IRFI as a form of progressive discourse in knowledge building oriented classrooms

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Abstract

Knowledge building discourse differs from typical classroom discourse (IRE/F). In this short paper, we synthesize and build on a previous paper (Laferrière & Lamon, 2010) that examined how students and teachers used knowledge building principles and Knowledge Forum (Scardamalia & Bereiter, 2003) for understanding the problems of climate change. At a micro level of analysis, our research focuses on the kinds of questions students asked and their subsequent discourse/explanation. We use schemes developed by Hmelo–Silver and Barrows (2008), Chan (see Lee, Chan & van Aalst, 2006) and Hakkarainen (2003). Results show a level of explanation in student discourse that contrast sharply with the IRE classroom discourse structure (teacher initiated question – student response – teacher evaluation, (Cazden, 1988) and with the IRF structure (initiation – response – feedback; see Sinclair, & Coulthard, 1975; Wells, 1993). The emerging discourse pattern identified in this paper is called IRFI (initiation – response – feedback / further inquiry).

Background

Classroom discourse

The typical classroom discourse structure has three turns (Sinclair & Coulthard, 1975; Mehan, 1979; Cazden, 1988, 2001), and is composed of the following moves: teacher initiation (e.g. ask a question) (I), student response (R) and teacher feedback/comment (F) or evaluation (E) of the student's response (IRF/IRE). According to Wells (1993, 1999), the IRF structure accounts for as much as 70% of all classroom talk, and is typical of classroom discourse (Lemke; 1990; Wells 1999). The use of Flanders' (1970) framework for studying classroom interaction has led to another observation; one that stresses that the teacher speaks for 60-80% of the time. Teachers ask most questions, call on students to answer and allocate turns (Greenleaf & Freedman, 1993).

The community of learners model (Brown, 1994, 1997), and the knowledge building community model (Scardamalia, Bereiter, & Lamon, 1994; Scardamalia & Bereiter, 2003, 2007) have arisen as powerful models for organizing the learning environment in ways that are especially respectful of research advances in the learning sciences (Bransford, Brown, & Cocking, 1999; Chan, & van Aalst, 2008; Sawyer, 2005; Zhang, Scardamalia, Reeve, & Messina, 2009). Unlike Brown and Campione's learning communities approach, knowledge building communities make use of information and communication technology because it not only affords communication without restrictions of time and space, it also allows dialogue that can become more reflective, democratic, and collaborative.

Idea improvement is the central concept of Bereiter and Scardamalia's knowledge building epistemology (Scardamalia et al, 1994). Other variants include the notions of dialogue (Wegerif, 2007), exploratory talk (Mercer, 2000), accountable talk (Michaels, O'Connor, Hall, &

Resnick, 2002), and depth of understanding (Woodruff & Meyer, 1997). Ideally, ideas get out into the whole community in a form that allows all to create new artifacts, to identify problems of understanding, to gather and critique information from authoritative sources, to design experiments and to create theories, explanations, historical accounts, problem formulations, or solutions.

Online Discourse

Lossman and So (2008) identified a "tendency to a higher diversity of verbal interactions online as compared to the more didactic teacher-centered discourse used in the classroom." (p.1). Bordage (2007) found that written discourse was more conducive toward explanatory discourse than the verbal face-to-face context in which no collaborative technologies were used. Cazden (2001) alluded to computer-supported collaboration as leading to variations in the IRE/F (teacher initiation-student response-teacher evaluation/feedback) basic classroom discourse structure. Cazden recognizes (2001) that online discourse is more public, a characteristic often stressed by Bereiter and Scardamalia since 1994. Cazden (2001) and Scardamalia, Bereiter, Hewitt, & Webb (1996), stressed nontraditional discourse in which collaborative explanations are encouraged. The latter emphasizes the role of online collaborative spaces to this end, and especially Knowledge Forum (Scardamalia, 2002).

This short paper presents the emerging IRFI pattern (initiation – response – feedback / further inquiry) when a knowledge building pedagogy is applied. To what extent were these teachers successful in transforming the IRF/E basic classroom discourse structure? To this end, we first provide contextual and methodological background, especially on the presence of explanation as a key indicator of knowledge building. Second, the methodology for analyzing classrooms' online discourse is described. Third, the results of studies are presented. Fourth, the discussion highlights next research steps.

Methodology

The unit of analysis was set in reference to the IRE/F sequence as we focused on sequences with at least a third turn/move or more. Idea improvement indicates that questions asked (I) in relation to problems of understanding and student responses (R) presenting explanations (Hakkarainen, 2003; Lipponen, Rahikainen, & Hakkarainen, 2002; Woodruff & Meyer, 1997; Zhang, Scardamalia, Lamon, Messina, & Reeve, 2007) are central. "Explanation-seeking why and how questions are especially valuable for progressive inquiry, whereas fact-seeking questions not embedded in genuine inquiry tend to produce fragmented pieces of knowledge" (Hakkarainen, 2003, p. 1073). Zhang et al. (2007) refined the explanation framework

in ways that deepen the understanding of student responses (R). As for the "E" (teacher evaluation), one of the knowledge building principles extends its meaning to 1) students providing responses to one another, ones found to be lengthy at times, and, in some cases, explanation-oriented ones (see Lee, Chan, & van Aalst, 2006). For knowledge building discourse to unfold an inquiry process must be triggered: Chan & van Aalst (2008) referred to collaborative inquiry, and Hakkarainen (2003) to "progressive inquiry"; Zhang et al. (2007) suggested the "inquiry thread" as a new unit of analysis when tracing ideas across views. The collaborative inquiry process is to be a lengthy one, centered on idea improvement and not task-centered and encompassing problems of understanding for knowledge building to occur (Scardamalia & Bereiter, 2006).

Contrary to synchronous classroom discourse where either one person speaks at a time (I, R, F/E) or all students are expected to provide the same answer (R), the asynchronous online discourse allows for multiple and diversified responses (Rs). The online classroom discourse sequence conceptualized as IRFI is the following one: an initiation question (I), one that would spark responses (Rs) leading, in a number of instances, to further inquiry (FI). Laferrière and Lamon (2010) found evidence of this inquiry-oriented basic pattern in Knowledge Forum databases. In this paper, further evidence is sought.

Participants

The presence of the IRFI pattern in the online discourse of classrooms using Knowledge Forum as their main collaborative technology is analyzed in the 2008-2009 online discourse of classrooms from rural schools part of the Remote Networked School (RNS) initiative, sponsored by the Quebec Department of Education, Leasure and Sport (Canada). This enduring initiative (2002-2010) aims at enriching the learning environment of rural schools using advanced collaborative tools. Knowledge Forum is used for written discourse within and between schools and desktop videoconferencing for oral discourse. It is a multi-level innovation (classroom, school, school district, university-school partnership, ministry of education) in the context of a province-wide education reform informed by the new science of learning. Among other collaborative activities, teachers engaged students in online discourse on climate change mostly, but not exclusively, during science education classes. Some classrooms participated in the Knowledge Building International Project (KBIP), which also included classrooms from Barcelona, Hong Kong, and Mexico in 2008-2009. KBIP teachers were learning to inform their pedagogy using the knowledge building principles when engaging students in written discourse on Knowledge Forum.

We report on the discourse of the 12 KBIP teachers and 216 students from Quebec who had their classrooms collaborate using Knowledge Forum and desktop videoconferences. Two thirds of these teachers had limited professional development, through contact with colleagues and members of the research and intervention team, and experience (one year or two) with knowledge building. Some students were members of a multi-age classroom and may have had some previous experience with knowledge building. But most of the students were using Knowledge Forum and engaging in knowledge building for the first year. Our research team documented (2009) that it is at their third year of engagement in the RNS initiative that some teachers begin to devote a substantive amount of time (30 hours or more) to networked learning and knowledge building. Basic indicators that these classrooms engaged in discourse were the following ones : 43 views (see illustrations, figures 1 and 2) were developed by students and 1385 notes were written in the 136 inquiry sequences analyzed. 48% of all sequences had three turns or more, and they are the data source for this study. 25% of all sequences qualified as idea improvement sequences because they were found to contain notes that 1) improve the preceding note(s), 2) challenge the preceding note(s), and 3) move forward the questioning/explaining process (Hamel, 2007; Laferrière, Allaire, Breuleux, Hamel, Turcotte, Gaudreault-Perron, Inchauspé, & Beaudoin, 2008).

Data analysis

To observe the presence of the IRFI pattern we focus on questions and explanations. For the analysis of questions asked, we use Hmelo-Silver and Barrows' (2008) grid, one developed for the study of groups engaged in collaborative problem-based learning[1]. Their grid distinguishes between questions that are task-oriented/meta level questions (group dynamics, monitoring, self-directed learning, need clarification, request/directive), short-answer questions (verification, disjunctive, concept completion, feature specification, and quantification), and long-answer questions (definition, example, comparison, interpretation, causal antecedent, causal consequence, enablement, expectation, and judgmental). Questions asked by teachers or students are distinguished. For the analysis of explanations, we used a classification system that combined Chan's (see Lee, Chan & van Aalst, 2006), and Hakkarainen's (2003) schemes. The categories are defined hereafter.

[1] Scardamalia and Bereiter (2006) distinguish knowledge building from problem solving in that knowledge building focuses on complex generalizable problems and problem based learning is context specific. However, Hmelo-Silver and Barrow's grid is applied to the resolution of complex problems, and was thought to be suitable for the task-at-hand.

	Categories
1	To give one's opinion without providing facts, evidence or elaboration. To repeat an already mentioned fact. To mention or enumerate facts.
2	To word and describe factual information (general descriptions), using the copy-and-paste function. To organize facts very briefly (descriptive terms), without making deep links to the question. To make use of examples and connectors.
3	To make inferences supported by facts. To partially explain (limited explanations or partially articulated constructions) beyond the simple description or information. The answer may be relevant or not to the question under study.
4	To make claims supported by explanations, evidence, and/or relevant examples. The structure is clear, articulated, based on an intuitive explanation or a scientific explanation is introduced.
5	To synthesize and/or refocus the discussion, highlighting key concepts and bringing other aspects of the discussion to light.

Results

An ongoing questioning process

A total of 136 questions were identified, and classified (Table 1). Task-oriented or meta-level questions were 8%. Questions calling for short answers were 25%. Almost three questions out of four were ones likely to generate long answers (71%). Compared to 2007-2008 data, students asked much less questions regarding the task itself, more short-answer questions, and less long-answer questions. Long-answer questions for both years was in the 71-73% range.

Table 1
Types of teachers' and students' question moves

	Task-oriented/ meta questions	Short-answer questions	Long-answer questions
Total 2008-2009 136 questions Teachers: 78 Students: 58	(5) 4% Teachers' questions: 2 Students' questions: 3	(35) 25% Teachers' questions: 11 Students' questions: 24	(96) 71% Teachers' questions: 65 Students' questions: 31
Total 2007-2008 209 questions Teachers: 95 Students: 114	(43) 21% Teachers' questions: 9 Students' questions: 34	(13) 6% Teachers' questions: 5 Students' questions: 8	(153) 73% Teachers' questions: 81 Students' questions: 72
Students	e.g., Self-directed learning e.g., Need clarification	e.g., Verification e.g., Disjunctive	e.g., Example e.g., Interpretation e.g., Causal consequence
Teachers	e.g., Request/directive	e.g., Concept completion	e.g., Definition e.g., Comparison

Table 2 shows that 86% (n=117) of all 136 questions were asked during the first turn (I). These questions were asked three times out of four (75%, n=87) by teachers (2007-2008: 79%) but they could have been the result of a classroom process of question identification, the teacher writing the question for a matter of convenience. Three questions out of four (75%) were long-answer questions, compared to 97% in 2007-2008.

Table 2
Teachers' and students' questions as initiation (I) moves

	Task-oriented/ meta questions	Short-answer questions	Long-answer questions
First-turn questions (I) 117	0 (0%)	30 (25%)	87 (75%)
Teachers 87 (75%)	0 (0%)	9 (8%)	63 (54%)
Student(s) 30 (25%)	0 (0%)	21 (17%)	24 (21%)

Only 3% (n=4) of second turn/moves (R) were questions (Table 3). Long-answer questions comprised 100%, compared to 65% in 2007-2008. Students asked the majority of the long-answer questions but the latter were few (n=4).

Table 3
Teachers' and students' questions as response (R) moves

	Task-oriented/ meta questions	Short-answer questions	Long-answer questions
Second-turn questions (R) 4	0	0	4 (100%)
Teachers 1 (25%)	0	0	1 (25%)
Student(s) 3 (75%)	0	0	3 (75%)

In the third move and beyond (FI), students and teachers also asked questions (Table 4). Students asked two-thirds of them (n= 10) of the questions, that is, almost the same percentage than in 2007-2008 (68%), and 20% of their questions were task-oriented or meta-level ones. They also asked short-answer and long-answer questions (20% and 27%; 2007-2008: 1% and 42%).

Table 4
Teachers' and students' questions as third move and beyond

	Task-oriented/ meta questions	Short-answer questions	Long-answer questions
Third-move and beyond questions (FI) 15	5 (33%)	5 (33%)	5 (33%)
Teachers 5 (33%)	2 (13%)	2 (13%)	1 (7%)
Student(s) 10 (67%)	3 (20%)	3 (20%)	4 (27%)

Figure 1 represents the distribution of questions (2007-2008 and 2008-2009) during the online classroom discourse. Teachers were active in the first move; but recall that in some cases they wrote a question following a discussion with their students regarding a question that might be of interest to inquire into. Moreover, we examined the moves (I, R, FI) variable 1 in relation to the types of questions, variable 2. Students' types of questions (task-oriented/meta, long-answer and short-answer questions) across moves revealed a significant difference (chi square = 38.468, d.f. = 4, p = 0.000); the same regarding teachers' types of questions (chi square = 33.298, d.f. = 4, p = 0.000).[2] The space taken by students in the classroom discourse after the teachers' initial moves is less substantial in 2008-2009 than it was in 2007-2008.

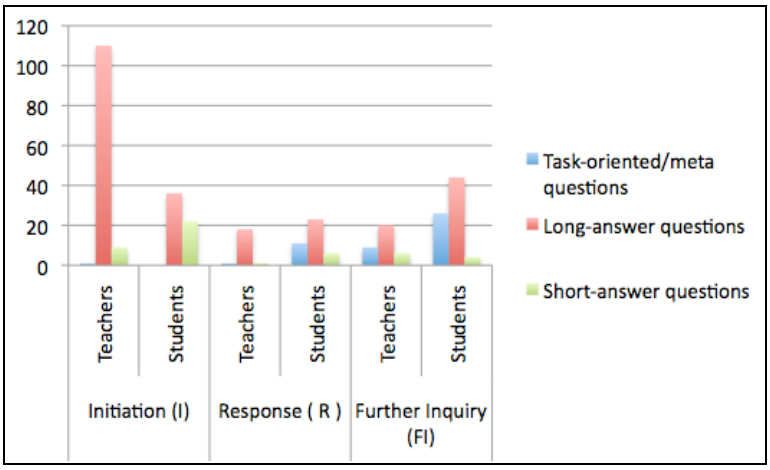

Figure 1. **Distribution of questions during online classroom discourse**

[2] Moreover, Cramer's Vs are respectively .334 (at 0.000) for students and .310 for teachers. This is an associative measure, which is to be interpreted as a correlation, 1 being indicative of a perfect relation and 0 as indicative of no relationship. Here, the relation between moves and types of questions is between weak and moderate.

Figure 2 shows where question-oriented action was concentrated: Long-answer questions dominated, and students took charge of progressive inquiry as they asked more further inquiry questions than teachers.

Figure 2. **A dynamic representation of teachers' and students' distribution of questions**

The above results are quantitative indications that the classroom discourse might be departing from the basic IRF/E structure. We now provide an illustration of one of these sequences that were analyzed: First, the teacher wrote the question, and then students wrote notes. They were encouraged to use the scaffolds provided in Knowledge Forum.

Starting Question 2: *Air:* Do we need air? Why? What for? (Let's put our knowledge together)

2.5 *We need air because…* : It's obvious that we need it. Furthermore, I answered this in the starting question 1. In short… We need air because our lungs feed themselves with it, and lungs are the second most important organ along with the heart that allows us to live. Air is also very, very important for animals and the Earth. All these are answers (My theory)

2.5.1 *Air….*: But we must not stay long with air because it can also kill us. (My theory)

2.5.1.1 *Understanding:* If you haven't understood, maybe our body does feed itself, but it also fights because there are killing germs in the air, so that's why we mustn't keep it too long. (My theory)

2.9 *Transportation:* We also need air for transportation, example, for airplanes, hang-gliders, hot air balloons, etc. (My theory)

2.9.1 *Not strong:* Air is too soft for you to fly in the air; it's rather the wind that is stronger. (My theory)

2.9.1.1 *We cannot:* We can't fly Penelope, unless it is really, but really strong. (My theory)

2.9.1.2 *He wanted to say in some way… :* What he wanted to say was that air allows us to move around, and can we say, to have fun. We can live with air, but we can also have fun! =) (he wanted to say in some way)

2.9.1.2.1 The wind: I said wind and air; we can only fly with the wind (My theory).

Overall, questioning was an ongoing distributed process rather than first-turn questions as in the IRF/E structure: Both teachers and students asked questions but questions differed in their potential to induce explanations. Explanation was distributed among students. They primarily used the scaffold "My theory", and the above illustration is an example of that.

An emerging explanatory process

Questions asked at one move or another led to a variety of ideas. Progressive discourse of an explanatory nature was likely to begin by a note presenting a student's initial understanding. Relevant explanations stressed specific problems and their causes. Figure 3 is an estimate of the

level of explanation, using Chan's scheme, observed in the sequences according to students' responses. It is clear that the explanations remained in the early stages. Nonetheless, they existed and reflected students responding to students during online classroom discourse.

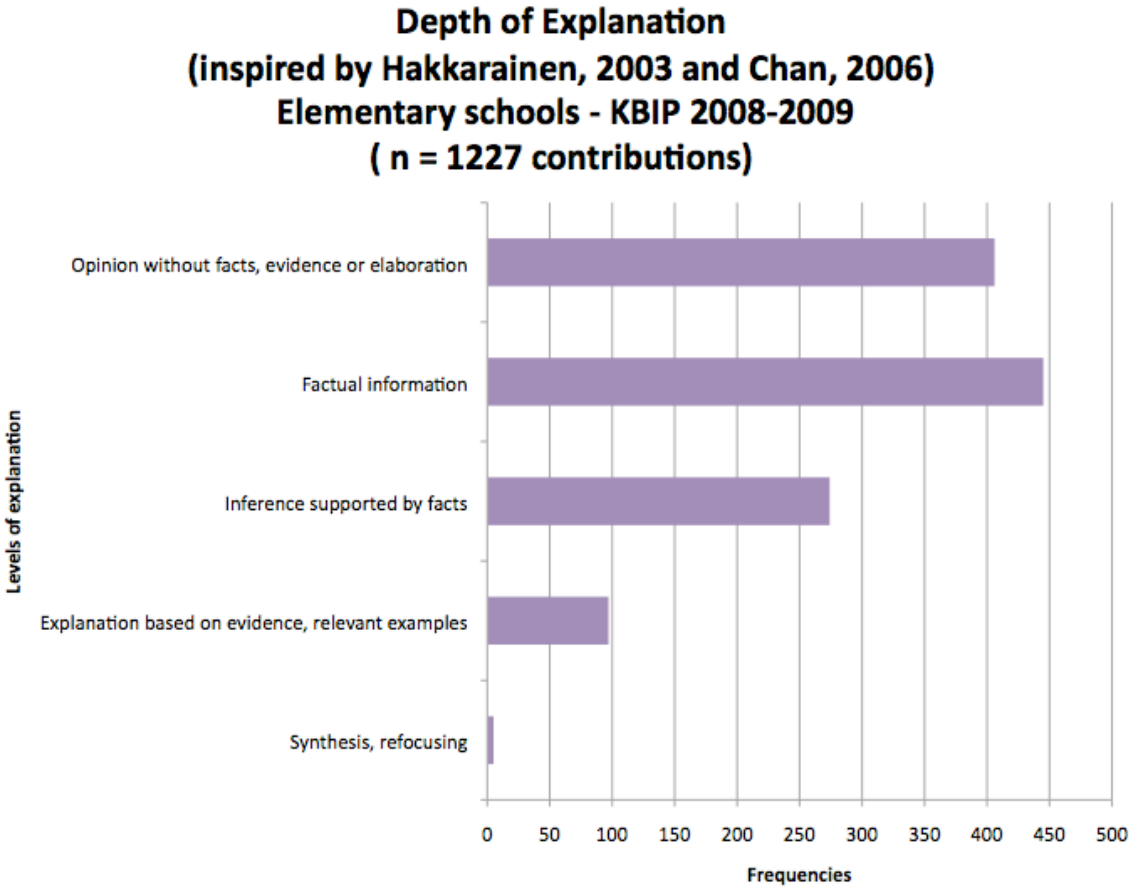

Figure 3. *Estimate of the level of explanation observed in the sequences*

These results are instructive to teachers who want students to provide more complete explanations. To this end, we looked at the types of explanations in relation to discourse moves.

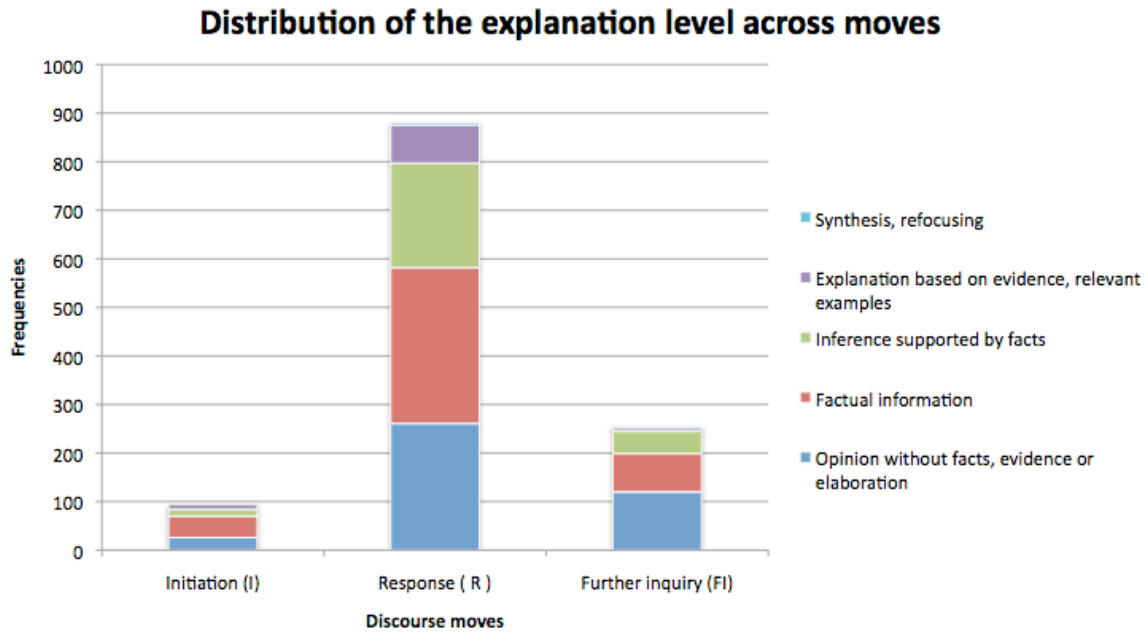

Figure 4. *Distribution of the explanation levels across discourse moves*

The level of explanation varies significantly (chi square = 47.399, d.f. = 8, p = 0.000; Cramer's V is .137) across discourse moves. Given this result and looking at Figure 4, one may interpret that as discourse moves on, factual information and inference supported by facts replace opinion without facts. Explanation, often present in second move, keeps occurring in the third move and beyond. As shown in Figure 5, discourse progression is primarily the result of long-answer questions.

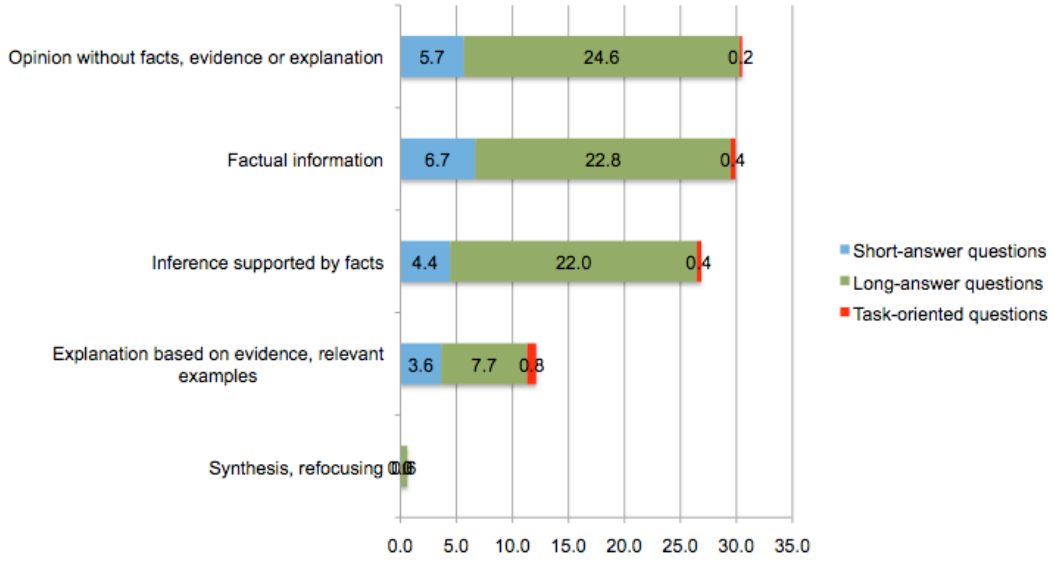

Figure 5. *Depth of explanation in students' contributions related to questions asked*

Depth of explanation vary according to the type of question asked (chi square=16.294, d.f. = 8, p = 0.038). Cramer's V is .181), thus meaning that the relation is rather weak.

Discussion, pedagogical implications, and future steps

Teachers were the ones who wrote up the first question regarding climate change, with or without preliminary discussion with students. We recall here that students who engage in collaborative inquiry are from different classrooms, thus teachers need to coordinate with one another and that have an influence of them taking the initiation move. They often identify an umbrella theme or question, leaving to students the definition of more specific questions.

Contrary to the basic IRE/F classroom discourse structure identified in the late seventies, questions kept being asked throughout discourse sequences, and students asked further inquiry questions in their third move and beyond. This is substantive evidence that what Cazden's saw as the potential of technology is being actualized (2001): classroom online discourse using Knowledge Forum, inspired by a knowledge building pedagogy, modifies the basic discourse structure of the classroom.

Students often used the scaffold "My theory". We need to inquire into the level of explanation that might evolve over time as students keep using this scaffold, thus making their theory evolve. If so, the concern then turns to the collective effort and the use of another scaffold to illustrate that very process.

IRFI is therefore suggested as the structure of progressive online discourse provided it is guided by a pedagogy that emphasizes authentic questioning and values collaborative inquiry within and between classrooms with the support of a powerful electronic forum (e.g., Knowledge Forum).

Some of the students' short-answer questions followed teachers long-answer questions. It was as if teachers' questions prompted students to ask specific questions. We do not know yet how the combination of long-answer and short-answer questions can be articulated for progressive online discourse. More investigation is needed regarding questions most likely to engage students in an inquiry process. Our analysis benefited from the works of Hamel (2007), Hakkarainen (2003), Lee et al. (2006) and Zhang et al. (2007) but more needs to be known regarding the nature of online questions (e.g., levels of structuring and abstraction).

We argue that not all online collaborative spaces afford progressive discourse. For instance, Knowledge Forum has affordances to this end: it has built-in scaffolds, which can be modified by the teacher in the pursuit of specific goals regarding students' online work and chosen by students (metacognitive acts) as a way to identify the nature of their contribution. Another research step for better informing teachers would be to analyze the scaffolds used by students across discourse moves, and especially in relation to questions asked and to the level of explanation.

Online discourse in which further inquiry (FI) is observed is recommended by the new science of learning. For the past decade, the learning sciences have been presenting research results that are rich in new conceptual tools to the professional community of educators. These results go beyond what was learned reading Dewey, Piaget and Vygotsky, although all three would be delighted with how we have built on their work.

One advance is a knowledge building community. Students construct their knowledge when they are learning from books or through inquiry. Here, we want to point out some important differences between learning and knowledge building. Because education and society in general is struggling to cope with the demands of the new economy, there is some interest in restructuring school activities and classroom discourse so that they resemble the workings of high-performing research groups—where a team is investigating real questions and members are trying to contribute to progress on those questions. This is knowledge building. Learning occurs in all activities directed toward gaining personal knowledge; knowledge building is activity directed toward constructing new knowledge for a community through theory construction and revision. Explicitly formulating "my theory" makes possible comparisons to other theories, tried out on relevant problems, subjected to criticism and continuous idea improvement.

What is particularly distinctive about a knowledge building community is the use of the twelve KB principles informing pedagogy, and using collaborative technologies. Online discourse in Knowledge Forum became integral in classrooms' progressive inquiry. Providing students with a cumulative database, as well as a means of recording information and ideas, is pivotal. It acts as a tool for making thinking explicit, encouraging creative thinking – the making of inspired hypotheses, the articulation of probing questions, the blending of others' findings with one's own, and the intensive attempt to solve authentic problems.

Project-based learning has been the way that teachers have integrated the computer and the Internet in their classrooms when applying a more active and collaboratively-oriented

pedagogy (see Kozma, 2003). It might be helpful to distinguish knowledge building from project learning; the essential difference is that students' work is not driven by the idea of creating a product. For instance, in Caswell & Lamon (1999) although students did create a video documentary, the idea of sharing what they knew with the rest of the school emerged from their work; it was not the starting point.

Moreover, knowledge building engages student in accountable talk (Michaels, O'Connor, Hall, & Resnick, 2002). Accountable talk encompasses three broad dimensions: one, accountability to the learning community, in which participants listen to and build their contributions in response to those of others; two, accountability to accepted standards of reasoning, talk that emphasizes logical connections and the drawing of reasonable conclusions; and, three, accountability to knowledge, talk that is based explicitly on facts, written texts, or other public information. These kinds of accountable talk share similarities with knowledge building principles: the first, accountability to the community, is akin to collective cognitive responsibility: team members produce ideas of value to others and share responsibility for the overall advancement of knowledge in the community; the second kind of accountable talk is like knowledge building discourse in that the knowledge itself is refined and transformed through the discursive practices of the community; and the third is akin to constructive use of authoritative sources: To know a discipline is to be in touch with the present state and growing edge of knowledge in the field. Taken together, research from the last 30 years (Cazden 1988), to research on the effects of accountable talk (Wolf, Crosson, & Resnick, 2006) and knowledge building along with research from the learning sciences (Graesser, Gernsbacher, & Goldman, 2003) as well as the present results are persuasive in arguing for a more collaborative classroom discourse aimed at progressive inquiry.

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