Advancing Elementary Students' Reading Comprehension Scores Through Knowledge Building

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Abstract: This study employs Knowledge Building pedagogy and Knowledge Forum technology to advance reading literacies in a third-grade elementary reading class in Taiwan. We hypothesized that sustained engagement in idea-centered discussions surrounding reading materials would lead to higher levels of reading comprehension (i.e., interpretation, and integration). Using a quasi-experiment design, we collected: (a) students' online Knowledge Building behaviors, (b) group reading discussions, and (c) students' reading comprehension assessment. Our findings reveal that the experimental group (Knowledge Building) outperformed the control group (direct instruction) on the comprehension assessment. Additionally, we found that the Knowledge Building intervention supported the development of students' higher-level reading comprehension.

Keywords: Knowledge Building, Knowledge Forum, reading comprehension.

Introduction

Digital technologies have vastly redefined what it means to be literate in an open information world, offering new opportunities and challenges for students to engage with multimedia representations of information (Coiro et al., 2014; Goldman & Scardamalia, 2013). It is common nowadays for students to navigate search engines, sift through multiple webpages, and participate in online communities in order to exchange ideas and information online (Leu et al., 2004). From an education perspective, the challenge for literacy education is engaging students in sustained collaborative work with their ideas toward enriching learning and understanding (Resta & Laferrière, 2007; Scardamalia & Bereiter, 1991). Since online reading is becoming increasingly more important, this study aims to explore how educators can help elementary students read, comprehend, and interpret reading materials effectively – furthermore, construct meaning, make inferences, integrate and evaluate information in a Knowledge-Building environment.

Literature Review

Knowledge Building is a principle-based pedagogy (Scardamalia, 2002; Scardamalia & Bereiter, 2010) that aims to enculturate students in idea-centered discussions and sustained idea improvement through the process of co-constructing community knowledge (Hong & Sullivan, 2009; Zhang et al., 2011). Knowledge Forum (KF), was developed to integrate technology and pedagogy to improve students' reading skills in a Knowledge Building community (Bereiter, & Scardamalia, 1991). KF represents a community space for students to engage in high levels of epistemic agency and collective responsibility for developing questions they care about, exchanging conceptual resources with peers, and building on one another's ideas. Knowledge Building unfolds as sustained knowledge advancement in KF (Bereiter, 2002). Previous studies have indicated that elementary school students' reading, writing, and related activities on KF were positively related with vocabulary growth (Chen et al., 2015), reading skills (Zhang, & Sun, 2011), and essay writing performance (Lin et al., 2018).

Building on these studies, the current study aims to address a better understanding of students' reading comprehension within KF. More specifically, we conducted a quasi-experimental study to explore whether students improve their reading skills via Knowledge Building activities in a third-grade reading class. Our three research questions are: (1) How were students involved in online reading activities in KF? (2) How did the discussions on KF unfold? (3) Did the KB group or the comparison group do better on reading comprehension?

Method

Research context and participants

The current study took place in an elementary school in Taipei, Taiwan. The sample included 51 third-graders from two classes: 24 students were in the experimental group with a teacher using Knowledge Building pedagogy, and 27 students were in the control group with a teacher using the traditional teaching method. The typical Chinese

literature class in Taiwan is taught in a lecture-based and teacher-centric styled, with students' reading comprehension assessed based on mastery of textbook contents. On the other hand, in the Knowledge Building class, the teacher encouraged students to engage in collaborative reading and writing to sustain idea improvement. To understand students' reading comprehension in both conditions, we compared their comprehensive skills at the end of the intervention.

Pedagogical design

The current study took place over one semester (14 weeks). Although the two teachers used different teaching methods, they used the same regular reading articles (11 articles/lessons in total in the textbook). Each reading lesson was taught over 6 periods (40 minutes per period).

The experimental group

The teacher in the experimental group has five years of teaching experiences (including two years of Knowledge Building teaching experiences). The class activities were divided into two parts: face-to-face (i.e., lectures, textbook reading, and class discussion etc.) and online activities (i.e., students' online collaborative reading). The online activities were designed and guided by Knowledge Building principles to collaboratively question and discuss ideas as a reading community. The students participated in the following Knowledge Building activities in KF: (1) summarized their main ideas after reading based on the lesson from textbook; (2) asked questions to one another; (3) further elaborated/clarified their initial ideas and/or integrated various ideas by addressing the questions being asked by others. The teacher encouraged the students to summarize and ask questions based on the texts, as well as integrate their classmates' comments with their initial ideas in order to advance the community knowledge.

The control group

The teacher in the control group has more than ten years of teaching experiences. In the control class, the reading activities were teacher-led, well-structured procedures. The teacher acted as the sole authoritative knowledge source – she gave lectures for every article and then asked students to individually respond to factual questions based on the texts. Each lesson followed the same script over the 14 weeks.

Data sources

Data was collected from KF and the pre-post reading comprehension test scores. For research question 1, we collected students' online collaboration, which included the number of notes contributed, read, and built on in KF. For research question 2, we analyzed the content of the discussion according to four different levels (low to high) of comprehension skills: *(1) retrieving explicitly stated information (2) making straight forward inferences (3) interpreting and integrating ideas and information and (4) examining and evaluating contents and textual elements.* For research question 3, we surveyed pre-post reading comprehension tests, which were obtained from PIRLS literacy passages (i.e., 28 multiple choice questions and several open-ended essays). We analyzed these according to the PIRLS scoring guideline to evaluate students' reading comprehension on four levels (same as RQ2). 30% of the open-ended essay questions were randomly selected to calculate the inter-rater reliability (using Spearman's, $r = .839$, $p < .01$).

Results

Students' online reading activities in Knowledge Forum

The result showed that the amount of activities that students were involved in on KF was increased over the 14 weeks. We divided online reading activities into two phases (7 weeks per phase). Our statistical analyses show that the number of notes contributed (first phase: $M = 12.42$, $SD = 3.63$, second phase: $M = 16.42$, $SD = 3.91$; $t = -5.35$, $p < .001$), number of notes read (first phase: $M = 92.63$, $SD = 46.22$, second phase: $M = 161.17$, $SD = 106.76$; $t = -4.15$, $p < .001$), number of keywords used (first phase: $M = 9.17$, $SD = 4.03$, second phase: $M = 11.67$, $SD = 3.74$; $t = -3.49$, $p < .001$) and number of scaffolds used (first phase: $M = 11.25$, $SD = 4.33$, second phase: $M = 15.75$, $SD = 4.10$; $t = -5.21$, $p < .001$) significantly increased from the first phase to the second phase. These results indicate that students were more engaged in posting their thoughts online and interacting with others in the later phase of the semester. However, the number of notes built-on, which means the number of replies to peers, was not shown to be significantly different (first phase: $M = 8.29$, $SD = 3.46$, second phase: $M = 8.50$, $SD = 2.62$; $t = -0.34$, $p > .05$) between the two phases of the semester.

Students' reading comprehension in Knowledge Forum

Figure 1 shows a KF view that students extended what they read in the Chinese literacy class — Hynobius formosanus (an endangered species in Taiwan). In the beginning, their discussions were focused on understanding characteristics of hynobius formosanus; content of these notes were basically retrieved from the textbook and the Internet. Their discussion then shifted toward bigger issues, such as the decline of hynobius formosanus in Taiwan and what people can do to conserve them, which indicates that students were integrating and interpreting previous information (i.e., characteristics and living habits etc.) into authentic problems for them. Students were discussing ideas to propose possible solutions to conserve the species in Taiwan. Moreover, Figure 1 shows that students marked their notes with problems and keywords to identify their ideas and information, and in turn, used scaffolds to organize their notes – features specifically designed for enhancing idea-centered discussions in KF.

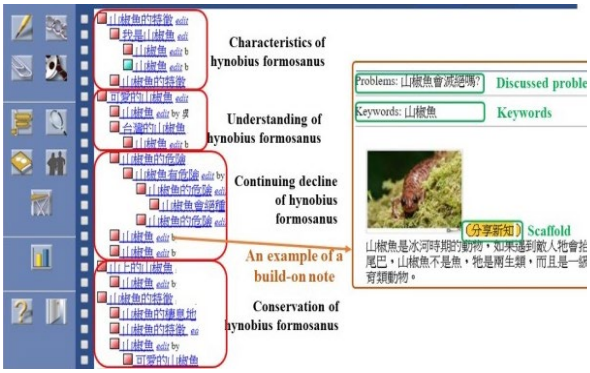
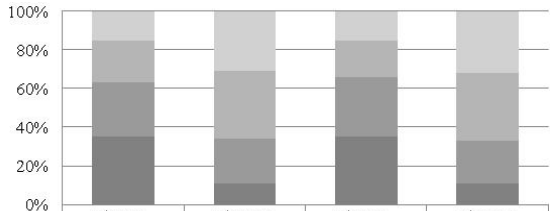


Figure 1. A KF view shows students' discussion the reading topic.



	Phase 1	Phase 2	Phase 1	Phase 2
	Discussed questions		Answered questions	
Level 4	15%	31%	15%	32%
Level 3	22%	35%	19%	35%
Level 2	28%	23%	31%	22%
Level 1	35%	11%	35%	11%

Figure 2. Students' notes related to questions and answered questions in four comprehensive levels on KF.

For our analyses, we divided all Knowledge Forum notes into questions they discussed and answered. We furthered coded notes' content according to four reading comprehension levels: *(1) retrieving explicitly stated information* (e.g., S15: The hynobius formosanus has white spots on the skin.) *(2) making straight forward inferences* (e.g., S1: The hynobius formosanus is a threatened species, its kin mucus is toxic that could protect it from danger.) *(3) interpreting and integrating ideas and information* (e.g., S24: The hynobius formosanus is a rare species and it lives in the high-altitude habitats. Their habitat is lost and degraded when global warming is increasing so that they cannot live there.) *and (4) examining and evaluating contents and textual elements* (e.g., S18: The hynobius formosanus lived since Ice Age, it can only live in high mountains. We should protect their habitats, the most important thing is to prevent global warming from becoming worse. As a result, they will not become endangered.). As shown in Figure 2, we also ran t-tests and showed that questions of level 1 ($t = 2.07$, $p < .05$) and level 2 ($t = 2.08$, $p < .05$) decreased significantly in the second phase (i.e., less retrieving explicitly stated information and making straightforward inferences). On the contrary, the questions of level 3 ($t = -3.28$, $p < .01$) and level 4 ($t = -2.15$, $p < .05$) positively increased in the second phase (i.e., more interpreting and integrating ideas and information and examining & evaluating content and textual elements). Our statistics revealed that that students' discussion progressed from basic comprehension levels (level 1 and 2) in the first phase to deep comprehension processes (level 3 and 4) in the second phase.

Comparison of students' reading comprehension

We examined whether our Knowledge Building intervention enhanced students' reading comprehension. Firstly, the pretest showed no differences between the experimental and control groups with respect to students' reading comprehension ($F = 2.697$, $p = 0.107$). Next, MANOVA indicated that the posttest scores were statistically significant at the .05 level. The experimental group outperformed the control group (experimental versus control: $M = 26.29$, $SD = 0.65$; $M = 23.11$, $SD = 0.61$; $F = 11.924$, $p < .001$) on the PIRLS, confirming our hypothesis.

Discussion and future directions

In this study, we examined Knowledge Building activities and reading comprehension development of third-graders in a Chinese literacy class. First, we examined the experimental group's online collaborative Knowledge Building activities in KF. Notes written, notes read, keywords used, and scaffolds used significantly increased during the semester. Second, we analyzed the experimental group's KF discussion and coded it along 4 levels of comprehension skills. We found that in the earlier phase, students were mainly focused on basic comprehension level (retrieving explicitly stated information and making straight forward inferences), whereas in the later phase,

their discussion turned to deeper comprehension (interpreting and integrating ideas and information and examining and evaluating contents, languages and textual elements). Third, we compared the reading comprehension of students in the experimental and control groups and found that Knowledge Building pedagogy and technology significantly advanced students' reading comprehension scores.

Previous studies on literacy education place an emphasis on explicit teaching strategies to provide effective instruction for students' reading comprehension (e.g., Guthrie et al., 2004). Based on this perspective, the teacher's role is to implement and manage instructional practices while monitoring student understanding. Our study, on the other hand, provides support for teachers adopting a principle-based approach to literacy instruction (i.e., identifying authentic problems, making use of authoritative texts to improve students' ideas, connecting ideas and building community knowledge through collective responsibility). Our findings suggest that when students engage in reading activities with appropriate Knowledge Building pedagogical and technological supports, students benefit in a way that advanced high-level reading comprehension. This is an important implication for embodying students' reading ideas during the Knowledge-Building process in a computer-supported collaborative learning environment. More specifically, our study shows that KF supports are especially helpful for engaging young students in deep and productive discussions surrounding complex ideas. Future work should aim to explore over extended periods of time the evolution of group knowledge processes that facilitate the development of students' higher-level literacy skills during Knowledge Building.

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