 23 CA, which are shadowed in Table 2.[1] It is interesting to note that the 'supportive' and 'cumulative' dimensions contain most of these categories (15 out of 23), and that most of them represent the characteristic of 'responsiveness' (21 out of 23). For this reason, the analyses presented below focus on this key characteristic of scaffolding.

We propose that this sub-set of CA illustrates the process we term 'dialogic scaffolding', i.e., the way the responsive support provided by a teacher is enacted through the dialogic interactions among teachers and students. These interactions steer the latter through joint activity and dialogue towards new understanding and learning. It is important to stress that students are active participants in this interactive process (Elbers, 1996; Mercer, 2000; Renshaw & Brown, 1999; Rogoff, 1990). Furthermore, all the CA that comprise the DTL system are conceived as dynamic interactional processes where the temporal sequencing of both the teacher's and students' interventions is crucial (rather than being interpreted as isolated events).

In educational settings, CA are typically clustered as part of wider IRF exchanges. These can be of two kinds (Rojas-Drummond, 2000): a) Spiral IRF exchanges are composed of two or more strings of IRF sequences related in topic, where one or more conversational turns simultaneously play the role of F and I (F/I), giving rise to a new, extended IRF sequence. Teacher's turns are adjusted to student's previous responses, aiming at advancing their reasoning and understanding; 2) Loop IRF Exchanges, in contrast, are composed of one IRF sequence where the F closes the exchange. As will be shown under Results, these types of exchanges occupy a central stage in our analytical work.

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[1] These 23 CA represent those where there was 100% agreement among judges.

Table 3
Segment 1 — Communicative Situation (CS): 'Discussing about transmission of HIV'.

General context: Edgar, Rodrigo and Karla are sitting around a computer, doing research on the topic of HIV, in order to write an article. They are also organizing their ideas in a mental map using Kidspiration (see Figure 4). In this segment they are discussing some information they have read about different forms of transmission of HIV: CE1-through sexual relations; CE2-from mother to baby; CE3-from infected needles.In CE4 they recapitulate what they have learned.

CE	Turn	Speaker	Dialogue	Move / IRF exchange*	CA per dimensions A	B	C	D	E
CE1	83	Edgar:	'How does the HIV virus enters into the body?' (*reading sentence i from the top of the map in the computer screen – see i in fig. 4*).	I					
	84	Karla:	Through having sexual relations.	R					
	85	Rodrigo:	Let's put first 'through having sexual relations' (*giving directions to Edgar. Edgar writes sentence ii in the map*).	R					
CE 2	86	Karla:	If the mother is infected with HIV, she can transmit it to the baby (*referring to the fetus, and pointing at sentence iii in the map*)	I					
	87	Edgar:	This is contagion through breast milk.	R					
	88	**Teacher:**	**Through what? (Teacher approaches the children)**	F/I	A6			D3	
	89	Edgar:	Through breast milk	R					
	90	**Teacher:**	**Are you sure it's through breast milk? (Teacher approaches Edgar and holds his shoulder).**	F / I				D3	
	91	Edgar:	No, it's through…	R					
	92	Rodrigo:	It's through the blood.	R					
	93	**Teacher:**	**And how is it transmitted through the bloodstream?**	F/I		B3			
	94	Karla:	It's because… [when the mother is infected	R					
	95	Edgar:	[the baby gets infected	R					
	96	**Teacher:**	**Aha!**	F					
	97	Karla:	And when she's infected she transmits it to the baby.	R					
	98	**Teacher:**	**And do you know how it's transmitted to the baby? (they all keep silence for a few seconds).**	F/ I			C5	D1	
	99	Rodrigo:	How?	R					
	100	**Teacher:**	**Do you know what a baby feeds when he or she is in the mother's womb?**	I				D8	
	101	Rodrigo:	[From the same thing that the mother feeds	R					
	102	Edgar:	[From what the mother… from what the mother eats	R					
	103	**Teacher:**	**And how does this nourishment reach the baby?**	F/ I		B3			
	104	Edgar:	Through the umbilical cord.	R					
	105	**Teacher:**	**And what goes through the umbilical cord besides this nourishment?**	F / I		B3			
	106	Edgar:	[Water	R					
	107	Rodrigo:	[Blood	R					
	108	**Teacher:**	**Blood.**	F					
	109	Edgar:	Aaah!	R					
	110	**Teacher:**	**And HIV is mainly infected…**	I			C8		
	111	Karla:	Through the blood!	R					
	112	**Teacher:**	**Through the blood (agrees with a nod).**	F					
	113	Karla:	Through what is in the blood.	R					
	114	**Teacher:**	**Now you have it! (The three children turn their heads to the screen).**	F					
	115	Edgar:	So it can be transmitted through the blood, right? (*Edgar looks at the adult*).	I					
	116	**Teacher:**	**Through the blood, o.k. Through the bloodstream, something like that.** (*Rodrigo, Karla and Edgar start discussing, and Rodrigo types sentences iv and v in the the map*).	R/ F				D4	
CE 3	117	Karla:	It is also infected through…(*Rodrigo is typing while Karla and Edgar are looking at the screen*)	I					
	118	Rodrigo:	Through… do you write it joint or separate? (*Asks whether the word 'a través' in Spanish is written as one or two words*).	I					
	119	Edgar:	And that's it; this is how it's transmitted (*Turns to look at the teacher*).	R					
	120	Edgar:	Oh, and through needles… (*Simulating an injection in the arm*). Right!	R					
	121	**Teacher:**	**[And through needles is…?**	F/ I		B3			
	122	Edgar:	[Aaah, but that's also through the blood! (*pointing at sentence v in the map*). (*Then Rodrigo types sentences vi in the map*).	R					
CE4	**123**	**Teacher:**	**Exactly! So, what have you just done?**	F/ I	A6		C7		E7
	124	Edgar:	Say the different ways it is transmitted (*looking at the map in the monitor and then turning to look at the teacher*).	R					
	125	**Teacher:**	**Joint three ideas…**	R			C8		
	126	Karla:	Into one.	R					
	127	**Teacher:**	**And what do you call this?**	I				D8	
	128	Edgar:	Generalization.	R					
	129	**Teacher:**	**Oh, you do remember!** (*Edgar smiles and the three children turn to the screen. Rodrigo then types sentence vii in the top of the map*).	F					

* Spiral IRF exchanges are shadowed.

2. Method

2.1. Participants

The selected data to be presented comes from a study of 120 Mexican sixth graders (11 to 12 y.o.) and their corresponding four teachers. These groups participated in an innovative educational program called Learning Together (LT) over an academic year. The program was designed to: a) foster the development of 'learning communities' within which children and adults co-construct knowledge; and b) enhance social, cognitive, psycholinguistic and technological abilities in the children (see Rojas-Drummond et al., 2010; and http://www.psicol.unam.mx/laboratorio_de_cognicion_y_comunicacion/Apj/index.html).

Children worked in triads to carry out investigations on a topic of their choice, and eventually produced an article, which was published in a popular magazine. They also created a Power Point conference and delivered it to a wide audience as part of a cultural fair. Throughout the implementation of the program, adults supported children's activities so that they learned: a) to use effective ways of communication for discussing and solving problems; b) to comprehend and produce texts of different genres, and c) to use ICT for diverse functional purposes. Four focal triads were randomly selected and their collaborative work was videotaped during selected sessions of the creation of their project, throughout the academic year (five on average). This enabled longitudinal, as well as micro-genetic analyses of adult-child and peer dialogic interactions during different phases of the overall process.

2.2. Procedures

For data analyses, we carried out the following procedures:

1) The DTL system was created, and the sub-system for characterizing DS was further defined, as described under Methodological framework (see Table 2).
2) All videos were transcribed verbatim, together with a description of the context, following guidelines developed by Edwards and Mercer (1987).
3) Units of analysis (including CS, CE and CA) were established for selected segments of each session,[2] using The Ethnography of Communication.
4) Videos and transcripts of these segments were analyzed mainly qualitatively using the DTL system, considering the whole session as context. To do so, sequences of turns were first categorized as either 'Spiral' or 'Loop' IRF exchanges. Categories of CA were then assigned to one or more turns of dialogue by at least two independent researchers, based on the chaining of conversational turns within each exchange, as well as across the complete transcript. The categorized segments were later compared and discussed until agreement between researchers was reached.

3. Results

To illustrate our approach to the in-depth micro-analyses of adult-children interactions, we present one representative example of a dialogue by Focal Triad 1, conformed by Edgar, Karla and Rodrigo, as well as their teacher, while doing research and writing on the topic of HIV. The dialogue and its analysis using the system are presented in Table 3. The table includes: a) the general context of the interactions (CS); b) the four CE which comprise the CS; c) the turns (83–129), d) the speaker; e) the dialog and its specific context (in parenthesis and italics); f) the 'move' (I, R or F), and type of IRF exchange ('spiral IRF exchanges' are shadowed); and g) for each dimension (A–E), the type of CA of one or more turns (see Table 2). To complement Table 3, Fig. 4 depicts the mental map the children gradually constructed in the computer screen as their dialogue progressed (the correspondences between the children's turns in Table 3 and their actions in the mental map in Fig. 4 are marked as i–vii in both). For practical reasons, we will only illustrate some of the categories that represent dialogic scaffolding from all five dimensions (namely: A6; B3; C5, C7, C8; D1, D3, D4, D8; and E7).

As shown in Table 3, the general CS 'Discussing about transmission of HIV' is composed of four CE. In CE1 (turns 83–85) the three children are discussing transmission of HIV through sexual relations.

CE2 corresponds to an interesting spiral IRF exchange (turns 86–116). Here the teacher uses a questioning strategy of 'extension' (A6), enacted by teacher and children discussing how HIV is transmitted from mother to fetus (as opposed to when born). This arises from turn 87, when Edgar shows certain initial confusion between these two forms (stating that the former is contagion through breast milk), and the teacher challenges his assertion in turns 88 and 90 (D3). Then, from turns 98–112, the teacher promotes children's understanding of the underlying mechanism through which HIV is transmitted from mother to fetus (through the bloodstream), by gradually 'reducing degrees of freedom' (C5). This is in turn achieved by a series of complementary scaffolding strategies, which reveal her responsiveness to children's initial misunderstandings and gradual increased comprehension of this mechanism as their dialogue evolves. These strategies include: exploring their initial level of understanding (D1); inviting them to expand their explanations of how HIV reaches from mother to fetus (B3); relating the discussion to prior knowledge (what a baby feeds while in the womb) (D8); and using 'cued elicitations' to narrow choices so that children 'discover' this mechanism (C8) ('And HIV is mainly infected…' [turn 110], to which Karla responds emphatically, as if reaching a new insight: 'Through the blood!'). The teacher closes the spiral IRF exchange with

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[2] We looked for representative examples illustrating phenomena of interest, including: adult-children and peer interactions; activities mediated (or not) by ICT; and display of diverse teaching-learning strategies and styles of communication.
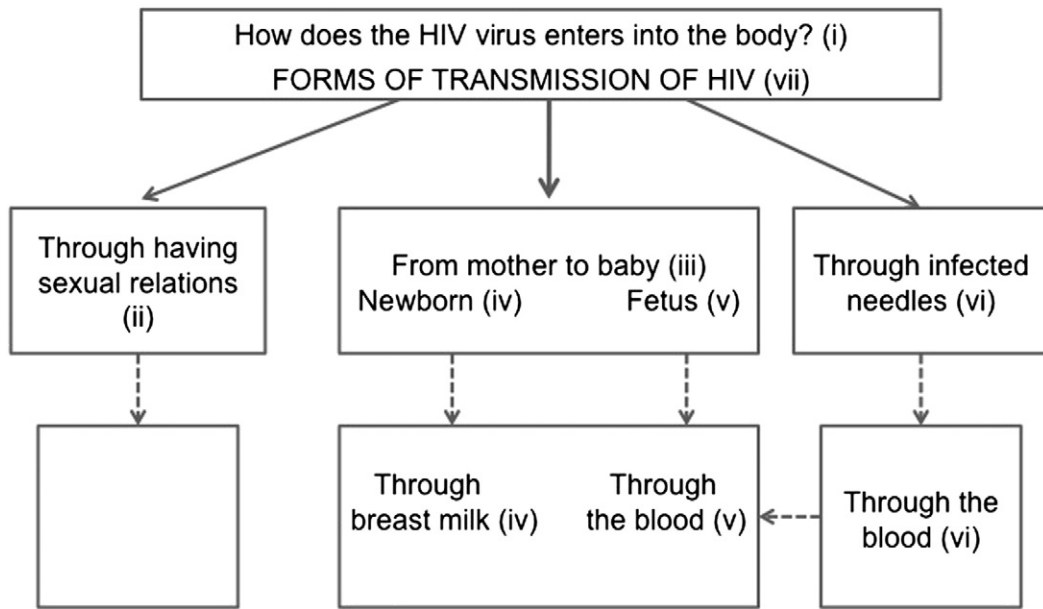
Fig. 4. Mental map constructed by Triad 1 during the dialogue presented in Segment 1.

informative feedback that offers a more precise term for this mechanism (D4) (from 'blood' to 'bloodstream' in turn 116). It is important to stress that children participate actively throughout the whole exchange by: asking questions (turn 83); asking for clarifications (turns 99, 115); making proposals (turn 85); offering explanations (turns 86, 87, 97, 113); and providing arguments (turns 94–95). As the rest of the analyses show, this is true for the whole of Segment 1 (see below).

As part of CE3 (turns 117–122), Edgar proposes a third form of transmission of HIV — through needles (turn 120). After the teacher invites him to expand on his proposal (B3) (turn 121), he seems to reach a new understanding — that this form of transmission is similar as from mother to fetus: 'Aaah, but that's also through the blood!' (turn 122).

CE4 is composed of another insightful spiral IRF exchange. In turns 123–129, teacher and students are recapitulating what they learned and analyzing their own learning process (E7). This springs from turn 123, where the teacher invites them to reflect on how they solved the activity ('what have you just done?') (C7). This is followed by a series of shrewd proposals by the children, partly promoted by the teacher's responsive interventions. In turn 124, as a way of synthesis, Edgar proposes they said 'the different ways (HIV) is transmitted'. Then in turn 125, as a response to a 'cued elicitation' by the teacher (C8), Karla further suggests they joined three ideas 'into one'. Lastly, as a response to the teacher's petition to name this process (turn 127), Edgar remarkably asserts they used 'generalization', which is indicative of a complex metacognitive reflection on their own learning process. It is important to clarify that children had previously learned to use generalization in order to synthesize ideas in the LT program. So they are appropriately applying this previous knowledge to the current activity (D8).

As part of children's active participation throughout the whole segment, it is interesting to observe how their mental map gradually became more complete and complex, as the dialog among all participants evolved. This in turn reflects progress in children's understanding of: a) the different forms HIV can be transmitted; b) the difference between transmission of HIV from mother to baby before and after birth; and c) the mechanism through which transmission occurs in each case. This progress was partly promoted by the teacher's adjusted and crafted interventions in response to children's initiatives and replies, which represent diverse forms of dialogic scaffolding. The interactions among participants are qualified as 'dialogic' since they illustrate a variety of CA from all the five core dimensions of our analytical system, and particularly the 'supportive' and 'cumulative' dimensions.

4. Discussion

Results presented exemplify ways in which the dialogical interactions among the participants, and especially the teacher's sensitive and responsive interventions, gradually lead to better understanding by the children. This increased understanding was revealed by the way children's dialogue and conceptual map gradually evolved. Further evidence of the children's deep understanding of the topic of HIV can be found in the article they published and the conference they presented at the end of the school year (see http://www.psicol.unam.mx/laboratorio_de_cognicion_y_comunicacion/Apj/index.html). In addition, Guzmán and Rojas-Drummond (2012) report empirical evidence of children's longer-term appropriation of oracy and literacy abilities for the whole sample of children, using experimental and control groups.

Our line of research for more than a decade shows that dialogic interactions between experts and novices and among peers are common in the LT program, since they are explicitly promoted. However, they are not typical of ordinary classrooms in official

schools in Mexico, where teaching styles tend to be more directive, transmissional and based mainly on recitation and rote learning (see INEE, 2007; Rojas-Drummond, 2000). Results also demonstrate that children who participate in the LT program, in comparison with peers who do not, develop better capacities to collaborate, to solve problems, to communicate orally, to comprehend and produce texts of different genres, and to use ICT functionally (Guzmán & Rojas-Drummond, 2012; Rojas-Drummond, Gómez, & Vélez, 2008; Rojas-Drummond, Mazón, Littleton, & Vélez, 2012; Rojas-Drummond et al., 2003; Rojas-Drummond et al., 2006). Some of the above evidence further suggests that the dialogic styles of interaction among participants are partly responsible for these achievements (see also Rojas-Drummond, 2000). Thus, we would argue that a 'dialogic approach' to investigating classroom interaction contributes importantly to our understanding and harnessing of the processes by which teachers and students construct knowledge jointly (Alexander, 2008; Hennessy et al., 2011; Mercer & Howe, 2012; Mercer & Littleton, 2007; Rojas-Drummond et al., 2010).

Our work contributes to theory, methodology and educational practice in the field. In the first case, we contend it is profitable to re-conceptualize 'scaffolding' within the theoretical framework of Rogoff's (1995) three analytical planes of socio-cultural activity, (as described under 'Antecedents'), since it enables researchers to understand scaffolding as part of wider apprenticeship activity systems. In addition, the concept of 'dialogic scaffolding' may contribute to establishing explicit links between this re-conceptualization of 'scaffolding' and current 'dialogic' perspectives for investigating teaching and learning. Such links allow us to take proper account of the key role played by the dialogic interactions among participants in scaffolding children's understanding and learning over time.

In terms of methodology, the analytical system for characterizing DTL in general, and DS in particular, can serve as a useful research tool to aid grounding empirically key concepts such as 'scaffolding' and 'dialogic interactions'. This is because: a) it extends the definitions of the five core principles originally proposed by Alexander (2008); b) it turns these definitions into 'dimensions of analysis of dialogic interactions'; and c) it further defines a wide variety of CA which can comprise each dimension. This system can thus shed light into what participants may actually do and say as part of classroom ongoing dialogic interactions, and particularly those that aim at scaffolding students' reasoning and learning over time. This tool can also help establish units of analysis systematically (including CS, CE and CA, as well as IRF exchange sequences). It is important to highlight that, in this and related work, we have found that 'spiral IRF exchanges' represent key higher-order units of analysis which allow us to pin-down where dialogic interactions reside, and particularly those that involve scaffolding processes. They also work as core indicators to predict these interactions when combining qualitative and quantitative analyses (see Rojas-Drummond, 2000).

Due to space constraints, the examples provided do not allow us to illustrate the wide range of CA included in the five dimensions of our analytical system. Likewise, we could not report sequences taking place in longer stretches of time. However, following guidelines from SDA, at present we are refining the system so as to carry out qualitative and quantitative micro-genetic and longitudinal analyses of how dialogic interactions evolve as novices become more competent over time, and how these interactions enhance children's learning.

Lastly, in terms of educational practice, a refined version of the system can serve as a guiding framework to support teacher professionalization. As part of these formative efforts, teachers can be made aware of the pivotal role played by the quality of their dialogic interactions with their students, as well as those occurring among peers. In addition, they can be encouraged to reflect on their own teaching practices, and how they can enrich them by incorporating effective dialogic styles of engagement. This can in turn endow them with a flexible, yet very powerful 'tool-kit', so they can use it in accordance with their specific socio-cultural context and needs, in the quest of fostering their students' learning, as well as their social, intellectual and psycholinguistic development.

Acknowledgments

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