# Fostering Collaborative Learning Through Knowledge Building Among Students With Low Academic Achievement

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**Abstract:** This study investigated whether students with low achievement were capable to collectively advance their online discourse in a knowledge-building environment. 37 students with low achievement from a 9th-grade Visual Arts course participated in the study. We analyzed students' online discourse. Findings indicated that students were able to collectively advance the community's discourse as they built on each others' ideas, generated theories, questions and metacognitive statements in a supportive knowledge-building environment augmented by reflective assessment. The study's findings have important implications for the design of technology-rich environments, and shed light on how teachers can use them to help learners to engage in productive collaborative inquiry.

## Introduction

Much research in the learning sciences studies computer-supported collaborative learning (CSCL), which often involves metacognition (Stahl, 2002). However, little attention has been given to how students with low achievement perform in CSCL—e.g., students who score in the lowest third on central examinations.

In Hong Kong, students are very competitive and achievement oriented, even in primary schools. Secondary schools are classified in three bands—Band 1 (highest) through Band 3 (lowest)—based on achievement on a government examination, in Grade 6, of the majority of its students. Most students in Band-3 schools are low academic achievers, and are not adequately engaged with their schoolwork (Shen, Lee, & Tsai, 2007). Students with low achievement are often found to have limited metacognitive skill; they exhibit low interest and negative attitudes toward their learning. Helping students like these to engage in collaborative inquiry and to benefit from it is a great challenge for educators.

Recognizing these challenges, this study designed a knowledge-building environment augmented by reflective assessment which has been shown positively affected students' learning and performance. The study aimed to investigate whether students with low achievement were able to collectively improve their online discourse in a knowledge-building environment. This study was part of a larger study that investigated whether students with low achievement were capable to use reflective assessment to improve their attempt at knowledge building (Scardmalia, 2002), using an assessment tool, the Knowledge Connections Analyzer (KCA) (van Aalst et al., 2012). The following research questions were investigated: (1) What was the nature of the knowledge-building discourse? (2) To what extent did students improve their discourse?

## Methods

### Research context and participants

The study was conducted in a Band-3 school in Hong Kong; it was actually at the 10$^{th}$ percentile. The participants were 37 students in a 9th-grade class taking a visual-arts course; they were taught in Chinese. Students made inquiry into the topics *"What is art?" and "How to evaluate art?"* over five months, one lesson per week. The teacher had much experience teaching the visual arts, had taken a postgraduate course on knowledge building, and had used knowledge building in the classroom for approximately 8 years. The participating students had no previous experience with knowledge building.

### Pedagogical design

The teacher used the following pedagogical process to familiarize the students with knowledge building, as described elsewhere in detail by van Aalst and Chan (2012); this process was adapted to the present context based on findings from a preliminary study: (1) *Helping students to develop inquiry, collaborative and metacognitive capabilities;* (2) *Deepening problem-centered inquiry in Knowledge Forum; and (3) Developing deep domain understanding and metacognitive skills through reflective assessment.* After working on Knowledge Forum to contribute a reasonable number of notes, students were guided to reflect on their notes by performing reflective assessment collectively and individually primarily with KCA data. To support productive reflection on the KCA data, students were provided with KCA prompt sheets that were both content-related and metacognitive, and corresponded to each of the four questions in the KCA. Around each question of the KCA, the teacher and the first researcher, with the help of the KCA prompt sheets, created opportunities for student reflection. Small groups of student were asked to reflect on the KCA data, to identify problems in their online discourse, and to make further plans to address the problems.

## Analysis and results

Data source in this study were computer notes students posted on Knowledge Forum. We analyzed the Knowledge Forum database using the inquiry thread analysis, followed by analysis of interactions and contributions within these inquiry threads. Then we report the results of characteristics of students' notes in three stages (Stage 1, Stage 2 and Stage 3), to evaluate the advancement of the online discourse.

### Inquiry thread analysis

All computer notes except three unfinished notes (400 notes) created during 2.5 months were put into inquiry threads, yielding 18 inquiry threads. An inquiry thread is a sequence of notes that aim to address the same principal problem (Zhang et al., 2007). To check coding reliability of inquiry thread analysis, two raters independently completed the task on 40% of the notes. The inter-rater reliability was .80 (Cohen's kappa). Some threads involved most of the students as authors (e.g., #1, #3, #4, #7, #8, and #13), whereas others involved only a small number of authors; this suggests that some problems attract more attention from the community than others (Table 1).

### Qualitative analysis of student interaction and contribution within inquiry threads

To characterize the students' interactions within and contributions to the discourse at a more granular level, we used a coding framework to code the notes in each inquiry thread. The development of the coding framework involved an iterative coding process of theory- and data-driven approaches. The coding schemes included three main categories of *questions, ideas* and *community,* and corresponding subcategories, and drew upon theoretical frameworks for social, cognitive and meta-cognitive processes of knowledge construction (van Aalst, 2009; Zhang et al., 2007). The coding framework and coding examples can be accessed online (http://kbc2.edu.hku.hk/ICLS2016coding.pdf). Two raters independently coded the notes from three inquiry threads ($n$ = 120, 30%). The inter-rater reliability was .78 for questions, .78 for ideas, .79 for knowledge quality, and .77 for community (Cohen's kappas).

Results from coding the discourse in the inquiry threads are shown in Table 1. We selected 14 large inquiry threads and present the numbers of questions and ideas in them. Inquiry threads defined as large included more than ten notes. Generally, the results demonstrated in Table 1 are consistent with the classification of the inquiry threads as a whole and suggest that students created many new ideas and were involved in explanation-oriented discourse. For example, students wrote more notes with explanations than notes with simple claims (approximate 145 and 113, respectively, for most metacognitive statement were elaborated explanations). This result indicates that students engaged in a deep—and not superficial— knowledge building process. At the same time questions and statements that were more explanatory appeared in those threads that concerned explanatory issues.

Table 1 also shows that the students asked many metacognitive questions (53 notes), and contributed a reasonable number of metacognitive statements that included meta-discourse (48 notes) to reflect on progress and highlighted promising ideas or problems for further inquiry. All these data indicate that students invested much effort into reviewing and reflecting on the online discourse. At the same time, metacognitive questions and metacognitive statement appear more in threads that concerned explanatory issues. We further categorized students' contributions to their community. As shown in Table 1, 222 notes were classified as *depending inquiry*, and 40 notes were *synthesizing notes*. These results indicate a high frequency of responses to others' questions and ideas, most of which focused on conceptual advancement and at creasing a knowledge space of value to both the community as a whole and individuals.

Table 1: Number of different categories of questions, ideas and community in inquiry threads

| | No. of notes | No. of writers | Questions | | | Ideas | | | | Community | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Notes raising factual questions | Notes raising explanatory questions | Notes raising metacognitive questions | New ideas | Simple claim | Elaborated explanation | Metacognitive statement | Lending support | Deepening inquiry | Regulating inquiry | Synthesizing notes |
| Total of the 17 threads | 400 | 37 | 12 | 13 | 53 | 27 | 111 | 97 | 48 | 11 | 222 | 66 | 40 |
| Mean (per thread) | 23.35 | 13.24 | .71 | .82 | 3.24 | 1.67 | 6.76 | 6.00 | 4.53 | 0.65 | 13.53 | 3.94 | 4.12 |
| SD | 16.24 | 6.32 | .77 | 1.07 | 3.13 | 1.96 | 4.34 | 6.09 | 5.91 | 0.86 | 10.58 | 3.58 | 5.44 |
| #1 | 40 | 20 | 1 | 3 | 9 | 4 | 9 | 8 | 4 | 2 | 20 | 9 | 4 |
| #2 | 15 | 10 | 0 | 1 | 5 | 2 | 3 | 1 | 2 | 1 | 6 | 5 | 2 |
| #3 | 62 | 26 | 0 | 1 | 11 | 1 | 17 | 18 | 11 | 1 | 34 | 13 | 8 |
| #4 | 28 | 17 | 1 | 0 | 4 | 5 | 7 | 4 | 4 | 1 | 16 | 6 | 2 |
| #5 | 10 | 8 | 1 | 0 | 3 | 0 | 4 | 1 | 1 | 1 | 2 | 6 | 0 |
| #6 | 21 | 15 | 0 | 3 | 1 | 4 | 4 | 2 | 4 | 1 | 11 | 4 | 2 |
| #7 | 33 | 18 | 0 | 1 | 4 | 2 | 11 | 10 | 4 | 0 | 24 | 5 | 3 |
| #8 | 43 | 19 | 0 | 2 | 4 | 4 | 8 | 6 | 16 | 0 | 17 | 6 | 16 |
| #9 | 17 | 15 | 0 | 1 | 2 | 0 | 7 | 6 | 1 | 0 | 13 | 2 | 1 |
| #10 | 14 | 13 | 1 | 0 | 2 | 0 | 6 | 3 | 0 | 0 | 5 | 2 | 0 |
| #11 | 26 | 13 | 2 | 0 | 3 | 5 | 5 | 10 | 1 | 3 | 18 | 3 | 1 |
| #13 | 41 | 19 | 2 | 2 | 2 | 0 | 14 | 20 | 1 | 1 | 33 | 2 | 1 |
| #14 | 23 | 10 | 2 | 0 | 3 | 0 | 7 | 5 | 5 | 0 | 9 | 2 | 5 |
| #16 | 11 | 10 | 1 | 0 | 0 | 0 | 6 | 3 | 1 | 0 | 9 | 0 | 1 |

Notes: Inquiry threads defined as large included at least ten notes each. #1 = relationship between good art and art is good; #2 = need of criteria of art; #3 = appearance and meaningfulness of art; #4 = principles of art; #5 = differences among works of art; #6 = role of art; #7 = criteria of art; #8 = fundamental criteria to judge art; #9 = eternity of art; #10 = reasons for judgment of art; #11 = creative ideas and second creation; #13 = art prices; #14 = defining art; #16 = art appraisal.

Table 2. Frequency and percentages of notes classified as questions, ideas, metacognition and rise-above during three stages

| | Question | | Idea | | Metacognition | | | | Rise-above | |
|---|---|---|---|---|---|---|---|---|---|---|
| | f | % | f | % | Metacognitive question | | Metacognitive statement | | f | % |
| | | | | | f | % | f | % | | |
| Stage 1 | 11 | 8.59 | 26 | 20.31 | 15 | 11.72 | 1 | 0.78 | 0 | 0 |
| Stage 2 | 2 | 1.56 | 45 | 35.16 | 20 | 15.63 | 11 | 8.59 | 7 | 5.47 |
| Stage 3 | 1 | 0.78 | 26 | 20.31 | 19 | 14.84 | 43 | 33.59 | 39 | 30.47 |

## Questioning, ideation, metacognition and rise-above

We further analyzed the characteristics of the students' notes in 14 large inquiry threads in three stages, each stage having an equivalent proportion of notes, to demonstrate the advancement of discourse. As the goal was to show the advancement of discourse, comparison analysis was conducted on explanation-seeking questions (questioning), explanations (ideation), metacognitive questions and statements (metacognition), and rise-above (synthesis). Table 2 shows the results for the three stages and compared them with the aggregated results for each stage. The frequency distributions for Stage 1 and Stage 2 differed significantly: $\chi^2(df = 4, N = 109) = 15.60$, $\phi = 0.38$. The effect size was moderate to large. The frequency distributions also differed significantly for Stage 2 and Stage 3 three, $\chi^2(df = 4, N = 167) = 31.56$, $\phi = 0.44$; a medium to large effect; and for Stage 1 and Stage 3, $\chi^2(df = 4, N = 142) = 53.00$, $\phi = 0.61$; that was a large effect size. The results indicate primarily that the students contributed more explanation-seeking questions in Stage 1 compared with any other stages, and that that they were mostly engaged in reflecting on and regulating their inquiry, and synthesizing their notes during Stage 3.

# Conclusions

This study investigated whether students with low achievement were capable to collectively improve their attempt at knowledge building. During the knowledge-building process, students with low-achievement in this class, in a supportive knowledge-building environment, were indeed able to assume high-level responsibility to collectively accomplish knowledge-building discourse. They engaged in productive interactions and progressively advanced ideas in the communal space. In addition, the pedagogical design is accessible to students with low achievement. The design incorporated three components: (a) periodic tasks that promoted collaboration and reflection, (b) opportunities for reflecting assessment data collaboratively, and (c) the framing of discourse improvement as collective responsibility. Although this pedagogical design was developed for engaging low achieving students to collectively advance knowledge-building discourse, we believe that this design would have important implication for the design of technology-rich environments to support learners and shed light on how teachers can use them to help learners to gain benefits from collaborative inquiry.

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