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Running Head: DEEP UNDERSTANDING AND LITERACY

**Developing Deep Understanding and Literacy while Addressing a Gender-Based
Literacy Gap**

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Abstract

Online discourse for a class of 22 students (11 boys and 11 girls) was used to assess advances in conceptual understanding and literacy. The students worked over a two-year period (Grades 3-4), during which they contributed notes to a collaborative, multimedia online knowledge building environment—Knowledge Forum®. Contributions revealed that both boys and girls produced a substantial amount of text and graphics, and that their written texts incorporated an increasing proportion of less-frequent, advanced words, including academic vocabulary and domain-specific words from grade levels higher than their own. Brief accounts of face-to-face classroom discourse indicate how deepening understanding and vocabulary growth mutually support each other in online and offline exchanges. The gender differences that were observed show boys doing slightly better than girls, suggesting that knowledge building has the potential to help boys overcome weaknesses in literacy.

Developing Deep Understanding and Literacy while Addressing the Gender-Based

Literacy Gap

Introduction

With the advent of the “Knowledge Age” in which social wealth is based upon the capability to create, advance, integrate, and use knowledge, there is need for a multi-literate society able to generate new knowledge, and education to engage all citizens in the process of knowledge creation that addresses disparities in achievement. Almost half of Ontario grade three students still fail to meet Ministry standards in reading and writing (Ontario Public School Boards’ Association, 2004). And worldwide, boys tend to lag behind girls in conventional literacy (OECD & UNESCO Institute for Statistics, 2003; Ontario Public School Boards’ Association, 2004). How to raise the level of literacy among all students and boys in particular represents an important challenge. The purpose of the present study was to explore whether a knowledge building approach (Scardamalia & Bereiter, 1994, this issue) might help with the parallel challenges of deeper understanding while helping to develop literacy among both boys and girls and addressing the literacy gap between them.

Developing Student Literacy in a Knowledge Building Environment

Recent research views literacy as a complex social practice learned through dialogic communication and apprenticeship into literate discourse communities (Applebee, Langer,

Nystrand, & Gamoran, 2003). A number of research initiatives explored how to use new technologies—computer-mediated communication in particular—to engage students in authentic literacy communities. For example, Lamy & Goodfellow (1999) created the “Lexica On-line” environment to promote reflective conversation around language topics and language learning issues, with a special focus on vocabulary learning. Students were required to download and read texts from the Web, extract and process vocabulary items, and participate in online discussion. Zhao and colleagues (Zhao, Englert, Chen, Jones, & Ferdig, 2000) developed the TELE-Web (Technology Enhanced Literacy Environment on the Web) system that included four central elements: Writing Room, Reading Room, Library, and Publishing Room, integrating multi-mode literacy instruction (oral, listening, reading, and writing). TELE-Web was designed to engage students in an inquiry-driven knowledge construction process, which necessitates active manipulation of information from multiple sources, generation of texts, and different forms of interactions and discourse involving peers, teachers, and experts. Similarly, Clarke and Heaney (2003) documented an “Author on-Line” (AOL) project, in which pupils read novels related to a topic, wrote book reviews and critiques, and interacted with peers, the teacher, book authors, and experts using an asynchronous computer conferencing environment. According to a recent review (Warschauer, 2007), learning environments based on synchronous and asynchronous online communication can promote student-directed interactions, extensive authentic writing with genuine audiences, and collaborative reading.

Many of the studies on literacy learning in online environments imply a connection between language learning and knowledge building. However, with rare exceptions (e.g., Thakkar, Bruce, Hogan, & Williamson, 2001), existing literature focuses exclusively on literacy practices in language classes and programs. The present study investigates student literacy practices as an important aspect of community knowledge building across content areas, exploring the possibility of developing literacy as an important by-product of productive knowledge work. According to Scardamalia and Bereiter (1994, 2006, this issue), knowledge building refers to a process in which members collectively generate and improve ideas of value to their community. This process is advanced through transformative, knowledge building discourse aimed at continual idea improvement, progressively expanding the base of conceptual facts. The knowledge building process is further supported by a computer-based knowledge building environment—Knowledge Forum® (see Scardamalia, 2004, for detailed descriptions). Knowledge Forum is a multimedia knowledge database with a set of features supporting collective knowledge building. By authoring notes¹, students contribute ideas, questions, empirical data, reference material, personal experiences/stories and so forth, to views, which are workspaces for various clusters of inquiry. Both notes and views can include multimedia elements (e.g., text, graphics, video). Supportive features for knowledge building discourse allow users to co-author notes, build on and annotate notes of community

¹ The italicized words in this section represent basic features of Knowledge Forum referred to throughout this article.

members, create reference links with citations to each other's notes, add keywords, and create rise-above notes to summarize, distil, and advance their discussions. Knowledge Forum also has "scaffolds" to aid the creation of various epistemic artefacts. The theory building scaffold, for example, encourages students to write notes conforming to the following: "My theory," "I need to understand," "New information," "This theory cannot explain," "A better theory," and "Putting our knowledge together." Teachers and students can customize the scaffold supports according to their curricular and subject matter needs. Activity (reading, writing, building on, referencing, etc) is recorded automatically. Analytic tools work as background operations so that patterns of contribution, revision, and interaction for each individual and for the class as a whole can be quickly assessed and fed back into the ongoing process. Within the knowledge building context, students generate problems of understanding, share new resources through cooperative reading, and create/improve diverse ideas through face-to-face knowledge building discourse. They contribute their problems of understanding, ideas, data, and resources, generated through face-to-face discourse, reading, experiments, etc, to Knowledge Forum for continual improvement.

Knowledge building practice in both online and offline environments creates diverse demands and opportunities for high-level literacy practices, including, wide, deep, and cooperative reading (Scardamalia, Bereiter, Hewitt, & Webb, 1996); extensive and authentic writing that integrates multimedia elements and involves real and responsive audiences (Warschauer, 2007); and open, extended, and continuous dialogic interactions

focusing on authentic problems and deepening understanding (Applebee, 1996; Bakhtin, 1981; Cummins & Sayers, 1995; Nystrand, 1997; Swain, 2000; Zhao et al., 2000). It is thus reasonable to expect that knowledge building practice should facilitate literacy development, including textual, graphical, and dialogic literacy. Dialogic literacy refers to the ability to engage productively in knowledge building discourse whose purpose is to generate new knowledge and understanding (Bereiter & Scardamalia, 2005). In the knowledge building process, idea advancement is the focus of the community, and literacy development for the individuals involved occurs as an important by-product (Scardamalia, 2003). This perspective has recently been supported by analyses of students' vocabulary growth (Sun, Zhang, & Scardamalia, in press) and sophisticated representations of ideas in graphic notes (Gan, Scardamalia, Hong, & Zhang, 2007).

Addressing the Gender Gap in Literacy

As an important aspect of the masculine disparity in school education, boys' under-achievement in literacy has become a disturbing issue in the last two decades. Significant gender differences were observed in both performance and attitude towards language learning, revealing boys' comparative disadvantage in every aspect of the language curriculum (Gorman, White, Brooks, Maclure, & Kispal, 1988; Millard, 1997; Ofsted, 1993). A recent study evaluated the reading achievement of fourth-grade students from 35 countries including Canada. In all countries, boys had significantly lower achievement than girls (Mullis, Martin, Gonzalez, & Kennedy, 2003).

Boys' disadvantage in literacy may be attributed to a number of biological,

psychological, social, and pedagogical reasons (Millard, 1997). In term of pedagogical design, current literacy curriculum is heavily dependent on the reading and writing of fictions characteristic of themes like human relationships and feelings, which are often not of core interests of boys. As well, literacy learning and assessment tend to exclusively focus on language classes, with literacy experiences in other subject areas and out-of-school contexts largely ignored. Online and multimedia literacy activities, which are becoming increasingly essential in the real world, are far under-represented in the curriculum. As recent studies suggest, boys demonstrate a perceived lack of purpose and relevance in schoolwork, and show a general lack of interest in print-based reading and writing activities. On the other hand, they have strong interests in electronic and graphic forms of literate practice, and are eager to ‘do’ literacy in public ways and in real-life contexts (Alloway, Freebody, Gilbert, & Muspratt, 2002). To help boys catch up in literacy, schools need to adapt their approach to literacy learning and teaching “in ways that are more ‘boy friendly’, without losing sight of practices that have enabled girls to succeed.” (Millard, 1997, p. 167) For example, the literacy curriculum should place more emphasis on learning from non-fiction texts, connect literacy learning with the whole school curriculum to promote knowledge construction with texts, and draw on new technologies and media to create live and stimulating contexts for literacy learning.

As has been noted previously, knowledge building pedagogy integrates literacy practice into efforts to advance understanding in different curriculum domains, increasing the chances of bridging students’ diverse disciplinary interests with literacy work. More

importantly, knowledge building practice is largely driven by students' authentic problems, and unfolds as a social and interactive process in which students pursue sustained knowledge building discourse as a community in both face-to-face and online environments, with the online multimedia environment supporting multiple modes of representing ideas. Given that knowledge building practice has the above properties, it should be able to engage boys deeply in literacy practice, and help both boys and girls expand the scope of their textual encounters and develop language competence. The present study focuses on an indicator of conceptual and literacy growth in a knowledge building class: vocabulary. The research question asks: Can boys and girls equally develop their literacy, vocabulary in particular, by participating in sustained knowledge building practice? This question is addressed through secondary analyses of an existing dataset that traces a class of students' discourse in Knowledge Forum over two school years (Sun et al., in press).

Method

Participants and Contexts

Participants were 22 students (11 girls and 11 boys) from the Institute of Child Study, a laboratory school affiliated to the University of Toronto. Most of the students were from a middle class background. They were eight-to-nine-year old in Grade 3 and nine-to-ten-year old in Grade 4. We analysed their online discourse over the two-year period—first in Grade 3 and then in Grade 4. In the two years, the students were taught by two different teachers, with equivalent experience in knowledge building pedagogy

and Knowledge Forum. As a part of the science and social studies curricula, the students investigated worms, plants, as well as geography in Grade 3; and living things, light, and Medieval Time in Grade 4. In these knowledge building classes, the students collectively generated questions and ideas through knowledge building talks, searched and shared information from books, the Internet, and other sources, generated experiments to test and advance their theories, and participated in online discussions in Knowledge Forum by writing new notes in views (i.e., spaces for contributing and developing ideas), reading existing notes, and building onto each other's notes to advance their communal knowledge. Problems, hypotheses, experimental findings, and information resources became the objects of sustained discourse in both online and face-to-face environments. Figure 1 shows students' discussions in a view titled "Plants: Composting" in Grade 3, together with a note about how plants grow.

Insert Figure 1 about here

The primary data source was students' online entries in Knowledge Forum over the two-year period, supplemented with the teacher's reflection journals providing accounts for the knowledge building designs and specific classroom scenarios, illustrating the interplay between online and offline processes. We analysed student word use in their Knowledge Forum notes in each half school year, which, for convenient purpose, we call a "semester" that consisted of approximately five months. Specific analyses of students'

texts included:

(a) Total words and distinct words written. We calculated the number of total words and distinct words written by each student in the two years in Knowledge Forum. Among the distinct words, we identified misspelled words and only counted the number of correctly spelled distinct words.

(b) Grade levels of new words. For each of the last three semesters, we used the analytic tools of Knowledge Forum to identify words that were used for the first time by a student (i.e., words that had not been used in previous semesters). Then we classified each new word as within or beyond Grade 4 based on the Basic Spelling Vocabulary List of Graham, Harris, & Loynachan (1993). The Basic Spelling Vocabulary List contains 850 high frequency words that accounted for about 80% of the running words that elementary students across the US use in their writing on various themes and of different genres, with 813 words assigned to the fourth and lower grades. This vocabulary list may not be able to reflect the exact picture of word use among Canadian students, however, it provides a general scope of basic written words among youngsters, and has been widely used by researchers and educators from English-speaking countries.

(c) Lexical Frequency Profiles. To assess the growth of students' productive written vocabulary over the two years, we used a measure of Lexical Frequency Profiles, which assesses students' vocabulary in use by analysing the percentages of word families at various frequency levels in a piece of written work (Laufer & Nation, 1995). Use of low frequency words is an indicator of richness in a learner's vocabulary (Nation, 2001). A

program called “Range” (Nation, 2001) was used to analyze the Lexical Frequency Profiles for each student’s notes in each semester. Three wordlists were used in this analysis: first 1,000 word families, second 1,000 word families (West, 1953), and the Academic Word List (Coxhead, 1998). The Academic Word List consists of 570 word families (e.g., assume, establish, conclude, analyse, assess, category) that are not in the most frequent 2,000 word families of English, but occur at a reasonably high frequency in academic texts of different disciplinary areas. These academic words are typical of academic discourse, allowing writers to write in an academic way, referring to others’ work and working with data and ideas.

(d) Use of domain-specific vocabulary. This analysis was performed based on a sample inquiry on optics conducted in the second semester of Grade 4. Over four months, the students investigated a range of core issues about light through a largely emergent process (see Zhang, Scardamalia, Lamon, Messina, & Reeve, 2007). From The Ontario Curriculum of Science and Technology (Grade 1-8), two coders cooperatively identified 89 domain words related to light, including names of core concepts, optical devices and optical phenomena. Most of these words come from: (a) Matter and Materials (Grade 4): Materials that transmit, reflect, or absorb light; (b) Energy and Control (Grade 4): Light energy; and (c) Energy and Control (Grade 8): Optics. A few words were identified from Earth and Space Systems (Grade 1) (e.g., heat, light, sun, shadow, etc.), and Earth and Space Systems (Grade 6) (e.g., stars, solar, lunar, eclipse). We created a wordlist composed of these 89 words as well as their grammatical variations (e.g., absorbs,

absorbed, absorbing for absorb), with a total of 180 words. Using the analytic tools of Knowledge Forum, we traced the occurrences of these words in students' notes in the optical discourse.

Results

Student Writing Over the Two-Year Period

The online discourse of the students included a variety of genres of writing. They stated important questions, proposed and developed ideas, reported experiments, narrated personal experiences and observations to elaborate and justify their ideas, introduced new information from authoritative sources, commented on each other's notes to improve ideas, and reviewed and summarized their discussions to achieve a higher level of conceptualization (see Zhang et al., 2007 for detailed analyses of these content categories). Over the two school years, students wrote an average of 61.90 notes consisting of 3,867.55 tokens (total words) and 715.45 types (unique words excluding misspellings), and read 46.50% (equivalent to a number of 566.84) of the notes of the community. As Table 1 shows, boys wrote a significantly larger number of correct distinct words than girls, with no significant difference in the number of total words.

Insert Table 1 about here

Literature expresses a concern over the unequal engagement of boys and girls in different subjects, with boys more deeply involved in natural science (Zohar & Sela, 2003). Can

knowledge building engage boys as well as girls in inquiry of both natural and social science topics? To clarify this issue, we analysed student writing and reading in three knowledge building initiatives implemented in Grade 4: (a) Light, an important area in physics, which is usually seen as an example of hard science; (b) Living things (e.g., characteristics of living things, biomes, symbiosis, evolution, and photosynthesis), an example of science but not as “rigorous” as physics; and (c) Medieval Time, an area of history and social study. Figures 2 and 3 show the total words written and percentages of notes read by the boys and girls in their online discourse. The students wrote more words in the light inquiry than in the other two inquiries ($F(2, 19) = 30.23, p < .001$) without significant gender difference ($p > .05$).

Insert Figure 2 about here

The Grade Levels of New Distinct Words

As Table 2 shows, both boys and girls introduced a growing number of new distinct words in each semester, a large proportion of which were beyond a Grade 4 level according to the Basic Spelling Vocabulary List for Grade 1-5 (Graham et al., 1993). Boys seemed to have included more new words than girls in the last two semesters ($p < .10$) and incorporated more upper grade words in the last semester ($p = .05$).

Insert Table 2 about here

Lexical Frequency Profiles

Our further analysis looked at the Lexical Frequency Profiles of students' notes in each semester by analysing their use of different bands of words (see Figure 3 through 5). Repeated measure ANOVAs were used to examine differences in percentages across the four semesters with gender as a between-group factor. Along the four semesters, both boys and girls tended to use a decreasing proportion of the 1st 1000 words ($F(3, 60) = 58.73, p < .001$), with a lower proportion of the 1st 1000 words for boys than girls ($F(1, 20) = 5.68, p < .05$). When it comes to the proportion of the 2nd 1000 words, there was a noticeable interactive effect between semester and gender ($F(3, 60) = 2.77, p = .05$). Tests of simple main effects indicated that boys used an increasing proportion of the 2nd 1000 words along the 4 semesters ($F(3, 18) = 5.50, p < .01$), with no consistent growth for girls. Both boys and girls incorporated an increasing proportion of academic vocabulary along the four semesters ($F(3, 60) = 33.08, p < .001$), with no significant gender difference ($p > .10$). There was a noticeable increase for every student in the proportion of academic words, including the least active students.

Insert Figure 3 about here

Insert Figure 4 about here

Insert Figure 5 about here

Use of Domain-Specific Vocabulary

This analysis was performed based on the students' study of optics in the second semester of Grade 4. Over four months, the students created 287 notes in seven views in Knowledge Forum. Their discourse covered all the required topics listed in The Ontario Curriculum of Science and Technology for Grade 4, as well as many topics expected for Grade 8, for instance, light waves, color vision, colors of opaque objects, concave and convex lenses, etc. Pre- post-test results showed significant knowledge advances for individual students. Ratings of students' ideas in the knowledge building discourse indicated that they had moved from intuitive understandings of optics to scientific accounts (see Zhang et al., 2007 for these analyses).

In the discourse, this community used 120 of the 180 domain-specific words (including grammatical variations) and 71 of the 89 lexemes identified from the curriculum about optics. The students incorporated almost all the optical vocabulary at or below Grade 4 (41 out of 46) and much of the vocabulary expected for upper grades (30 out of 43) into their online discourse. To exemplify how students appropriated new

domain-specific vocabulary into knowledge building discourse, we looked at inquiries of how light travels, as reflected in classroom, face-to-face discourse and in Knowledge Forum, aided by the classroom records of the teacher. The problem of “how light¹ travels” caught students’ interests. They first came up with the idea that light travels in a straight line. Later, by talking with an uncle who had a science background, SL picked up the concept of light wave, which he apparently recognized as something he and his classmates needed to understand. According to the Ontario Curriculum, understanding of “light wave” is expected for students in Grade 8. The apparent contrast between “straight line” and “wave” triggered a debate among the students. In a classroom talk, EL spoke about the wave theory of Christiaan Huygens, as found in a book: Light looks like little “c” emitting from the source. CJL presented his experiment originally conducted by Thomas Young, in which light, passing through a tiny hole in cardboard, produces two light spots on a board held behind the one with the hole. He concluded that the hole separates the wavelengths of light and causes us to see two light spots thus proving that light travels in waves. As they would normally do, after this face-to-face talk, students logged into Knowledge Forum to record their important ideas and problems arising from the talk. As an example, Figure 6 shows CJL’s note on Thomas Young’s experiment. The students continued their discussion online and generated diverse explanations. A conceptual advance was achieved when JD made a “rise-above” note of these

¹ Italic words in this section represent domain-specific words identified from the curriculum document.

perspectives by saying: “Putting our knowledge together, ... light travels in a straight line but it is a wave. Light is made up of the electromagnetic waves.” This then became a new object of discussion. Students’ deepening understanding and vocabulary expansion appeared to mutually support each other, contributing to the knowledge work of the community.

Insert Figure 6 about here

On average, each student used 43.50 (SD = 8.63) of the 120 words. The average number of occurrences of such words was 207.08 (SD = 93.42). As Table 5 shows, boys used more distinct domain words than girls in their discourse on light ($p < .05$), with no significant gender difference in the number of total domain words.

Insert Table 3 about here

Discussion

To investigate whether sustained knowledge building practice can help both boys and girls elaborate scientific concepts and develop their productive written vocabulary, this study analysed vocabulary used by elementary students in text and graphics notes contributed to their online knowledge building discourse over two school years. We

also considered results from related studies of growth in graphical representations (see Gan et al., 2007 for details) and idea advancement (Zhang et al., 2007). There were substantial increases in the amount of written text produced in Knowledge Forum over the four semesters, by both boys and girls. In each semester, they incorporated a large number of new words, 40.65% of which were beyond a Grade 4 level. The analysis of Lexical Frequency Profiles indicated that students increasingly used less frequent words in their discourse. The number of distinct words in student writing should not be understood as the actual size of students' productive written vocabulary. However, according to Laufer and Nation (1995), there are strong correlations between learners' Lexical Frequency Profiles and their vocabulary size as measured by direct testing. Learners who used lower proportions of high-frequency words in their texts scored higher in the vocabulary test. Existing research (Nation, 2001) suggests that the change of Lexical Frequency Profiles in free writing takes a long time. It is not easy to bring low frequency words into productive use. The present study observed changes in students' Lexical Frequency Profiles, suggesting that along the knowledge building practice, the productive written vocabularies of these students increased substantially.

It is particularly noteworthy that there was a significant increase for both boys and girls in the percentage of words from the Academic Word List. For example, students widely used words from the following word families: theory, design, create, debate, evidence, hypothesis, approach, challenge, clarify, identify, expand, adjust, link, category, conclude, cooperate, and so forth. Vocabulary choice is a strong indicator of whether the

writer has adopted conventions of the relevant discourse community (Nation, 2001).

Writers with academic purposes need to gain control of the academic vocabulary in order to be recognized as a member of the academic writing community. The literature suggests these words are hard to learn and use, and mainly developed late through secondary and higher education (Corson, 1997). The knowledge building practice examined in this study created rich opportunities for students to encounter academic vocabulary in various, authentic contexts (e.g., reading, talking, online discussions) and bring the vocabulary into productive use in knowledge building discourse, the sort of oral and written dialogues that academic communities typically use to advance knowledge in a field (Bereiter & Scardamalia, 2005).

The analysis of the knowledge building discourse in the optical inquiry showed that students addressed many deep issues in the domain, building on their intuitive understanding to achieve more coherent, scientific ideas. Coinciding with the processes of deepening understanding, their knowledge building discourse incorporated almost all the domain-specific terms expected for Grade 4 or below, as well as about 3/4 of those expected for upper grades. They collectively identified important concepts from multiple sources (e.g., reading materials, dialogues with adults, peer talks, experiments), turned them into objects of sustained inquiry and knowledge building discourse in both online and offline environments, and used them as tools to understand deeper issues in the domain. As our earlier analyses revealed, there was a significant correlation between the total occurrences of the domain-specific words in students' notes written for the optical

inquiry and the complexity level of their understandings summarized in their portfolio notes as rated on a four-point scale from unelaborated facts to elaborated explanations (Sun et al., in press). Productive engagement in disciplinary knowledge building and literacy practices (e.g., learning of new vocabulary, written discourse, reading for problem solving, classroom talk) appear to be supportive of each other,

While both boys and girls were able to develop their vocabulary along the knowledge building discourse, the boys in this study outperformed girls on a number of indicators. As they proceeded with knowledge building, boys tended to write a larger number of distinct words in their discourse. Particularly, they incorporated more distinct words beyond a Grade 4 level, words of the 2nd 1000 word families, and technical terms relevant to the domain of inquiry. These results suggest that knowledge building practice has the potential to engage boys actively and productively in literacy work. It can help integrate literacy work into authentic inquiry in various content domains To solve authentic problems and improve ideas in a content domain, students read a wide variety of materials and participate in sustained, knowledge building discourse that involves multiple genres of writing, increasing the scope of their textual encounters. The knowledge building discourse is supported by the online multimedia environment of Knowledge Forum, which encourages collective advancement of knowledge in a public, communicative space. All these properties seem to be able to adapt literacy work in a way that can accommodate the preferences of boys as identified by researchers (Alloway et al., 2002; Millard, 1997), and develop their literacy in a more effective way. These

efforts will not disadvantage girls by altering the conditions under which they succeed in language classes. But rather, by participating in knowledge building practices, girls will also be able to expand their literacy engagement (e.g., non-fictions, visual and digital literacy) and have their literacy strengths updated in the era of information technology and knowledge innovation.

Conclusions and Implications

Based on the analyses of students' vocabulary use in extended knowledge building discourse, the researchers suggest that sustained knowledge building practice can engage students of both genders in important conceptual work, reflected in contributions to a multimedia knowledge building environment that engages them in multiple forms of literacy. The knowledge building approach, supported by this environment, has the potential to help boys overcome their weaknesses in literacy, especially through advances in their productive written vocabulary embedded in text and graphic notes. Along with earlier analyses of students' vocabulary growth (Sun et al., in press) and graphical literacy (Gan et al., 2007), this study provides further evidence for the possibility of developing students' literacy as a by-product of knowledge building (Scardamalia, 2003). Advances are reflected in both written and graphics productions that were independently assessed as demonstrating significant idea improvement. Establishing the finding that deep, sustained work with knowledge and ideas results in substantial gains in literacy has significant implications for school reform: Solid literacy training and creative knowledge work, essential for education for a Knowledge Age, can be actualized through the same

process, as knowledge building focuses on sustained idea advancement in a communicative, multimedia surround, thus enabling literacy development as an important by-product of sustained work with ideas. This finding points to a new, active approach to developing high-level literacy and closing literacy gaps without needing to limit time and resources committed to sustained knowledge work. Specific design issues for facilitating literacy learning in knowledge building classes (e.g., cooperative reading of difficult texts, collective responsibility for language use) were elaborated in an earlier paper (Sun et al., in press).

The findings of this study were derived from analyses of a relatively small sample of students based on naturally generated discourse data. Further studies need to re-examine these findings using a control group design among a larger sample of students, use multiple measurements to assess student vocabulary growth (e.g., direct test and essay writing), encompass other literacy performances such as writing quality, and provide deeper, qualitative accounts for students' literacy work and knowledge building outside of Knowledge Forum.

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Figures

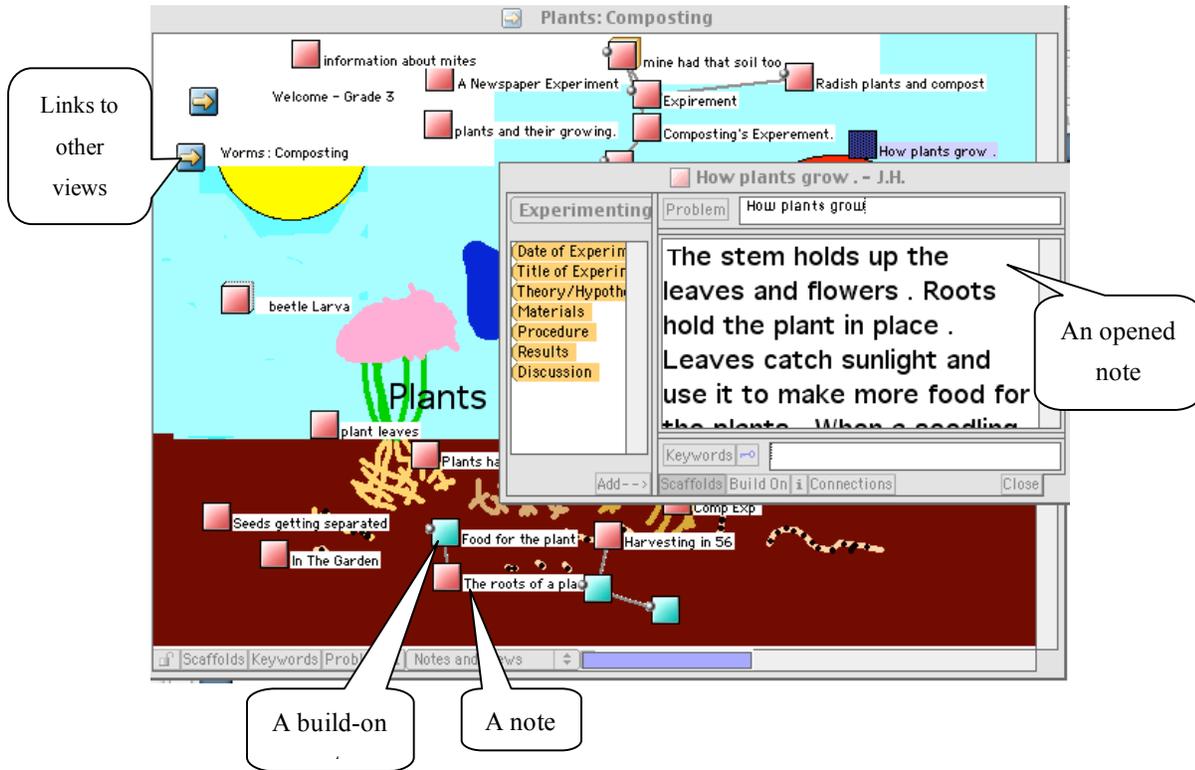


Figure 1. Students' textual and graphical inputs to a Knowledge Forum view: "Plants: Composting".

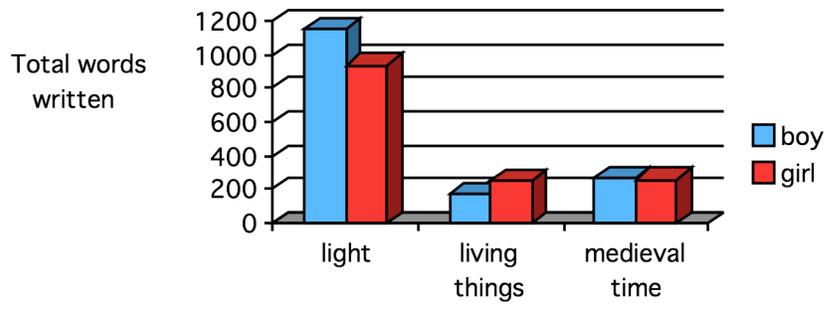


Figure 2. Total words written by the boys and girls in the three content areas.

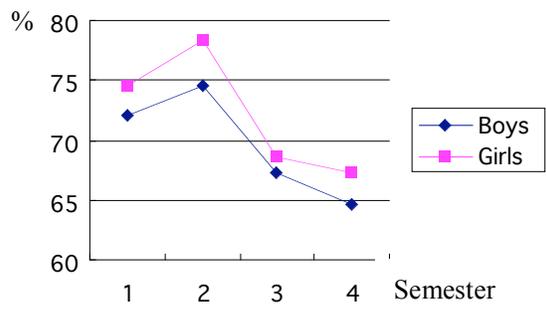


Figure 3. The percentage of the 1st 1000 words in each student's writing.

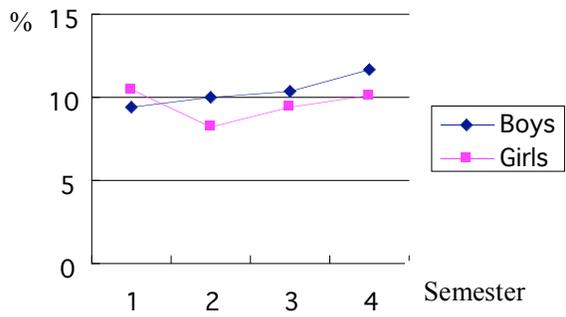


Figure 4. The percentage of the 2nd 1000 words in each student's writing.

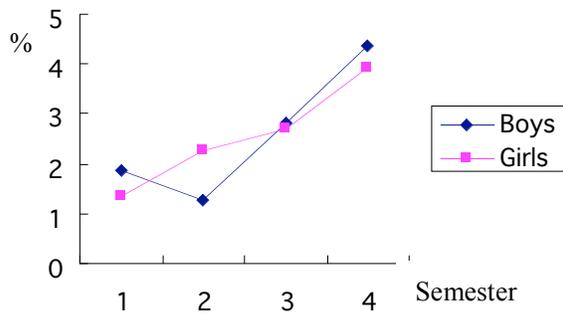


Figure 5. The percentage of academic words in each student's writing.

1801, Thomas Young's experiment - C.L.J.

ICS Grade 4

Problem

My theory
My problem of
New informatio
I need to unders

New information In 1801 **Thomas Young** showed that light travels in a **wave**. He did that by an **experiment**. This is what he did. He took a single light source and took a board and cut two pinholes in the board, then he shone the light through the **pinholes**. On the other side of the wall the light shows a **pattern**. It goes **light light, dark, light light** ect. What I mean is that instead of only making two light spots on the wall, he proved that **6 light spots were created**. This proves that light must travel in a **wavy line**. If light travelled in a **straight line**, he should only have made two light spots on the wall. I did this **experiment** in class and got the same results. I used **straight lines** in my drawing to show how the **wavy lines** travel. ☺

the one source of light

the two pin holes in the board

The light spots on the wall

Keywords: cut two pinholes, dark, experiment, light light, light spots were, light spots were created, line, pattern, pinholes, straight, Thomas Young wave wavy wavy line

Add --> Scaffolds Build On i Connections Close

Figure 6. A student note on how light travels.

Tables:

Table 1

Total Words and Distinct Words Written over Two Years.

	Boys	Girls	T (df)	p
	Mean (SD)	Mean (SD)		
# of total words	3798.18(2281.14)	2663.18(583.24)	1.60 (11.3)	.14
# of correct distinct words	800.55(231.37)	630.36(93.81)	2.26 (20)	.04*

Note. * $p < .05$

Table 2

The Number of New Distinct Words and New Words Beyond the Grade 4 Level.

	Boys	Girls	T (df)	p
<u># of new words</u>	Mean (SD)	Mean (SD)		
2 nd semester	113.73(54.32)	98.18(39.76)	.77(20)	.45
3 rd semester	281.00(84.77)	224.09(63.67)	1.78(20)	.09
4 th semester	377.36(95.99)	312.55(67.69)	1.83(20)	.08
<u># of new words beyond Grade 4</u>				
2 nd semester	64.55(41.44)	49.91(20.65)	1.05(20)	.31
3 rd semester	188.18(70.74)	150.55(46.71)	1.47(20)	.16
4 th semester	284.91(83.42)	225.45(47.30)	2.06(20)	.05

Note. New words were defined as words that were used for the first time and had not appeared in writing of previous semester(s). Words used in the first semester were not included in this analysis.

Table 3

Use of Domain-Specific Words in the Knowledge Building Discourse on Light.

	Boys	Girls	T (df)	p
	Mean (SD)	Mean (SD)		
Distinct matches	50.82(7.14)	42.44(8.23)	2.52 (20)	.02*
Total matches	253.73(123.00)	192.73(33.93)	1.59 (11.51)	.14

Note. * $p < .05$