Questioning and the Quality of Knowledge Ideas in a CSCL Context: A Study on Two Age-groups of Students

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Abstract: This paper aims to study the relationship between the type of questions posted and the quality of knowledge ideas expressed in a CSCL context. Previous studies suggest that this relationship may be different for different age-groups. This study was conducted with two classes of students—at grades 6 and 10 respectively. The discourse was analyzed at both thread- and individual-student- levels. It was found that for the sixth-grade students, those who asked better questions also expressed better knowledge ideas. For the tenth-grade students, such a relationship at the individual-student-level was not found. Nonetheless, at the thread-level, there is a positive correlation between the presence of better questions and more developed knowledge ideas in the tenth-grade students' online discourse, but not in the sixth-grade students'. The results suggest further discourse characteristics in addition to questioning to be related to the quality of knowledge ideas expressed.

Introduction

The relationship between questioning and inquiry has been articulated since the time of ancient Greeks. Socrates illustrates how to use questions to seek for knowledge. Aristotle suggests that the kinds of questions we ask are directly related to the knowledge we can get and he is the first person to develop a classification for different kinds of questions (Dillon, 1984). In the context of computer-supported collaborative learning (CSCL), students can conduct collaborative inquiry in a technology-mediated environment. It is important for them to generate questions and to build their inquiry on these questions (Scardamalia & Bereiter, 1991). The pedagogical approach of knowledge building emphasizes students' collective responsibility for the advancement of the community's knowledge (Scardamalia, 2002). Its implementation in schools is usually integrated with an asynchronous online platform, the Knowledge Forum® (KF), which is specifically designed to create a knowledge building environment for students to make their ideas explicit so that everyone can contribute to the continual improvement of ideas (Scardamalia, 2002). Student's self-generated questions are considered especially important in knowledge building as it emphasizes the epistemic agency of students (Scardamalia, 2002; Zhang, Scardamalia, Lamon, Messina, & Reeve, 2007). On the other hand, students can articulate their "knowledge ideas" (Hakkarainen, 2003) in the process of inquiry, which can be intuitive ideas, scientific theories, or the information they gathered. Based on these knowledge ideas, students can generate further questions so that their inquiry can be carried forward (Hakarainen, 2003). Hence, during the course of an inquiry, there will be a number of questions as well as knowledge ideas generated by students. Although there are case studies reporting that by formulating better questions, students can articulate better knowledge ideas, less research is conducted to examine the relationship between questioning and the quality of knowledge ideas quantitatively. In two previous studies in which a student was taken as the unit of analysis, some contradictory results on the above relationship were found (Hakkarainen, Lipponen, & Jarvela, 2002; Lee, Chan, & van Aalst, 2006). Nonetheless, to capture a complete inquiry, a discussion thread seems to be more appropriate as the unit of analysis for examining the relationship between questioning and knowledge ideas. This paper aims to study the relationship at both thread- and individual-student- levels. As suggested by previous studies, the relationship might be different for different age-groups (Hakkarainen et al., 2002; Lee et al., 2006), a total of two age-groups of students are examined in this study.

Literature Review

In traditional classrooms, questions are usually asked by teachers. The structure of initiation-response-evaluation (IRE, Mehan, 1979) depicts the patterns often found in classroom discourse, in which the teacher initiates a question; the students respond; and then the teacher evaluates the responses. The number of questions students asked in classroom settings is low (Graesser & Person, 1994). On the other hand, there are studies reporting that students' questioning is beneficial to their text comprehension and learning (e.g., King, 1990; Palincsar & Brown, 1984); it is also found that even elementary students are capable of generating questions of high quality (Hakkarainen, 2003; Scardamalia & Bereiter, 1991). Compared to an ordinary classroom, collaborative inquiry pedagogical designs allow students to generate questions for further inquiry more easily. In CSCL studies, the analysis of discourse related to questions is often found (e.g., Hakkarainen, 2003; Hmelo-Silver, 2003; Zhang et al., 2007).

To analyze the questions generated by students, it is necessary to classify different types of questions that can be found in educational settings. In the past years, different classification frameworks have been developed (e.g., Dillon, 1984; Grasser, 1994; King & Rosenshine, 1993). For example, in analyzing the questions students asked in interactions related to a task of text comprehension, King and Rosenshine (1993) differentiated the following question types in order of increasing quality, 1) fact questions; 2) definition questions; and 3) integration questions targeting the integration of ideas or information. In their study, King and Rosenshine (1993) also investigated the effect of training students to ask questions with the help of question stems. They found that compared to the control group, students in the training condition asked more high-quality questions and the knowledge they constructed was also of higher quality (see also King, 1994).

Students' questions are also classified in the literature on knowledge building, and the classification is based on their epistemological nature—whether they target factual or explanatory knowledge. Questions seeking explanations are more productive from the perspective of knowledge building as they are related to a deeper level of understanding compared to fact-seeking ones (Hakkarainen, 2003; Lee et al., 2006; Zhang et al., 2007). In addition to the questions asked, students can articulate knowledge ideas in the process of inquiry, which can be responses to questions, intuitive theories, and scientific information (Hakkarainen, 2003). In the literature on knowledge building, the quality of knowledge ideas is examined according to their "levels of explanation" (e.g., Hakkaranen, 2003; Lee et al., 2006; Zhang et al., 2007). The rationale is again based on the epistemological nature of knowledge, in which explanation is more illustrative of deep understanding compared to factual knowledge. A total of four levels of explanation are classified in Zhang et al.'s (2007) study: 1) unelaborated facts; 2) elaborated facts; 3) unelaborated explanations; and 4) elaborated explanations, indicating an increase in quality. Fact refers to the description of terms, phenomena, or experiences, while explanation refers to reasons, relationships, or mechanisms. In addition to this differentiation of fact and explanation, Zhang et al. (2007) takes into consideration how elaborated the knowledge ideas are.

Both students' questions and their knowledge ideas are important elements in the process of inquiry, as questions may lead to the articulation of knowledge ideas, and the articulation of knowledge ideas may lead to further research questions. Through continuous iterations of these cycles, students' collective knowledge can be advanced. Case studies have been reported to describe how elementary students can engage in these iterated cycles to advance their inquiry (Hakkarainen, 2003; Zhang et al., 2007). Although case studies are helpful to illustrate how students may deepen their inquiry by questioning and putting forward knowledge ideas, a correlation analysis may be a more cogent way of investigating the relationship between levels of questions and levels of explanations. Hakkarainen et al. (2002) analyzed this relationship among three classrooms of fourth-grade and fifth-grade students, finding a positive correlation. However, the unit of analysis they employed was a student, thus more accurately, the correlation implied that a student generating a higher proportion of explanation-seeking questions was also the one who has a higher level of explanation expressed. In another study with a sample of ninth-grade students, Lee et al. (2006) found that the correlation between levels of question and levels of explanation was not significant. Nonetheless, both of these studies employed a student as the unit of analysis. Although a thread seems to be more appropriate to capture a complete inquiry as it contains a series of related notes, in the literature on knowledge building, no research has been attempted to examine the relationship between questioning and levels of explanation quantitatively with a thread as the analytic unit. In this study, both a thread and a student are taken as the units of analysis respectively to examine the relationship between the types of questions and the quality of knowledge ideas.

Method

Research Context

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. As previous studies suggest, the relationship between levels of questions and levels of explanation may be different for different age groups (Hakkarainen et al., 2002; Lee et al., 2006), a total of two databases, one primary and one secondary, were analyzed to see if different patterns were found. Previous studies suggested that a long period of inquiry is needed for productive knowledge building discourse to emerge (e.g., Zhang et al., 2007), these two databases had the longest period of inquiry among all databases at the time the analysis was conducted. Students of both grades had a period of about six weeks to conduct their inquiry.

The first database contains the discourse of a class of 41 tenth-grade students in a secondary school; they formed six groups inquiring on topics of Water Quality, Plastics, and Ideal Vehicle. The students and their teacher were both new to knowledge building. The second database composed of the discourse of a class of 44 sixth-grade students in a primary school, who formed seven groups to inquire on topics of Global Warming, Energy Crisis, and Species Extinction. Two teachers were involved in the facilitation of knowledge building in the second database. One of them and about one fourth of the students had the experience of participating in knowledge building activities in the previous year. The other teacher and the remaining students were new to this pedagogical approach.

Knowledge Forum®

Throughout the process of inquiry, students had to engage in discussions on Knowledge Forum® (KF), which is an asynchronous online platform specifically designed to facilitate knowledge building (Scardamalia, 2003). Students can contribute their questions and ideas in the form of notes, and other students could respond and further improve the ideas by writing build-on notes. In writing a note, students may use "scaffolds", which are meta-cognitive prompts in the form of word cues such as "New information", "New idea", and "My theory", so that they can better identify the nature of their note content (e.g., "New information" or "New idea"), or identify a knowledge gap (e.g. "I need to understand"). Notes and their build-on notes were linked physically in the form of build-on threads. Thus within a thread, there were a series of related notes.

Levels of Questions and Levels of Explanation

The online discourse collected in this study is analysed to identify, for each note, the quality of questions asked and the level of explanation of knowledge ideas expressed (where relevant). "Explanation-seeking questions" refer to those targeting at explanations, while "fact-seeking questions" are those targeting at factual information (Hakkarainen, 2003). In addition to these two categories, there were questions targeting at simple clarifications, hence a third category, "simple clarification", was included. Such a differentiation was adopted in a recent study conduct by van Aalst (2009). Presented in table 1 are examples of these three levels of questions taken from students' notes collected in this study.

Table 1: Examples of the three levels of questions generated by students.

Levels of Questions	Examples
Explanation-seeking	"How UV (ultra violet) works to improve water quality?"
Fact-seeking	"Which country is using solar energy to move the car?"
Simple clarification	"Can you put up some picture, to let us know what red panda looks like?"

In parallel to the classification of levels of questions, students' non-question-asking notes were analyzed according to levels of explanation of their knowledge ideas. The analysis involves two steps: 1) determining whether a knowledge idea is articulated in a note; and 2) if a knowledge idea is articulated, what its level of explanation is. To be qualified as a "knowledge idea", some knowledge contents have to be expressed in a note. The following are examples of notes with no knowledge idea articulated: "*I agree*", "*We can have a further discussion on this topic*". Notes containing simply copy-and-paste contents, information of websites, or pictures copied from elsewhere were also considered as having no knowledge ideas expressed.

For notes with knowledge ideas expressed, the coding scheme developed by Zhang et al. (2007) was employed to identify their levels of explanation. Presented in table 2 are examples of notes coded at these four levels in this study.

Table 2: Examples of the four categories of levels of explanation.

Categories	Examples
Elaborated explanation	"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 die."
Unelaborated explanation	"UV (Ultra Violet) is a light. It is a kind of waves and it is not a matter. It does not remain in the water."
Elaborated fact	"Fossil fuel is composed of three kinds of elements: gas, oil, or coal. Fossil fuel energy is a nonrenewable type of energy, that means, it would disappear if we use it all or if we waste it, we wouldn't get it again. Fossil fuels are the remains of ancient plant and animal life found in earth, rock, and clay. Fossil fuels are mined by people for use as an energy source."
Unelaborated fact	"In fossil fuel, there are coal and oil."

To conduct the quantitative analysis, the coding of the level of explanation was converted to a numeric score according to the procedure in Zhang et al.'s (2007) study: "elaborated explanation" was assigned with a score of "4", "unelaborated explanation" as "3", "elaborated fact" as "2", and "unelaborated fact" as "1", indicating a decrease in quality. Notes with no knowledge ideas expressed were not assigned with any score. The "average level of explanation" of a build-on thread was calculated by averaging the levels of explanation of the notes within the thread. On the other hand, the "average level of explanation" of a student was calculated by averaging the levels of explanation of the notes contributed by the student.

Similarly, for questions generated by students, an explanation-seeking question was assigned a score of "3", a fact-seeking question "2", and a simple clarification question "1", indicating a decrease in quality. The "average level of questions" of a thread was calculated by averaging the scores of questions generated in a thread. Similarly, the "average level of questions" of a student was calculated by averaging the scores of questions contributed by the student. While the quality of questioning was captured by the "average level of questions", a quantitative measure was also included in this study. The "questioning density" of a thread was calculated by dividing the number of notes with questions asked divided by the total number of notes within the thread—it is hence the proportion of notes in a thread containing questions. Similarly, the "questioning density" of a student was calculated by dividing the number of notes with questions by the total number of notes contributed by the student; it was a quantity measure of how many questions were asked by a student with respect to the total number of notes he/she created.

Results

Descriptive Analysis: Levels of Questions and Levels of Explanation

A total of 620 and 630 discussion notes were generated by the tenth-grade and sixth-grade students respectively, which resulted in a total of 76 and 69 build-on threads respectively. Among the notes created, a total of 231 and 132 questions were identified in the discussion of the tenth-grade and sixth-grade students respectively, suggesting that the tenth-graders tended to ask more questions compared to the sixth-graders. All these questions were analyzed on their levels of questioning. Presented in table 3 are the numbers and percentages of questions classified at different levels. Nearly half of the questions of both grades of students were classified as explanation-seeking. Only a low percentage of their questions were simple clarifications (Tenth-grade: 15.6%; Sixth-grade: 20.5%). The tenth-graders had about 40% of their questions classified as fact-seeking, while that for the sixth-graders was about 30%. Hence although the two grades of students differed in the numbers of questions asked, the proportions of levels of questions were quite similar.

Table 3: Numbers and percentages of questions in different levels of questions.

Grade		Levels of Questions			
		Simple clarification	Fact-seeking	Explanation-seeking	Total
Tenth	Number	36	92	103	231
	%	15.6	39.8	44.6	100
Sixth	Number	27	41	64	132
	%	20.5	31.1	48.5	100

On the other hand, a total of 430 and 425 notes of the tenth-grade and sixth-grade students respectively were found to contain knowledge ideas, and these were analyzed for their levels of explanation. Table 4 presents the distribution of levels of explanation of the notes with knowledge ideas. It can be seen that for both grades, slightly more than half of their notes with knowledge ideas were classified as unelaborated facts (Fact-Unelab.). 17% and 16.9% of the notes with knowledge ideas of the tenth-grade and sixth-grade students respectively were elaborated facts (Fact-Elab.). The tenth-grade students had 27.9% (20+7.9) of their notes with knowledge ideas classified as explanatory, which could either be unelaborated explanations (Expl.-Unelab.) or elaborated explanations (Expl.-Elab,), comprising a total of 120 notes. For the sixth-grade students, 28.7% (19.1+9.6) of their notes with knowledge ideas were classified as explanatory, which comprised a total of 122 notes.

Table 4: Distribution of notes with knowledge ideas in different levels of explanation.

Grade		Levels of Explanation				
		Factual		Explanatory		
		Fact-Unelab.	Fact-Elab.	Expl.-Unelab.	Expl.-Elab.	Total
Tenth	Number	237	73	86	31	430
	%	55.1	17	20	7.9	100
Sixth	Number	231	72	81	41	425
	%	54.4	16.9	19.1	9.6	100

Correlation Analysis

Correlation with a Thread as the Unit of Analysis

Previous literature on knowledge building found that short threads are less illustrative of a deeper level of understanding (Zhang et al., 2007). In this study, there were threads with only a small number of notes; they are deemed to be too short to illustrate how questioning and levels of explanation are related within a thread. Hence only threads with six notes or more are included in the analysis in this section. A total of 45 (59.2% out of 76) and 38 (55.1% out of 69) build-on threads of tenth-grade and sixth-grade students respectively were with six notes or more, and they were included in the correlation analysis. The correlation results are summarized as in table 5. For the tenth-grade students, the average level of explanation of a thread was significantly correlated to the average level of question ($r=.448$, $p<.01$) but not questioning density of a thread, suggesting that the quality rather than quantity of questions was related to the level of explanation of a thread for the tenth-graders. For the sixth-grade students, neither the average level of questions nor questioning density was significantly related to the average level of explanation of a thread.

Table 5: Relationship between levels of explanation and questioning with a thread as the analytic unit.

Grade		Average Levels of Questions	Questioning Density
Tenth (n=45)	Average Level of Explanation	.448**	.026
	Average Level of Questions		.161
Sixth (n=38)	Average Level of Explanation	.295	-.245
	Average Level of Questions		.284

*: p<.05; **: p<.01

Correlation with a Student as the Unit of Analysis

If a student is taken as the unit of analysis rather than a thread, a contrasting correlation pattern was found. As summarized in table 6, no significant correlations between the average level of explanation of a student and the average level of questions or questioning density were found for the tenth-graders. On the contrary, the average level of explanation of a student was positively correlated to the average level of questions for the sixth-graders. Such findings were in fact consistent with previous research that levels of questions were found to be related to levels of explanation for primary grade but not secondary grade students if a student was taken as the unit of analysis (Hakkarainen et al., 2002; Lee et al., 2006).

Table 6: Relationship between levels of explanation and questioning with a student as the analytic unit.

Grade		Average Levels of Questions	Questioning Density
Tenth (n=41)	Average Level of Explanation	-.174	-.167
	Average Level of Questions		.2
Sixth (n=44)	Average Level of Explanation	.425*	.054
	Average Level of Questions		.074

*: p<.05

Case Studies

In order to make sense of the above findings in the context of this study, two case studies are presented in this section. The first case is a sixth-grade student who is among the highest in both the level of questions and the level of explanation expressed. The second case is a thread of the tenth-grade students, which illustrates how questioning might deepen the level of explanation in a thread; it also illustrates that students asking better question might not be the ones who contributed notes with higher levels of explanation.

Sixth-grade Students

Tommy (fake name) was a sixth-grade student. He has written a total of 21 notes, distributed among eleven threads. Of the notes he has written, nine contained explanatory knowledge ideas (unelaborated or elaborated explanation) and a total of five questions were asked, of which four were explanation-seeking ones. His explanation-seeking questions distributed among three threads, yet they did not seem to be helpful to advance the inquiry in those threads. For example, in the thread of "Ground heat energy", in response to the articulation that not all places are suitable for this form of energy, Tommy asked the question, "*But how come New Zealand can do it?*" The question was not addressed by other students at all. In the thread of "Solar energy", although Tommy did not ask any questions, he contributed two notes with unelaborated and elaborated explanations respectively, as illustrated in the contents of notes taken from this thread presented in table 7. In this thread, students were arguing on whether solar energy is useful. In the first note written by Tommy (Note#A4), it was said that solar energy is not that useful because there may be rainy days. Then a student opposed to this point by articulating that the weather of Hong Kong, the place they live in, is usually hot. In the remaining notes, Tommy tried to clarify whether it is the hot weather or sunlight that generates solar energy. Explanatory-seeking questions were also found in this thread (Note#A13 & A14), but they received no responses.

Table 7: Contents of notes taken from the thread of "Solar energy" of the sixth-grade students.

Note#	Student	Note Content	Coding
A1	G6_1	Solar energy is good because1.All countries have sun 2.Solar energy does not need too much space.	Fact-Unelab.
A2	G6_2	I agree your own opinion, cause it won't need a lot of space and everywhere got sunshine.	Fact-Unelab.

A3	G6_3	I agree too because it use less energy.	Fact-Unelab.
A4	**Tommy**	**I don't think solar energy is good because when there are some continuous rainy days in a week, the day time might not be long enough to produce energy, so if we rely on the solar energy, it might cause no electricity for us to use in summer.**	Fact-Elab.
A5	G6_4	I think it is not a good point. Because Hong Kong is always very hot.	Fact-Unelab.
A6	**Tommy**	**There might be hot days, but I'm not sure that there is sunlight. Solar energy needs sunlight.**	Expl.-Unelab.
A7	G6_2	I'm sure that everyday might be sunlight, unless there's bad weather, like typhoon, raining heavily and also storm......	Fact-Elab.
A8	G6_3	I think the solar energy machine can get the energy and use for more than one day.	Expl.-Unelab.
A9	G6_4	Hong Kong is a very hot place.	Fact-Unelab.
A10	G6_3	Hong Kong is not EVERYDAY hot. Sometimes, HK can be cold	Fact-Unelab.
A11	**Tommy**	**Hot doesn't mean that there is enough sunlight, you need sunlight to heat up the solar panels. Just like today, although it is hot, there is no sunlight. While in Arctic, there are some extreme situations, like 10 days have sunlight, and 10 days NO sunlight.**	Expl.-Elab.
A12	G6_4	Solar energy can help to solve problems for people around the world. In some places, people do not use electric or gas cookers.	Fact-Unelab.
A13	G6_1	How can the sun help them cook?	*Quest.-Expl.*
A14	G6_3	What is the way of fixing the solar panels if the panels are out of order? It is a very big problem. We will have no energy to use!!!	*Quest.-Expl.*

Tenth-grade Students

In the thread of the sixth-grade students presented in the last section, questioning seemed to play a limited role in the advancement of knowledge. For the tenth-grade students, as suggested by the correlation results, there seemed to be a positive relationship between levels of questions and levels of explanation of a thread. Table 8 presents the note contents written in the thread of "Substance of fuels". The thread began with a fact-seeking question of "What is the chemical substance in fossil fuel?" It received an unelaborated factual response that fossil fuel contains coal and oil. Then the students went on with the inquiry on other substances which can be sources of fuel such as LPG (Liquefied Petroleum Gas) and water. The proposal led to the request for explaining how water can be a kind of fuel, which resulted in the inquiry on the mechanism of fuel cells, in which liquid hydrogen is used for generating electricity with water as the byproduct (Note#B11). In the last few notes, the students inquired on whether the output of a fuel cell is strong enough.

Throughout this thread, a series of questions were generated to drive the inquiry forward, and the discourse changed from factual (Note#B1 to B3) to explanatory (Note#B4 to B11). A total of eight questions were found in this thread. Although the students did not start their inquiry with an explanation-seeking question, two questions of this type were generated in the process of inquiry, leading to the explanatory exploration of how water can be a source of fuel and the mechanism of fuel cell. It can also be observed from this thread that the students who contributed notes with unelaborated or elaborated explanations (G10_3. G10_6, G10_2) are not the same as those who asked explanation-seeking questions (G10_4, G10_1) or other types of questions (G10_5, G10_7). Such a finding is in line with the previous result that there was no significant correlation between levels of questions and levels of explanation at an individual level for the tenth-grade students.

Table 8: Contents of notes taken from the thread of "Substance of fuels" of the tenth-grade students.

Note#	Student	Note Content	Coding
B1	G10_1	What is the chemical substance in fossil fuel?	*Quest.-Fact*
B2	G10_2	In fossil fuel, there are coal and oil.	Fact-Unelab.
B3	G10_3	To protect the environment, I think using LPG is better............. Also, some Japanese scientist tries to use water to be fuel.........	Fact-Unelab.
B4	G10_4	Water..? Is it really possible?	*Quest.-Expl.*
B5	G10_3	Water is formed by hydrogen and oxygen. They could be a kind of good fuel.	Expl.-Unelab.
B6	G10_5	How????	*Quest.-Sim.*
B7	G10_6	Decompose water, form hydrogen and oxygen, then burn both of them.	Expl.-Unelab.
B8	G10_1	Burning hydrogen and oxygen can supply such great energy for the car to move?	*Quest.-Expl.*
B9	G10_4	I think it is the problem of the amount you use only...	Fact-Unelab.

B10	G10_6	Of course is enough! Hydrogen burn in air and oxygen support combustion. So they can provide that much energy.	Expl.-Unelab.
B11	G10_2	Fuel cells have been developed which convert hydrogen directly into electricity. This is attractive since the only byproduct is water. There are still significant problems since carbon dioxide is typically produced by use of electricity, which is mostly produced from fossil fuels.	Expl.-Elab.
B12	G10_1	Sorry, what is fuel cell? Is it a kind of fuel that very common to use in car?	*Quest.-Fact*
B13	G10_7	Fuel cell: An electrochemical cell in which the energy of a reaction between a fuel, such as liquid hydrogen, and an oxidant, such as liquid oxygen…. source: http://dictionary.reference.com/search?q=fuel%20cell	Copy & Paste
B14	G10_2	Here is the picture of the fuel cell running process: http://www.newmango.com/info_fuel.html From the picture, we know that the Natural gas + air -> DC POWER and Water+ Heat.	Fact.-Unelab.
B15	G10_7	How about the output of the cell? Will it be strong?	*Quest.-Fact*
B16	G10_2	I am sorry I do not understand what means strong?	*Quest._Sim.*
B17	G10_7	I mean will the current be strong enough?	*Quest.-Fact*
B18	G10_2	Yes, the fuel cell can provide enough energy to the car.	Fact.-Unelab.

Discussion

This paper examines the relationship between levels of questions and levels of explanation at both a thread level and an individual level. At a thread level, a positive correlation was found for the tenth-grade but not the sixth-grade students. An opposite pattern was found at an individual level, in which a positive correlation was found for the sixth-grade but not the tenth-grade students. The latter finding is in fact compatible to previous studies that a positive correlation at an individual level was found for primary grade but not secondary grade students (Hakkarainen et al., 2002; Lee et al., 2006).

If the results of the sixth-grade and tenth-grade students are considered together, there appears to be a developmental difference between younger and older students. For the younger students (sixth-grade), those who ask good questions are the ones with high-level explanations expressed. For the older ones (tenth-grade), the ability to ask good questions appears to have developed independently of the ability to construct high-level explanations. Nonetheless, in a build-on thread of the tenth-graders, there were good questions asked by some students and high-level explanations constructed by other students, resulting in a positive correlation between levels of questions and levels of explanation of a thread. On the contrary, in the discussion of the sixth-grade students, good questions were found in some threads and yet the students addressing them were not able to construct high-level explanations; while in other threads, although good questions were not found, there were notes with high-level explanations.

In the context of CSCL or collaborative learning more generally, students usually engage in collaborative inquiry, and it is important for good questions to be generated and high-level knowledge ideas expressed. More studies are needed to explore whether such a developmental difference really exists, whether it is related to students' ability or their willingness to ask questions and express ideas, whether such a difference is hindering or facilitative to collaborative learning, and whether it can be weakened or strengthened through suitable pedagogical designs.

In previous studies on knowledge building in which the participants were mainly primary grade students (e.g., Hakkarainen, 2003; Hakkarainen et al., 2002; Zhang et al., 2007), it was reported that even elementary students were capable of asking questions of good quality and to build their inquiry on these questions. While the sixth-grade students in this study seemed to be less able to advance their inquiry through questioning. The case study also suggested that even some good questions were asked by the sixth-grade students, they were not addressed by the others. One possible reason is that the teachers and students were relatively new to the pedagogical approach of knowledge building. In previous studies, it was mentioned that the teacher played an important role in the facilitation of knowledge building (Hakkarainen, 2003; Zhang et al., 2007). It seemed that more facilitation from the teachers is needed in helping younger students to formulate better questions, address the questions that were not responded to, and further their inquiry through questioning. However, as suggested by the thread of "Solar energy" presented in the case study, although questioning seemed to play a limited role, some discourse progresses were observed with respect to the oppositions and counter-oppositions put forward by the students, arguing on whether solar energy is useful and whether it can be applied in the context of Hong Kong.

In the literature on knowledge building, it is reported that knowledge building is different from argumentation because the latter focuses on persuasion and the winning of arguments rather than shared understanding and progress (Scardamalia & Bereiter, 2006). However, in more recent studies, argumentation is mainly regarded as a form of discourse found in social contexts when people expound and explore diverse or contradictory ideas (Andriessen, 2006; Leitao, 2000). Rather than focusing on who wins an argument, analytic frameworks are developed to examine how students interact with one another in the presence of opposite ideas (Erduran, Simon, & Osborne, 2004; Leitao, 2000; Pontecorvo & Girardet, 1993). These frameworks might provide valuable insights on how progress can be made through discourse. Although the case study of the tenth-grade students suggested that they were more capable to construct explanations to questions raised by other students, and in fact a significant correlation was found between levels of questions and levels of explanation of a thread for the tenth-grade students, the percentage of variance that can be explained for is about 20% (square of .448), further studies are needed to examine other discourse characteristics such as argumentative interactions that are related to the deepening of explanation within a thread.

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