The Role of Argumentation in Online Knowledge Building Activities

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Abstract: This paper attempts to study the relationship of argumentation and knowledge building at a discourse level. Its basic research question is whether discourse more indicative of argumentation also indicates characteristics of knowledge building. A total of two databases of online discourse generated by sixth-grade and tenth-grade students were analyzed to see whether the findings can be generalized. It was found that when students put forward arguments, more of their discourse was of higher quality from the perspective of knowledge building. The pattern was consistently found for the two grades of students, even though they produced different amount of arguments in their discourse. Besides, their discussion threads were more sustained with the appearance of opposite ideas.

Keywords: Argumentation, knowledge building, CSCL

Introduction

Both knowledge building and argumentation are important sub-fields in computer supported collaborative learning (CSCL) (Andriessen, Baker, & Suthers, 2003; Koschmann, 2003), yet not much research was conducted to examine their relationship. This study attempts to relate them at a discourse level, to see whether argumentation is a kind of productive discourse indicating knowledge building. In the literature on knowledge building, the most popular analytic method is to look at types of questions and levels of explanation (e.g., Hakkarainen, 1998; Lee, Chan, & van Aalst, 2006). More recently, an "inquiry thread", which is a series of notes addressing the same research problem, is used to analyze collective knowledge advancement (Zhang et al., 2007); however, the major analytic method is to look at the generation of subordinate question. This paper attempts to explore whether argumentation can play any role in online knowledge building activities.

1. Literature Review

1.1 Knowledge Building

According to Scardamalia & Bereiter (2006), knowledge building is the process through which knowledge advances in human societies, and that learning can take place in the process. Its pedagogy emphasizes students' collective responsibility for the advancement of community knowledge and the improvement of ideas. With the emergence of the knowledge society, Bereiter (2002) argued that school education should focus more on knowledge building, in which learning is necessitated by the process and integral to it.

1.1.1 The Online Platform

In traditional classrooms in which interaction is mainly face-to-face, knowledge building is difficult to be implemented as ideas generated by students are not easy recorded for further improvement. Thus its pedagogy is fully integrated with an asynchronous online platform, the Knowledge Forum® (KF), creating a shared network space so that students can make their ideas explicit and share with others with a goal to advance the knowledge of the collective. Students can write new notes, read other's notes and respond by writing build-on notes. Students can visualize their interactions with one another as notes and their build-on notes are linked.

1.1.2 Indicators of Knowledge Building

Knowledge building emphasizes students' generating their own questions in the process of inquiry. The differentiation of fact- and explanation-oriented questions has been used in a number of studies for assessing knowledge building, in which the latter indicating a more advanced level (Hakkarainen, 1998; Lee et al., 2006). Hakkarainen (1998) classified the knowledge ideas generated to address those questions in terms of five levels of explanation, in the sequence of sophistication: 1) isolated facts; 2) partially organized facts; 3) well-organized facts; 4) partial explanation; and 5) explanation.

A similar differentiation can be found in the Structural Observed Learning Outcome (SOLO) taxonomy, which was developed to measure students' learning outcome both quantitatively and qualitatively (Biggs & Collis, 1982). To apply the taxonomy, a learning task is identified and students' approach to the task is assessed. At the lowest "*prestructural*" level the task is not approached appropriately, students may not understand the task at hand. At the second "*unistructuural*" level one aspect of the task is picked up, while at the third "*multistructural*" level several aspects are picked up, which represents an increase in quantity; while transitions beyond represent a change in quality. At the fourth "*relational*" level several aspects are picked up and integrated into a coherent whole. At the highest "*extended abstract*" level, the coherent whole is generalized to a higher level of abstraction. The transition from *multistructural* to *relational* is similar to that from fact to explanation. The taxonomy further differentiates a high level category of *extended abstract*, which is in line with knowledge building which emphasizes students' theory-building efforts. In this study, the SOLO taxonomy is used as an indicator of knowledge building.

Besides looking at individual notes, more recently, Zhang et al. (2007) proposed for the identification of "inquiry thread", which is a series of notes addressing the same research problem, for analyzing the collective knowledge advancement of students. In Zhang et al. (2007)'s study, an inquiry threads is divided into three time-stages for examining whether there is improvement in ideas as reflected by the change in levels of scientificness of the discussion content. There is also attempt to capture the knowledge advancement by tracing the series of questions generated (Zhang et al., 2007).

In a recent paper, Scardamalia & Bereiter (2006) wrote that knowledge building discourse has a set of commitments: to progress, to seek common understanding, and to expand the base of accepted facts, which distinguish it from other forms of discourse including argumentation and debate that emphasize evidence and persuasion as currently practiced in schools. Such incompatibility may be due to the diverse theoretical and pedagogical implications associated with the word, "argumentation". There are researchers focused on aspects of persuasion and winning-the-debate, which may not be compatible with the goal of knowledge building, yet there are those focused on collaborative and transformational aspects of argumentation (e.g., Leitao, 2000), which can offer valuable insights to theories of knowledge building.

1.2 Discourse of Argumentation

As a form of discourse, argumentation can be conceptualized by its two basic operations: 1) justification of one's viewpoints and 2) recognition of opposing viewpoints (Leitao, 2000). In the first operation, an argument is used to justify a claim, and the analysis can be based on the structure of argument (Toulmin, 1958). In the second operation, the focus is on the process of argumentation, which can be captured by some interactive frameworks.

1.2.1 Toulmin (1958)'s Model of Argument

In the contemporary analysis of argumentation, the most cited work is Toulmin (1958)'s model of argument. Before the model was put forward, the study of argumentation was mainly in the field of logic. Central in his model is that an argument is constituted of a claim, the data supporting the claim, and the warrant linking them. It provides a structural framework for analyzing arguments in everyday language, but it has been criticized as covering only one side but not both sides of argumentation (Van Eemeren & Grootendorst , 1999). For argumentation to be useful in education, it has to be more dynamic, dialogic, and collaborative (Driver et al., 2000).

1.2.2 Pragma-Dialectics

A more interactive model of argumentation is pragma-dialectics proposed by Van Eemeren & Grootendorst (1999), analyzing how people with different opinions resolve their difference. The model employs speech acts (Searle, 1979) in the analysis to avoid using strategies of classical dialectics such as attack and strategical concession which target at defeating the opponent in a debate. In more recent work on argumentation, utterances are classified in terms of their communicative functions, as reviewed in the next section.

1.2.3 Communicative Function of Utterance & Elaboration of Knowledge

Van Boxtel et al. (2000) employed a two-level analysis to examine the argumentative discourse of students working on collaborative learning tasks. First of all, based on its communicative functions, an utterance was classified as: "Statement" (providing information), "Argument" (Continuation, Reason, Condition, Consequent, Disjunctive & Counter), "Evaluation" (personal opinion or judgment), "Questions" (Disjunctive, Verification own, Verification other, & Open), and "Responsive" (Confirmation, Acceptance, & Non-confirmation). Then a series of related utterances (an episode) was used to analyze the elaboration of knowledge; three types of episode were differentiated: 1) "question episode", containing mainly questions and their answers; 2) "conflict episode", identified by the appearance of non-confirmation and counter-arguments; and 3) "reasoning episode", containing definitions, observations and hypotheses related to domain concepts. The identification of episodes is in fact similar to that of inquiry threads, but the framework takes into account whether opposite ideas can be found.

1.3 Research Question

The purpose of this study is to see whether argumentation can be a kind of productive discourse indicating knowledge building. Its basic research question is whether discourse more indicative of argumentation also indicate characteristics of knowledge building.

2. Method

2.1 Data

The data analyzed in this study were part of the "Learning Community Project" (LCP), which was launched to promote knowledge building and support its implementation in secondary and primary schools in Hong Kong. In previous literature on knowledge building, participants were usually primary students (e.g., Hakkarainn, 1998; Zhang et al., 2007). To see if the findings can be generalized, a total of two databases, one primary and one secondary, were analyzed. The first database composed of 44 sixth-grade students in a primary school; they formed seven groups to inquire on topics of global warming, energy crisis, and species extinction. The second database composed of 41 tenth-grade students in a secondary school; they formed six groups inquiring on topics of water quality, plastics, and ideal vehicle. The analysis was based on their discussion notes generated on KF.

2.2 Note-Level Analysis

A discussion note was classified according to its communicative function. An "Argument" is defined as "a claim supported with reason(s)", which is based on the justification function of argument (e.g., Leitao, 2000). The definition suggests there is another category of "a claim without reasons", which is termed, "Statement". There were notes aiming at providing information but not for supporting claims, they were categorized as "Information". Finally, the category of "Question" was differentiated. Thus the four categories of communicative function of notes are: Argument, Statement, Information, and Question. Examples of these categories were as shown in the following table.

Table 1. Examples of the Four Basic Communicative Functions

Argument	Ground heat energy is not too useful because it isn't safe and the machines are hard to build. The cost and risk is very high.
Statement	I agree.
Information	UV (Ultra Violet) is a light wave which has more energy than the visible light. Its wave length is shorter so that every time it contains more energy. This energy can change the nature of the bacteria so the bacteria dies.
Question	What is the chemical substance in fossil fuel?

Notes in non-question categories were further classified by the SOLO taxonomy (Biggs & Collis, 1982): *unistructural*, *multistructural*, *relational*, and *extended abstract*; with the former two representing lower quality from the perspective of knowledge building while the latter two representing higher quality. Presented in table 2 are examples of each SOLO category. Some of them had already been classified in terms of communicative function. In the example of *extended abstract*, a principle that if something is used by more people, it will become cheaper, was articulated to support the use of wind energy.

Table 2. Examples of the Four SOLO Categories

Unistructural	I agree.
Multistructural	Ground heat energy is not too useful because it isn't safe and the machines are hard to build. The cost and risk is very high.
Relational	UV (Ultra Violet) is a light wave which has more energy than the visible light. Its wave length is shorter so that every time it contains more energy. This energy can change the nature of the bacteria so the bacteria dies.
Extended Abstract	I think that the price for the wind energy is expensive, but there are more people using it for the future, it will be more common and cheaper.

2.3 Thread-Level Analysis

To assess the improvement of ideas, a series of notes addressing the same research problem was identified as an inquiry thread (Zhang et al., 2007). Then based on whether opposite ides were found, a thread was classified as argumentative and non-argumentative. Following the procedures of Zhang et al. (2007), threads with ten notes or more were selected and then divided into three time-stages, for examining whether changes in quality of discussion as indicated by SOLO categories can be observed in the two types of thread.

3. Results

3.1 Communicative Functions of Note

A total of 558 and 643 notes were generated by the sixth-grade and tenth-grade students respectively. About half (49.9%) of the sixth-graders' notes were classified as Argument, about one fifth as Information (21.1%) and Question (20.6%), and the remaining 8.3% were Statement. For the tenth-graders, a lower proportion of notes were classified as Argument (26.1%), about one third as Information (33.9%) and Question (32.1%), and the remaining 7.8% were Statement. Thus compared to the sixth-graders, the tenth-graders generated more Information and Question, and fewer Arguments.

3.2 SOLO Categories among Argument, Statement, & Information

Tables 3 to 5 represent the distribution of SOLO categories within categories of Argument, Statement, and Information respectively. As shown in table 3, although the total number of arguments produced by the tenth-graders (188) was fewer than the sixth-graders (300), the percentage distribution of SOLO categories within each of the two grades was similar. About 40% of the arguments were *unistructural*, 20% *multistructural*, and about 40% were *relational* or *extended abstract*. As *relational* and *extended abstract* represent notes of higher quality, it could be said that 40% of the arguments putting forward by students were of high quality, and the pattern was consistent found for both grades of students.

Table 3. SOLO Taxonomy Categories Among “Arguments”

Grade		**SOLO Categories Among Arguments**	**Total**

Grade		SOLO Categories Among Arguments				Total
		Uni-structural	Multi-structural	Relational	Extended Abstract	
Sixth	Number	122	61	95	22	300
	%	40.7	20.3	31.7	7.3	100
Tenth	Number	75	36	65	12	188
	%	39.9	19.1	34.6	6.4	100

For the distribution among "Statement", one thing can be noted in table 4 is that there were only two SOLO categories (*unistructural* and *multistructural*), as none of the statements were classified as *relational* or *extended abstract*. About 90% of statements were *unistructural* and the remaining 10% were *multistructural*.

Table 4. SOLO Taxonomy Categories Among "Statements"

Grade		SOLO Categories Among Statements		Total
		Uni-structural	Multi-structural	
Sixth	Number	45	5	50
	%	90	10	100
Tenth	Number	53	3	56
	%	92.5	7.5	100

Similarly, none of the notes classified as "Information" belonged to the category of *extended abstract*, as shown in table 5. Although the tenth-graders wrote more information-notes (244) than the sixth-graders (127), the percentage distribution of SOLO categories of the two grades was comparable. Roughly speaking, the proportions of *unistructura*l, *mulitistructural*, and *relational* categories were 60%, 20%, and 20% respectively. Thus by comparing the categorization results, it seems that when students put forward arguments, more of their notes will be of higher quality compared to notes providing information.

Table 5. SOLO Taxonomy Categories Among "Information"

Grade		SOLO Categories Among Information			Total
		Uni-structural	Multi-structural	Relational	
Sixth	Number	79	22	26	127
	%	62.2	17.3	20.5	100
Tenth	Number	134	51	59	244
	%	54.9	20.9	24.2	100

3.3 Length of Thread and Changes in Quality of Discussion

A total of 51 and 61 inquiry threads were identified for the sixth-grade and tenth-grade students respectively. 19 (37.3%) of the former and 27 (44.3%) of the latter were

non-argumentative, that is, no opposite ideas were found in the thread. As shown in table 6, argumentative threads were significant longer than non-argumentative ones on average for both sixth ($F(1,49)=25.5$, $p<.001$) and tenth-grade students ($F(1,59)=29.6$, $p<.001$). Further analysis suggests that the difference in length was mainly due to the increase in arguments in argumentative threads for both grades; no significant difference was found for the number of statements and information between the two types of thread.

Table 6. Length of Thread and Quality Across Three Stages for Long Threads

Grade	Types of Thread	Number	Length	Stage 1	Stage 2	Stage 3
Sixth	Non-Argumentative	19	5.84	1.33	1.38	1.17
	Argumentative	32	13.97	1.89	1.89	1.94
Tenth	Non-Argumentative	27	6.37	1.57	1.65	1.36
	Argumentative	34	13.65	1.67	1.77	1.97

Following Zhang et al. (2007)'s procedures, threads with ten notes or more were selected and then divided into roughly three stages. Based on the scoring method of "1" for *unistructural*, "2" for *mulitistructural*, "3" for *relational*, and "4" for *extended abstract*, the quality in each stage was calculated by averaging the scores of notes in a thread. However, only two and five non-argumentative threads of the sixth and tenth-graders respectively were with ten notes or more. While a total of 21 and 18 argumentative threads of the sixth and tenth-graders respectively satisfied this criterion. As can be seen in table 6, no improvement in quality was observed for non-argumentative threads for both grades, and in fact there seemed to be a slightly decrease at stage 3. A slight but not significant improvement was observed for argumentative episodes of the tenth-grade students.

4. Discussion

In previous literature on argumentation, there are studies analyzing what counts as good argument (e.g., Means & Voss, 1996), and it is articulated that quality of argument is field-dependent (Toulmin, 1958). In this study, quality was measured by an indicator of knowledge building. Unlike previous studies in which good and bad arguments are differentiated (e.g., Means & Voss, 1996), this study compared argument-notes to notes with other communicative functions, finding that when students put forward arguments, more of their notes will be of higher quality compared to the generation of information and statement. The pattern was consistently found for both grades of students, even though the sixth-graders produced more arguments and fewer information than the tenth-graders. Besides, the category of highest quality, *extended abstract*, only appears in arguments.

Another important characteristic of argumentative discourse is the presence of opposite ideas. In the analysis based on inquiry thread, in which a series of notes was taken into consideration, it was found that non-argumentative threads were usually short, only a few were with more than ten notes; while with the appearance of opposite ideas, longer threads were found. As knowledge building emphasizes the continuous improvement of ideas, it is important for students to engage in sustained inquiry. The results suggest that without a difference in ideas, it is difficult for an inquiry to be sustained, as reflected by the short thread length. However, in the analysis of the changes in quality of discussion, only a slight but not significant improvement was found in

argumentative episodes. In the literature on argumentation, there are further differentiation of types of argumentation based on the appearance of reasons and rebuttals, which are challenges posed directly to previous arguments (Erduran, Simon, & Osborne, 2004). Further research is needed to examine the effect of different types of argumentation on the sustainability of inquiry, and whether there are different patterns of knowledge advancement in argumentative and non-argumentative threads.

A starting point of this study is a concern of whether argumentation is compatible to knowledge building which emphasizes on shared understanding (Scardamalia & Bereiter, 2006). The empirical finding suggests that at a discourse level, argumentation is constructive to knowledge building. It should be noted that students in this study were not asked to argue or debate with one another. Rather, their discourse was generated when they engaged in online knowledge building activities, and analyzed from the perspective of argumentation. When they generated arguments, more of their notes were explanatory, which was considered to be of higher quality from the perspective of knowledge building. This study found further that in threads where opposite ideas were found, more arguments were put forward, and students' inquiry was more sustained. Thus no matter based on the operations related to justification and opposite ideas, discourse of argumentation is beneficial to knowledge building.

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