Complementary Social Network and Dialogic Space Analyses: An E-discussion Case Study

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Abstract: The role of e-discussion and e-collaboration with peers in the context of problem solving has been widely discussed. Two strands of analysis, one focused on dialogic space of and key discussion events of widening and deepening, and one focused on social networking, were undertaken in a case study of a graphic, synchronous e-discussion. These approaches are shown to be complementary, as cross-analysis makes it possible to reveal interesting phenomena in the discussion and suggest directions for intervention.

Analysis of Dialogic Collaboration in Networked Environments

Socio-cultural theories of learning emphasize the construction of knowledge through social interaction. Such construction of knowledge takes place in learning situations in which students collaboratively solve a problem, combining and integrating their own perspectives, thinking and combining everyday experience with scientific thinking (Collins, Brown, & Newman, 1989). More than merely the construction of knowledge in the mind of the individual, it is a joint enculturation and meaning-making process embedded in the social context of activity (Cobb & Bowers, 1999). Adding another contextual dimension has to do with the use of information and communication technologies to support collaborative and co-operative connections between one learner and other learners, learners and tutors, and learners and resources (e.g., Dillenbourg, Schneider, Synteta, 2002).

Wegerif et al. (2008) focused on the thinking that occurs in the context of dialogues in networked environments of online collaborative learning, attempting to track the development of higher order thinking and learning skills within the 'dialogic space', the metaphorical arena within which dialogic discussions occur. The space of debate or dialogue (and by extension the group's thinking) can develop via deepening, i.e. delving into an issue and increasing the degree and depth of reflection focused on it, or broadening, i.e. widening the range of relevant perspectives and relevant knowledge brought into the dialogue.

Dialogues occur within networks and use the tools, resources and affordances of these environments. Wegerif et al. (2010) illustrated how specialized ICT tools using also an AI component can help to both deepen and broaden the dialogic spaces, for example via constructing and modifying a shared external representation of a dialogue using the Digalo tool also used in this study (see further below).

Determining points or events of deepening or broadening within an e-discussion involves an in-depth analysis of the discussion's flow and structure as well as the content of individual utterances. Other means of analyzing aspects of such discussions are available, stressing measures of participation and social interaction, making it easier to understand the contribution of each participant to the process. Theoretically, the optimal situation is that in which each of the discussants is an active participant in the discussion, whether his or her utterances lead to the development of a certain idea raised in the discussion (deepening) or is in conflict with another idea in the discussion (widening, in a sense) (McLoughlin & Luca, 2000). Researchers focus, for example, on measures of participation and interactivity such as the number of responses for each utterance, or the number of implicit or explicit links between utterances.

The leading approach to analyzing the social dimension of asynchronous e-discussions (e.g., those that take place in online forums) is that of Social Network Analysis (SNA), a key technique in modern sociology and anthropology. Using special algorithms, SNA produces schematic diagrams of the connections between individuals in a community, in which points or nodes may represent participants in an activity or discussion and the ties between them are represented by lines connecting the nodes. Measures of connectivity and other relational concepts are calculated based on data such as the distances between points in the diagram (the larger the distance, the weaker the connection). Two interesting measures in this context are closeness, i.e., the degree to which a participant is connected to other participants, and *betweenness*, the degree to which a participant connects between other people (e.g., Cho et al., 2007).

Context and Methods

The current study attempts to combine two strands of analysis, one focused on the dialogic space of group e-discussions and key events of widening and deepening, and one focused on the social network created between the participants within the activity. The presentation of the SN is based on the connectors which the participants made between each others' contribution. In our case we didn't differentiate between the green (supporting) connectors and the black (neutral) connectors. The two approaches we took are shown to be complementary, as

cross-analysis makes it possible to reveal interesting phenomena on the relations between dialogic engagement and the way that the participants "behave" as a group in a problem solving context. This is demonstrated via a case study of a graphic, synchronous e-discussion using the Digalo/Argunaut tool (http://www.argunaut.org/).

The E-Discussion Environment

Digalo is a tool that graphically supports e-discussion and e-argumentation, which are held within an object space called a "map", where users contribute to the discussion by adding shapes representing an argumentative ontology (e.g., a rectangle for claims) and typing their utterances onto them. Users may also link shapes to other shapes, using arrows of different types (support, opposition, reference), which may be modified or deleted. This tool has been widely used in various pedagogical R&D projects in Israel, Europe and South America.

The Participants and the Activity

As part of an R&D project entitled "Network of Modeling and Formal Representation in Mathematics", 18 Colombian engineering students (ages 18-20) took part in an hour-long Digalo-based mathematical problem-solving activity, in small groups of 5-6 students each (3 groups in total). The e-discussion of one of these groups (6 students with a teacher-moderator) was chosen for analysis as case studies, due to its richness.

The problem presented to the students was as follows: *A car is traveling in the maximum permitted speed of 82.8 Km/h. When the car is 65m away from the junction, the driver sees the traffic light turn from green to yellow. The driver needs to take a decision whether to continue or to stop the car. If he decides to continue he should make sure that he crosses the junction before the traffic light turns red; if he decides to stop, he should make sure that the car stops before the junction. Consider also that that the traffic light stays yellow for 3 seconds before it turns red. If the width of the junction is 15m, the average reaction time of a human being is 1 second. Assume that braking decelerates the car at 5m/s^2. What should the driver decide, and why?*

Analysis of the Discussion Map

The discussion map was analyzed in depth using a coding schema suggested by Wegerif et al. (2008) as well as through SNA measures based on previous work done by Cho et al. (2007) and de Laat et al. (2007). The coding schema of the dialogic space enables us to identify critical moments of the discussion whereas a critical moment is identified as a point where the discussion is either widening with open questions and disagreements, or deepening with cumulative perspectives on the same problem. Beyond the analysis of critical thinking focusing on claims, counterclaims and reasons, it labels each new perspective or point of view on a problem and focuses on the dimension of dialogic engagement, which includes not only addressivity and expressions of empathy but also expressions of doubt, changes of mind, ventriloquation (the presence of another voice within an utterance) and elicitation of the views of others. Students' style of participation was also followed by tracing individual dialogic utterances, its cumulative contributions to other utterances and its relevance to the learning outcomes of the group. The SNA measures used (e.g., betweenness and closeness that entail the geodesic distance of each actor in the net to all the others actors) give us an idea of the nature of interaction and relations within the group.

Findings

The e-discussion took about 50 minutes and included a total of 46 contributions. In the first 10 minutes, each of the six students participating in the discussion made discussion contributions that they classified as "suggestions" (e.g., "*the car should stop: if we use the equation of t=d*v it gives us more than the 3 seconds that we have for the traffic light to change from yellow to red*"), and later proceeded to connect their shapes to each other using only supporting (green) and neutral (black) connectors (connectors were also added by Mquinteroc, their teacher moderator, who did not otherwise participate in the discussion). As the discussion continued, three different threads of meaningful dialogic engagement developed (Fig. 1 below).

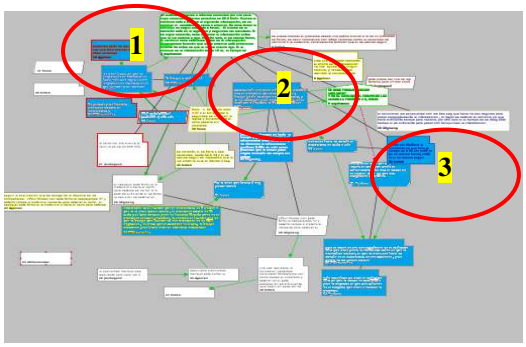

Figure 1: Discussion threads in the e-discussion map: the blue connected shapes pertain to a thread

The first thread (involving students Fmora, UCHernandez and Agalvan) discussed the calculation of speed and

distance, with a widening aspect from UChernandez in contribution #14 adding the aspect of acceleration and deceleration to the mix. This is a point of widening, yet it receives no further elaboration. The second thread (UCgrozog, Jbuitragoc2 and Fmora) is a deepening thread discussing speed, distance and issues related to mathematical representation of the problem. In the third thread (Fortizb, Agalvan, UChernandez, Fmora and Agalvan), also a widening thread, the participants discuss how to represent the problem and additional elements are added and discussed (e.g., the width of the junction). Table 1 below presents the two widening threads.

Table 1: Discussion threads #1 and #3 – the widening threads

Participant	Contrib.#	Contr. type	Content
Discussion thread #1		Suggestion	t=d/v =80m/23m/s=3.47 s. if we had 3 seconds it is breaking the rules [i.e., we would have to travel faster than permitted] but if we had 4 seconds the car could pass without any problem
Fmora	6		
UChernandez	14	Suggestion	it is possible but we also have to evaluate the acceleration and the deceleration of the car
Agalvan	18	Suggestion	We can start from here but we have to evaluate the other variables
Fmora	23	Formula	82.8 km/h*1000m*(1h/3600 s) =23 m/s
UChernanadez	33	Suggestion	the time=distance / velocity
Fmora	38	Formula	he has to stop, if we look at the equation t=v*d this will allow us 3 seconds for the yellow light to turn so he will not be able to cross
Discussion thread #3		Suggestion	Vo=83 km/h and Vf=83 km/h (the speed) is constant: 83 km/h all the time. The distance is x=65 m (if he decides to brake) and x=80 m if he decides to go on.
Fortizb	12		
Agalvan	19	Explanation	My friend, I think that we cannot add up the distance until the junction (65 m) with its width (15 m), because they are two lengths.
Uclhernandez	13	Suggestion	But the sum of the two lengths is the total distance that the car has to go before the lights change. We have to take into account the units' conversion, so that we can speak the same language.
Fmora	22	Explanation	We have to take into account the conversion of km/h to m/s
Agalvan	24	Suggestion	This sum would not be the total distance because the width is immaterial for the vehicle. What is important for us is the distance that the vehicle must go.

The SN analysis of the group discussions is represented in Fig. 2 and Table 2 below. Figure 2 demostrates the interrelations between the group members based on the connections made between the participants' contributions in the Digalo map. The bold lines represent strong connections between the participants. Here we can see the centrality of Fmora, UCgrozo and UChernandez. In Table 2 we present numerical data related to the participants' rates of participation in the network with respect to the number of contributions that each of them made, and the rate of "farness" and "closeness" of each actor to the central actor in the network. These measures also quantify the importance of an actor within a network, referring to the frequency with which a node appears on the geodesic (shortest path) that connects a pair of nodes. An actor who is in the geodesic path connecting two nodes of the network has an intermediary position within the group, a person through which everybody connects to the other participants in the net.

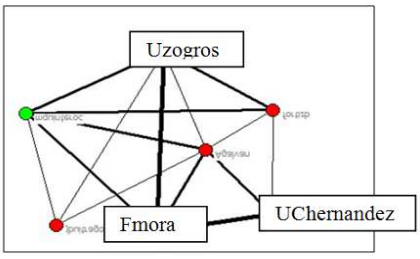

Figure 2. The social network diagram of the group

By looking at Table 2 we can identify the centrality of Agalvan in this network, with closeness of 100 and betweenness of 2.58, much more than the other participants. It is also worth noting that despite the low rate of betweenness (0.25) of UChernandez, he holds a central position in the network, as can be seen in Fig. 2. This phenomenon is interesting in light of these participants' dialogic engagement in the Digalo discussion (see Table 1). UChernandez's had an important contribution (#14) for widening the discussion in thread 1, which

apparently did not receive much attention or reactions from his fellows. It is possible that the other participants did not take him seriously because of his low betweenness position in the SN. Based on pure SNA measures, Agalvan does hold a central position, but his involvement in the dialogic space entailed mainly organizational or moderator-like moves ("*We can start from here but I see that we have to evaluate the other variables*" [cont. #18 thread 1]), which in some cases contained only poor advice to solve the problem posed (as in contribution #19, in thread 3, where he tells the group that "the width of the junction and the distance that the car has to go have two distinct units of measure" (?)).

Table 2. Measures of social network analysis

Participant	No. of connections	Farness	Closeness	Betweenness
Fmora	10	8	75	0.67
Agalvan	9	6	100	2.58
Mquinteroc (teacher)	9	7	85.7	0.92
Ucgrozo	9	7	85.7	0.92
Fortizb	6	8	75	0.67
UChernandez	6	9	66.7	0.25
Jbuitragoc2	3	9	66.7	0

Discussion

The findings in our research point toward some possible advantages embedded in the comparison between, or combination of the analysis of the dialogic space and SNA. One possible direction is the joint consideration of SN connectivity measures, on the one hand, and the participants' contribution to the discussion and to solving the problem, on the other hand. As for the former, it is possible that somebody like UCHernandez is found to be central in SNA, but quite unnoticed or ignored (even if his some of his contributions were valuable) in the dialogic space, in which most of his links (connectors) with the other participants were created by him and not by them. Participation may not be enough, indeed, even if it brings valuable content to the discussion, as long as the group does not take up the contributions seriously and assimilates them in deepening and widening threads. These elements, as they find expression both in the discussion and the associated SN, may be the result of the previous (pre-discussion) character of the group and the social interrelation of its members (Cho et al., 2007). Another phenomenon is that of Agalvan. He is not the teacher (which is Mquinteroc), but he adopted a teacher or mediator-like role. He is seen as central from an SNA viewpoint, with the highest betweenness measure. When observed in the dialogic space, he shows involvement in the major strands of the discussion, especially as one that gives advice and makes comments on how to advance. He does so, however, as a mediator between other participants, providing only few elements or ideas likely to contribute to the solution of the problem. Similar phenomena have been observed in SNA of (asynchronous) forums (De Laat et al., 2007). Our approach may lead to an improvement in the way interventions take place in e-discussions.

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