Exploring patterns of interaction in Knowledge Forum databases using Knowledge Connections Analyzer (KCA)

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Abstract

The purpose of this study is to explore the patterns of interaction in Knowledge Forum databases using the Knowledge Connections Analyzer (KCA), so that pedagogical issues related to facilitating knowledge building can be identified and further addressed. Eight databases developed by teachers and students in the Knowledge building Teacher Network are analyzed according to the four questions embedded in the KCA. Results identify substantial differences among these databases regarding the four questions for which the KCA retrieves evidence. Implications are also discussed.

Keywords

Knowledge building, interaction, assessment

A list of relevant conference themes

This study aimed to provide a better picture of the state of online discourse in the Knowledge building Teacher Network (KBTN) in Hong Kong using the KCA which was designed to be a tool to support Embedded and Transformative Assessment. The final goal was to optimize knowledge building, which involved the following aspects:

1. Technology for knowledge creation
2. Assessment for knowledge creation
3. Professional development

Introduction

Research on knowledge building shows that knowledge building can benefit diverse learners, from low- to high-ability ones (Chuy et al., 2010; Niu & van Aalst, 2009; Zhang, Scardamalia, Lamon, Messina, & Reeve, 2007). However, research also identifies problems with the quality of discourse in Knowledge Forum®. For example, students may be reluctant to read, write notes, or build on others' notes, and discussions end prematurely (Hewitt, 2005); discourse may be knowledge sharing rather than knowledge creation (van Aalst, 2009), and so on.

The Knowledge Connections Analyer (KCA; van Aalst, Chan, Tian, Teplovs, Chan, & Wan, 2012) is an assessment tool designed to be used by students and their teacher to inquire into the state of the online discourse in their community. The KCA retrieves evidence on four everyday language questions that students may have about their online work: 1) Are we a community that collaborates? 2) Are we putting our knowledge together? 3) How do our ideas develop over time? 4) What is happening to my own ideas? The KCA is an extension of our research program on reflective assessment in knowledge building using eportfolios (Lee, Chan, & van Aalst, 2006; van Aalst & Chan, 2007), and provides tools that facilitate the anaysis necessary for e-portfolios, but we also envisage other ways of working with the KCA to embed reflective assessment in knowledge building.

The goal of this study was to gain a better picture of the state of online discourse in the Knowledge building Teacher Network (KBTN) in Hong Kong using the KCA, with a view to developing an understanding of the kinds of results students may obtain, of the nature of the goals that may emerge from use of the KCA, and of the usfulness of the analysis provided by the KCA. This exploratory work is necessary for providing professional development focusing on Embedded and Transformative Assessment with the KCA in classrooms. To this end, we ran the KCA on eight databases of the KBTN and reported the prelimiary findings.

The Knowledge Connections Analyzer

The Knowledge Connections Analyzer (KCA) is designed to be a tool to support Embedded and Transformative Assessment (Scardamalia, 2002); it not only analyzes collective effort, but also individual roles. Students and teachers can utilize information provided by this tool to plan and reflect on the well-being of their community and their contributions in light of various indicators of progress, such as collaborative dynamics, synthesis and rise above, idea improvement and individual roles and accomplishment.

The first question "Are we a community that collaborates" is a community-oriented question, which aims to visualize knowledge building as a collective effort to advance the community knowledge. The KCA analyze this question from the perspectives of having an audience for their work and being audience to the others' work in the form of read, built-on, linked-to and rise above. The second question "Are we putting our knowledge together" focuses on the analysis of synthesis/rise-above notes, which tries to simplize the knowledge building principles of rise above, idea diversity and epistemic agency. This question is analyzed in the KCA by providing percentage of notes containing references and percentage of notes used as reference. The third question "How do our ideas develop over time" focuses on the dynamics of idea improvement, which is visualized by the percentage of notes that have received a certain level of interaction, including keywords and scaffolds used in these notes.

The above three questions emphasize collective aspects of knowledge building, but the forth question "What is happening to my own notes" focuses on individual aspect of knowledge building. This question intends to provide embedded and transformative assessment data for students' reflections and further planing. The key purpose of each of the four questions, their connection with the knowledge building principles and analyzing perspectives are listed in table 1.

Table 1: Embedded knowledge building principles in the four questions

Questions	Key Purpose	Knowledge building principles	Perspectives
Are we a community that collaborates?	A community-oriented question that asks whether collaboration is a well-developed practice in the community	Community knowledge, collective responsibility, democratizing knowledge	To what extent students *have an audience* for their work and *be audience to* the others' work in the form of read, build-on, link-to, and rise-above to their notes
Are we putting our knowledge together?	To explore the extent to which synthesis and rise-above are occurring from the collective aspect	Rise above, idea diversity, democratization of knowledge, and epistemic agency	The percentage of notes with references and the percentage of notes used as reference
How do ideas develop over time?	To explore the extent of community engagement, and the emergency of new ideas from collective aspect	Improvable ideas, epistemic agency	The percentage of notes that have received a certain level of interaction, such as read, build-on, link-to, rise-above; keywords introduced, scaffolds used
What is happening to my own notes?	To help students to reflect on the quality of their own notes and their impact on the community's discourse	Embedded and transformative assessment	A ranked list of one's notes that prompted a given type of interaction with specified frequency, and the details of each interactions

Are we a community that collaborates?

"Are we a community that collaborates?" is a community-oriented question that asks whether collaboration is a well-developed practice in a community. In the process of knowledge building, students should be aware of and build onto the ideas of their peers, and help one another to improve ideas. It is of paramount importance to read, respond to and link to one another's idea in order to collaborate successfully, and further contribute important and non-redundant information or ideas that advance the frontiers of the whole community's knowledge.

Are we putting our knowledge together?

Knowledge Forum® provides some functions to support meta-discourse, which includes reference links and rise-above notes. Here "meta-discourse" refers to discourse by which students structure knowledge by identifying connections, synthesis, and creating new levels of conceptualization; it differs from discourse about ideas (Scardamalia & Bereiter, 2006). This structuring is of great importance for reducing clutter, identifying knowledge gaps and advances, organizing contributions, and determining whether deepen the inquiry (van Aalst, 2006). The KCA can provide student and teachers such data by generating results from the perspectives of notes containing and being used as references. The KCA also provides detailed information about notes containing references and being used as reference, so teachers and

students can track and analyze these notes qualitatively and see whether there is really rise-above in terms of idea improvement.

How do our ideas develop over time?

The previous two questions focus on community members' interactions, and their synthesis and higher level conceptualization. And this question focuses on the disciplinary content of the discourse, which is critical for students to improve their ideas (van Aalst et al., 2012). To deal with this question, KCA first identifies notes that have received a target level of attention by students, such as the set of notes that have been read by at least 10 students or that have at least two build-on notes. Then, the KCA provides a complete set of keywords used in these identified notes. Students and teachers can retrieve these notes, and analyze them qualitatively to see whether there is idea improvement. The reason why the KCA focus on the analysis of the keywords is that student and teachers can utilize these keywords to identify important aspects of disciplinary knowledge, such as concepts, theories, and situations.

What is happening to my own notes?

"What's happening to my own notes" aims to help students to reflect on their own notes in terms of the quality of their notes and their impact on the community's discourse. Students can use the KCA to select a particular interaction (e.g. read, built-on, used as a reference) and request a ranked list of the notes that prompted such interaction with specified frequency. They can then use the set of notes generated to inquire into their note-writing effectiveness.

Case study

Sample

In this study, we selected eight databases across Hong Kong. These databases were taught by four teachers during the period 2007-2012, and the participants included humanities, languages, science, and knowledge building; see Table 2 for detailed information of the databases.

Table 2: Detailed information about the databases

	Participants	Grade level	Total community members	Total number of notes	Time spent on Knowledge Forum®	Have reflective assessment/portfolio note or not
H-S4	Humanities	Form 4, Grade 10	19	310	About one month (May 20, 2011-June 13, 2011)	Yes (Reflective assessment)
H-S3D	Humanities	Form 3, Grade 9	42	368	One month (May 26, 2011-June 25, 2011)	Yes (Reflective assessment)
H-S3E	Humanities	Form 3, Grade 9	43	511	About four weeks (May 26, 2011-June 20, 2011)	Yes (Reflective assessment)
MKB		Master course on	29	489	About two and a half months (Feb 2, 2012-	Yes (group portfolio notes)

		knowledge building			April 22, 2012)	
L-3C	Language	Form 3, Grade 9	40	277	About five and a half months (Sep 6, 2010- Feb 21,2011)	Yes (Reflective assessment)
L-2B	Language	Form 2, Grade 8	41	387	About two weeks (Sep 7, 2009-Sep 24, 2009)	Yes (Reflective assessment), but students did not drag the others' notes when did reflections
L-3E	Language	Form 3, Grade 9	42	114	Two months (April 9, 2009- June 9, 2009)	No
S-4E	Science	Grade 10 (Primary)	43	924	Around two years (Oct 5, 2007-Mar 12, 2009)	No

Data analysis

For the first and second question, this study mainly reported the results generated by the KCA. For the third and forth question, this study mainly reported our qualitative analysis results of the notes retrieved by the KCA. The detailed analysis of each question was described in the following sections.

Are we a community that collaborates?

To examine whether collaboration really happened in a community required the analysis of the quality of the interactions and how these interactions contributed to the production o f knowledge. To analyze collaboration, the KCA generated reports from two perspectives: the extent to which students received contacts and made contacts to others in terms of read, build-on, link- to and rise-above, because relationships in the note-linking network were directed (e.g., A reading B's notes different from A's notes read by B).

Are we putting our knowledge together?

The KCA provided pie charts of the percentage of notes that contained or were used as references, and a table showing the content of the notes containing references and being used as references respectively.

How do our ideas develop over time?

For this question, we first used the KCA to identify the notes that had been read by at least a quarter of the community members in each database. For these keywords, we selected the four keywords that were used most frequently. Then, we retrieved and qualitatively analyzed the content of the subset of notes in which a particular keyword was used.

What is happening to my own notes?

For this question, we randomly chose five students in each database. We then retrieved all the notes written by each student and qualitatively analyzed these notes to see what was happening to these notes of each student (e.g. did their notes show evidence of idea improvement?)

Results and discussion

1. Are we a community that collaborates?

Figure 1 showed that H-S4, MKB and S-4E were in the high range box in terms of percentage of students who had collaborators, around 80%; H-S3D and H-S3E in the middle range box, around 50%; and L-3C and L-3E in the low range box, about 20%. It meant that about 80% of students in H-S4, MKB and S-4E had at least five fellow students reading at least three of their notes, building on and linking to at least one of their notes, the percentage was high; around 50% in H-S3D and H-S3E; and around 20% in L-3C and L-3E, the percentage was low. These results indicated that for some classes, such as H-S4, MKB and S-4E, the practice of collaboration in the form of read, build-on and link-to was well developed and it was encouraging; but for some classes, such as L-3C and L-3E, the practice needed to be developed, particularly in the form of build-on and link-to, the percentage in each of the two classes being 15% and 0, and 12% and 12% respectively. Figure 1 also demonstrated that for most of the databases, the percentage of students who had an audience for their work in the form of read was relatively higher than that of the other two types of interaction: built-on and linked-to, but for the database H-S3D, the percentage of read was relatively lower than that of the other two interaction types, which was 50%, 55% and 57% respectively. In general, students' notes were fewer built on and linked to than read by community members (See Figure 1). Here the settings for analysis of each interaction type were: (1) read: five members of collaborators at least and three notes involved at least; and (2) built on and linked to: five members of collaborators at least and one note involved at least.
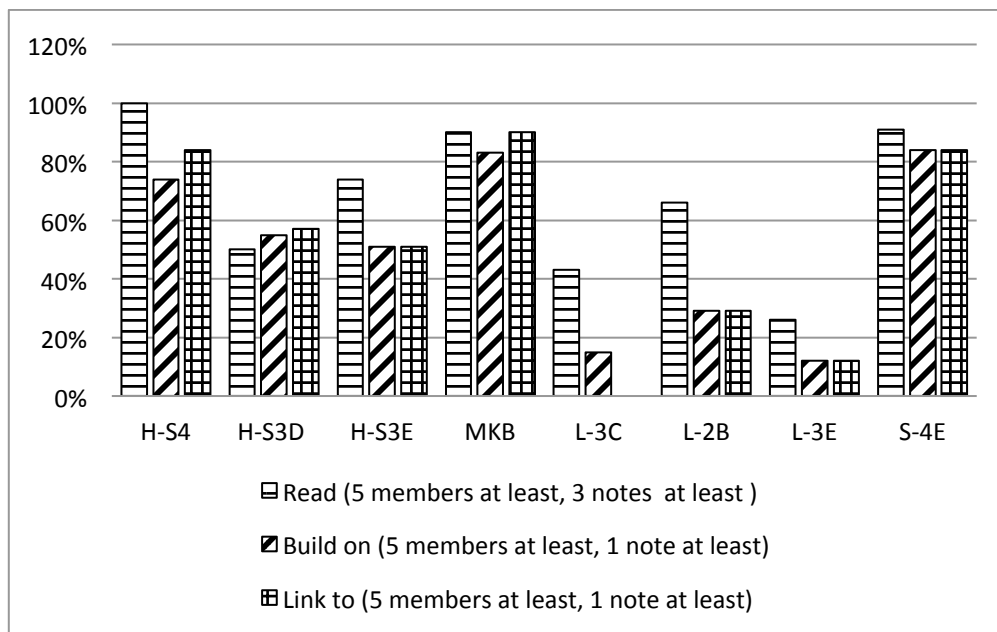

Figure 1: Percentage of students who have an audience for their work

Figure 2 (the same analysis settings with Figure 1) showed the same results in terms of percentage of students who were collaborators to the others with Figure 1. These results indicated that for some classes, such as H-S4, MKB and S-4E, around 80% of students had followed at least five students, at least reading three of notes, and building on and linking to one note of each of them, which informed that the practice of collaboration was highly developed; for some class, such as H-S3E, about 50%; and for some class, such as L-3E, around 20%, the percentage was low. Particularly, for some classes, such as L-2B and L-3E, the practice of collaboration in terms of build-on and link-to was not well developed, only around 10% of students had followed at least five students, building on and linking to one note of each of them. Furthermore, for some class, such as L-3C, the practice of linking to was not developed at all. Figure 2 also demonstrated that for most of the databases, such as H-S4, MKB, L-3C, L-2B and L-3E, the percentage of students who had an audience for their work in the form of read was relatively higher than that of the other two types of interaction: build-on and link-to, but for the database H-S3D and S-4E, the percentage of read was relatively lower than that of the other two interaction types. Generally, students built on and linked to fewer notes than they read (See Figure 2).
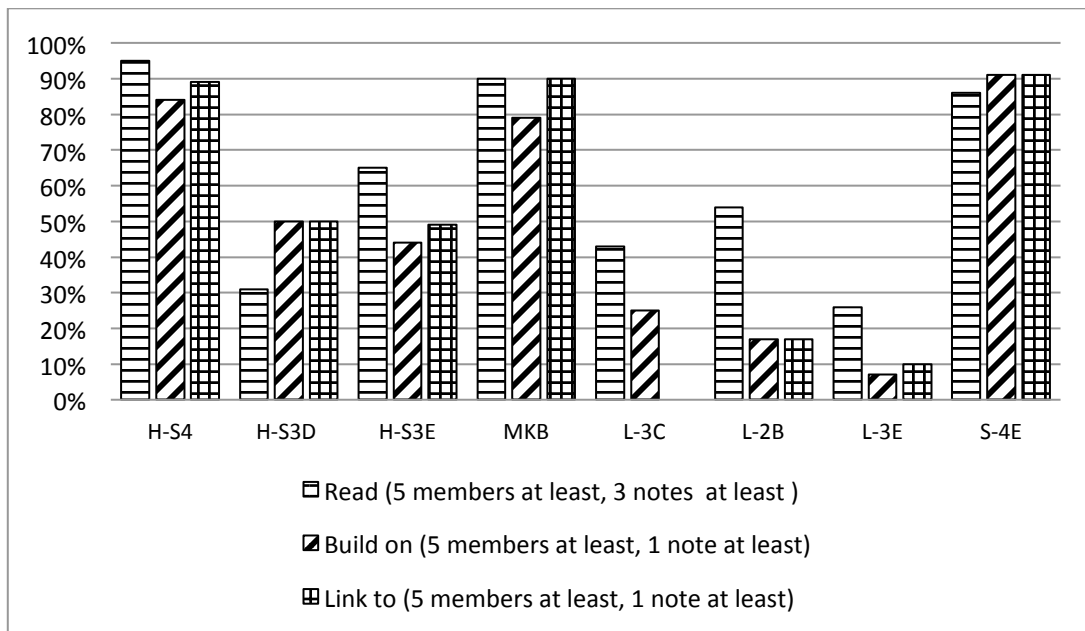

Figure 2: Percentage of students who were an audience for other students' work

Knowledge building is a collective endeavour, which requires community members taking collective responsibility to advance the frontier of community knowledge. In this collaborative process, students "develop awareness of their community by reading notes in the community knowledge space" (Zhang et al., 2009), and make the collaboration go deeply and advance the whole community knowledge by building on and linking to one another's notes. Therefore, the practice of collaboration is crucial for the whole community in order to improve their ideas. Analysis of these databases suggests that for some classes, this practice is highly developed, the percentage of students who have collaborators and who are collaborators to others is high and encouraging; but for most of the classes, the practice is not well developed, in particular in the form of build-on and link-to. Therefore, future research should focus on how to facilitate the whole community to develop this practice in order to promote idea improvement.

2. Are we putting our knowledge together?

Results suggested that the practice of putting our knowledge together was not highly developed in most of the databases, and there were considerable differences among the databases. For example, for databases L-2B, L-3E and S-4E, the percentage of notes with references and notes used as reference were low, only about 2% of all the notes contained references or were used as references; but for some databases, such as MKB, H-S4 and L-3C, the practice was relatively well developed: 18%, 14% and 7%, respectively, of the notes in these databases contained references, and 39%, 22% and 37%, respectively, used as references. Results also showed that the percentage of notes with references was lower than or equal to that of note used as references in each of the selected databases. And for most of the databases, there were differences between the percentage of notes containing references and that of notes included in other notes as references. For example, for H-S4, the percentage of notes with references was 7%, while the percentage of notes used as references was 37% (See Figure).

Such difference among these databases may be due to students in some classes, such as MKB, were instructed on how to do synthesis or rise-above notes, while students in other classes were not supported and facilitated to do such things. Another factor that may account for such differences maybe students in some class were not requested to do an individual or group portfolio notes, or reflective assessment; or even they did reflective assessment, they were not asked to drag and use the others' note to support their theories, such as students in L-2B; however, in some classes, such as H-S4 and MKB, students were asked to do an individual or group portfolio notes, and in these portfolio notes, they were instructed to use all the good notes (not just notes written by themselves) in the database to justify their claims. This factor also could explain the big differences between the percentage of notes with references and that of notes used as references in some databases. Overall, all the above results suggested that, the practice of putting our knowledge together was not well developed in any database. However, this practice is a very important aspect of knowledge building. So more effort should be made to help students to develop this practice.
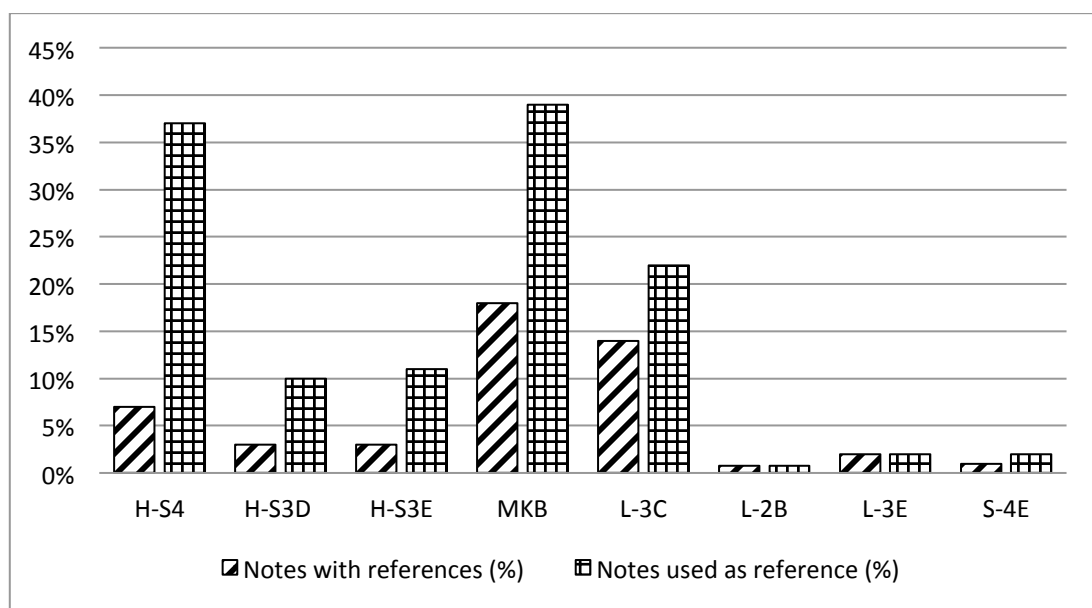

Figure 3: Percentage of notes with references/used as reference

3. How do our ideas develop over time?

We analyzed all eight databases. But due to word limit, we reported here only our analysis of the MKB database, which was created by a Master class on knowledge building. We first used the KCA to identify the notes that had been read by at least 7 students (a quarter of students in the course). These notes had more than 50 distinct keywords that were used in more than one note. The four most often used keywords were authentic problems (used in 5 notes), collaborative learning (5), discourse (5) and challenges (4). We reported our qualitative analysis of "discourse". The transcript below showed the five notes or excerpt of the notes, in which this keyword was used, presented in chronological order. All keywords were shown in boldface in the transcript. In addition, all the names appearing in the following notes were different from their real names

Note 1, February 19, "Misleading assumption", 17 readers (59% of the whole community members)

The theory of George, is based on the assumption that the learners are originally not willing to learn and it is necessary for the teachers to motivate them to learn and make inquiry. I need to understand: Shall we make a better assumption about the motivation of our students? We all are inclined to make inquiry indeed. The question is how can we sustain and further make use of it. Our children will not be willing / able to make inquiry and contribute to their community, if the environment is "over structured and managed" (Scardamalia, M. 2002 p.23). However, how much is too much? Can we (both the teacher and student) really let the mind of us free under this kind of education system (**discourse**) in Hong Kong? If it is not possible now, how can we make it possible in the future??

Note 2, February 19, "What is the discourse inside our classroom?", 13 readers (45% of the whole community members)

What is the **discourse** inside our classroom? How does the **discourse** relate to Knowledge Building (KB)? The interaction between the teachers and students would not be changed, if the classrooms' **discourse** remains unchanged. If we want to reconstruct the **discourse** so as to make the KB more possible and successful in Hong Kong, we should, perhaps notice and understand the **discourse** of our classroom, and how does it shape the learning and teaching first. Recent research indicated that in Hong Kong, traditional patterns of classroom interaction (teacher-centred **discourse**) had not been transformed dramatically despite the demands for instructional reforms. For example, Webb et al. (2006) found that teachers still relied on recitation approaches, in which they assumed the primary responsibility for solving the problem, having students only provide answers to discrete steps. Moreover, the teachers' **discourse** behaviours were modelled later by their students in small-group discussions, "The students, who adopted the role of help-givers, resembled their teachers, did most of the work, provided mostly low-level help, and infrequently monitored other students' level of understanding" (Lam, 2009). The above **discourse** and situation may occur again, if we employ the KB without the self-awareness of such teacher-centred **discourse**. The next question is: How can we reconstruct the **discourse**, so that we can make KB more possible and successful in Hong Kong?

Note 3, February 27, "Does Knowledge building (KB) really create more workload or not?", 26 readers (90% of the whole community members)

Instead, under the **discourse** of KB, the expectation is fair and liberal, cognitive responsibility is expected to be shared by all the community members (both the students and teachers), the teacher is not expected to know all, and actually all the members are expected to answer the questions and create knowledge. Under the KB **discourse**, students indeed share the workload with the teacher (e.g. to provide information, to make inquiry and assessment etc.). The workload may increase in a sense that we need to think more creatively with our students.

Note 4, February 28, "A lighthous or chain? or...", 12 readers (41% of the whole community members)

Knowledge building has never neglected the value of basic ability, curriculum and learning, but it is not all of education. Or 21st century education should have something more than that, children should not only learn or learn to learn, but also create, and they can. I think curriculum itself is not a problem, or, it is needed, as Olinna said. However, the paradigm and value behind the curriculum is, as the **discourse** which creates accordingly, may flourish or squander the children's idea and their capability of knowledge innovation. What kind of **paradigm** is behind the curriculum which we employed to educate 21st century student? 20th? 21st? or still i 18th 19th ??

Note 5, February 29, "what is the meaning of cognitive responsibility among us?", 15 readers (52% of the whole community members)

What is the meaning of **cognitive responsibility** indeed? Does grouping really work, if the **discourse** remains unchanged? Cognitive responsibility in knowledge building is more than "Let's share the responsibility and get the job done." If the members (students and teachers) really engage in the KB **discourse**, they will have the sense of responsibility to create and contribute to the knowledge community, peer influence or pressure would not be their primary concern. The members will self initiate the necessary effort to refine the ideas and find the process rewarding itself.
If the teacher still act as a information hub and keep focusing on the task and activities but not idea, it may just improve the student's "cognitive task responsibility", but not the **cognitive responsibility**.

The above five notes focused on why and how to restructure the current discourse to make students create new knowledge. Note 1 made an argument that students were active learners, they were willing to make inquires, which was totally different from George's assumption. Further, this note proposed an inquiry on how to structure the present discourse to make students as active agents. Note 2 made some conceptual progress by explaining why we should understand the discourse inside the classroom, contextualizing it in Hong Kong, its' relationship with KB; and deepening the inquiry by proposing a new question on how to restructure the discourse to make it align with knowledge building. Note 3 deepened the inquiry proposed in Note 2 by explaining the possibility of knowledge building discourse from the perspective of shared workload. Workload had been an important issue to the teachers in this course, and now a shift was suggested wherein students took on some work that usually carried out by the teacher. Note 4 asserted that the paradigm and value behind the curriculum affects the knowledge building discourse, which should be considered in how to restructure the current discourse. This was really a significant improvement on Note 2. Note 5 argued that teachers must change their role, from knowledge providers to knowledge facilitators, in order to facilitate knowledge-building discourse, from the perspective of cognitive responsibility.

Idea improvement is the essence of knowledge building. But it is not a simple thing to facilitate students to advance their ideas. When we qualitatively analyze these databases, we found that most of the discourse just remained "knowledge sharing level", and not so much discourse involved knowledge creation elements, though there were some differences among these databases in terms of idea improvement. This result is consistent with van Aalst's (2009) finding that much of the discourse frequently relates to knowledge sharing, rather than knowledge building or knowledge creation. Knowledge building can benefit diverse learners (Chuy et al., 2010; Niu &

van Aalst, 2009; Zhang et al., 2007), but the premise here is that we should know well and maximize the knowledge building dynamics.

4. What is happening to my own notes?

For this question, we randomly chose five students from each database and analyzed each of these students' notes qualitatively. But due to word limit, we reported here only our analysis of one student in the H-S4 database, which was created by 19 secondary students (Form 4, Grade 10) on Visual Arts. The transcript below presented the four notes in chronological order written by Simon (the name was different from its' real name).

Note 1, May 22, "Aesthetic value"

My theory is that aesthetic value refers to your feelings and experience of beauty, and significance of perceptions gained from feelings of like or disgust.

Note 2, May24, "Judgement of aesthetic value involves objective and subjective factors"

No, aesthetic value is affected mainly by subjective factors, but also affected by objective factors at the same time. As what I said in the past, the judgement of the art works is objective after your understanding of them.

Note 3, May 24, "The understanding of art works is not equal to personal opinions with 100 percent"

 [My theory] Yes, the personal understanding and cognition of the art works is equal to personal opinions to a large extent, but this personal opinion is an objective judgement.

Note 4, May 26, "There is no consensus of judgment of art works; even there is, disagreements are also involved"

Different people often have different opinions on the same art work, which is obviously subjective thinking. However, there is another aspect, which is objectiveness. Objectiveness is distinct from subjectiveness, which is from the perspective of a third party, talking about the facts. The facts that are understood and recognized by all people are not equal to subjective opinions. For example, your judgement of a piece of art work involves your subjective judgement, which is uncertain, and the objectiveness of the art work. Therefore, the judgement result is controllable.

Moreover, the objectiveness does not mean a consensus of judgement of the same piece of art work among all people. The probability of all people reach a consensus on the same piece of art work is negligible; otherwise, the three so-called areas-black, white and gray, which are in a continuum, will not exist in our society. And what is your opinion? In addition, there is no consensus at the beginning; the consensus results from the negotiation between objectiveness and subjectiveness.

These four notes focused on the definition of aesthetic value and factors affecting the judgement of aesthetic value. Note 1 provided a definition of aesthetic value. Note 2 explained that subjective factor mainly while objective factors slightly affected the judgment of aesthetic value, which was a necessary and important advancement on Note 1. Note 3 further elaborated the explanation in Note 2, the judgment of aesthetic value involved both subjective and objective factors. Note 4 provided an elaborated explanation, with an example and evidence, on how subjective and objective factors affected the judgement of aesthetic value, and the interaction between the two, which showed a significant conceptual improvement on Note 3.

When we analyzed these individual notes in a particular database, we found that there were differences among individual students: some students produced a lot of improvable ideas progressively, but some students made little improvement. Such difference may be due to their prior knowledge, interests and motivation. We also found that there were differences among these databases: for some database, such as H-S4, a lot of evidence showed that there was idea improvement, though students in this class were low-ability ones. Further analysis of this database revealed that the teacher made full use of formative assessment: using a lot of data from the analytic toolkit (Burtis, 1998) to push students to think about their progress before each class. So this picture may suggest that teachers' pedagogy, guidance and scaffolds are of paramount importance. Therefore, more research should focus on how to facilitate students to generate creative and meaningful discourse.

Actually, the KCA also can provide some indicators of the quality of the knowledge created by individual students. For example, the bigger the numbers of each interaction type (read/built-on/referenced to) of an individual note, the higher the quality of the note or the more promising of the note to the improvement of the community knowledge. So students interested in a particular inquiry thread can pool data together and collaboratively identify gaps and generate promising improvement strategies.

Conclusions and implications

This paper reports the analysis results of eight databases developed by teachers and students in the Knowledge building Teacher Network according to the following four aspects embedded in the KCA: having collaborators or being collaborators to others, synthesis/rise-above, idea improvement, and the quality of notes created by individual students and their impact on the community's discourse. Based on the quantitative data generated by KCA and qualitative analysis of data identified by KCA according to some particular settings, we find that there are differences among these databases in the form of the above four aspects. There are also differences within each database. For instance, for some databases, the practice of collaboration, synthesizing, advancing community ideas is highly developed, but for the others, such practice is not well developed. And for some databases, the practice of collaboration is relatively well developed, but the practice such as synthesizing and rise above is not well developed. Even in an individual database, some students develop well and others even do not develop at all in terms of building knowledge. Such differences may be due to different pedagogies or scaffolds provided by different teachers, students' prior knowledge or the nature of the subjects. So future research should address these issues and focus on how to facilitate students to generate knowledge building discourse.

When we qualitatively analyze each of eight databases, we find that there seems to be some connections between idea improvement, from perspectives of community knowledge and individual knowledge, and the practice of collaboration in terms of read, build-on and link-to, and the practice of synthesizing/rising above. It means that, if the practice of collaboration and synthesizing/rising above is well developed in a community, there seems to be more evidence showing that more improvable ideas have been produced by the community. Such situation also occurs to individual students if he/she collaborates well with others and tries their best to rise above the

notes in the database. These findings have valuable pedagogical implications for researchers and teachers, though such findings need further empirical evidence.

Collaboration among students in the form of read, build-on and link-to is of paramount importance for the well-being of a community and for the idea improvement. They understand what the community knows by reading, and improve the community ideas by building on and linking to notes in the communal space. However, according to our analysis and observations, most databases do not well develop such practice, especially regarding building on and linking to. Therefore, how to help students engage in productive collaboration seems to be an important issue for researchers and teachers to address.

Furthermore, synthesizing/rising above deals with idea improvement, which is a very important aspect of knowledge building. Students advance the frontier of the community knowledge, to some extent, by summarizing or synthesizing notes in the community. But our analysis suggest that such practice is not well developed in any database. Therefore, how to facilitate students to develop such practice and sustain knowledge building needs to be addressed. In addition, in a particular database, some students develop well while some students do not develop well or even do not develop at all in terms of building knowledge. Such differences may be due to individual differences, such as prior knowledge, interest or academic ability. However, we believe that teachers' scaffolds are useful, and think that teachers need to try every effort to help all students engage in knowledge building and help them make some progress. But, such practice is really challenging. Therefore, in order to figure out such issues, teachers and researchers should collaborate together.

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