Addressing Gender Gap in Literacy through Knowledge Building:
A Follow-up Analysis of Different Content Areas

(A rough draft)

Abstract

This study analyzed 22 fourth-graders (11 boys and 11 girls)' reading and writing behaviors and the level of vocabulary use in online knowledge building discourse across three content areas: light, living things, and Medieval Times. Results showed that in most of the indicators there was no significant gender difference, suggesting that boys and girls can be equally engaged in knowledge building work in different subject areas, including science and social studies, and develop their productive written vocabulary along the process.

Key words: knowledge building, literacy, gender gap, science

Introduction

Developing literacy as by a product of knowledge building

There are two primary demands driving educational reforms of today: one is to raise literacy of all students and close gaps related to gender, races and other social factors; the other is to develop creative capacity in knowledge work. The essence of knowledge building pedagogy and technology is to engage students in creative, communal knowledge work across different subject areas, and develop literacy and other basic skills as a by-product of this process. According to Scardamalia and Bereiter (1994, 2006), 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. 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, 2004); 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). 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, as reported in Sun, Zhang, and Scardamalia, (2006).

Addressing Gender-Related Gaps in Literacy and Disciplinary Learning

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). 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.

Meanwhile, females' underachievement in science tests has been reported in 28 countries in Europe, North America, Asia, Oceania, and the Middle East (Zohar & Sela, 2003; Labudde, Herzog, Neuenschwander, Violi & Gerber, 2000). In science classrooms, boys receive more attention from teachers than girls do (Jones & Wheatley, 1990). Compared to boys, girls seem less interested in science, attach less importance to science, and feel less confident in their science abilities (see Jovanovic & King, 1998). For girls, but not for boys, there was a decrease in science ability perceptions over the school years, suggesting that boys and girls experienced the classrooms differently (see Jovanovic & King, 1998). The materials used to teach science in schools, such as textbooks, bulletin board materials, computer software, etc., also can reflect and reinforce the instructional gender bias in associating science activities and careers more with males than with females. Even experiences outside the science classroom such as playing with science-related hobbies, toys, or games, are more frequently associated with boys than with girls, reinforcing the gender gap in science problem solving in school. All of these situations can work together through the school years to erode girls' confidence and even success with later science-related efforts in high school, college, and beyond (Greenfield, 1997).

Studies also suggested a number of teaching strategies that may help to narrow the gender gap (see Lorenzo, Crouch & Mazur, 2006), including: using interactive environments that enhance cooperation and communication, activities that decrease competitiveness, alternation between group discussion and structured teaching, activities that foster students' understanding, and diverse and frequent assessment practices and feedback, etc. Lorenzo, Crouch & Mazur's (2006) showed that teaching with certain interactive strategies (e.g., cooperative problem-solving activities) not only yielded significantly increased understanding in an introductory physics course for both males and females, but also reduced the gender gap. In the most interactively taught courses, the pre-instruction gender gap was gone by the end of the semester.

Interestingly, the above pedagogical strategies and designs for engaging girls more deeply in science learning converge with a number of designs for promoting boys' literacy development (Alloway et al., 2002). These two lines of research highlighted common design features such as communicative, cooperative, interactive learning environments and authentic activities focusing on deepening understanding. Knowledge building pedagogy focuses on deep understanding and idea advancement through interactive discourse in a communal problem solving space. It 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 in a community in both face-to-face and online environments, with the online multimedia environment supporting multiple modes of representing ideas. Learning environments of this nature may help address gender-related gaps that have been disturbing in traditional classrooms. Our recent analysis of vocabulary use by elementary students in their online knowledge building discourse over two school years suggests that sustained knowledge building practice can engage students of both genders in important conceptual work. While both boys and girls were able to develop their vocabulary along the knowledge building discourse, the knowledge building approach has the potential to help boys overcome their weaknesses in literacy (Sun, Zhang & Scardamalia, 2007).

The present study addresses a follow-up question concerning gender differences in specific curriculum areas: Can boys and girls equally engage in and develop written vocabulary through knowledge building work in science as well as in social study subjects? It analyzes boys and girls' engagement and vocabulary use in Knowledge Forum across three content areas: (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 "rigors" as physics; and (c) Medieval Time, an area of history and social study.

Method

Participants and Contexts

Participants were 22 grade 4 students (11 girls and 11 boys) from the Institute of Child Study, a laboratory school at the University of Toronto. Most of the students were from a middle class background. We analysed their online discourse in three knowledge building initiatives: Living Things, Medieval Times, and Light. The first two initiatives were conducted in the first half of the school year, overlapping with each other and lasting two months each. The Light initiative was conducted over a four-month period in second half of the school year. 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.

The primary data source was students' online entries in Knowledge Forum in the three content areas mentioned above. We analyzed the gender differences in students' engagement and word uses in Knowledge Forum across the three content areas. Specific analyses of students' texts included:

(a) Engagement in Knowledge Forum. We analysed students' writing and reading behaviours in Knowledge Forum, including the number of notes contributed, the percentage of notes read, and percentage of notes linked with other notes as an indicator of dialogical writing, the number of total words and distinct words written by each student in the inquiries of the three areas.

(b) Lexical Frequency Profiles. To assess the level of word use for each student in each content area, 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). Learners who used lower proportions of high-frequency words in their texts scored higher in the vocabulary test (Laufer, 1998; Nation, 2001). Two word lists were used in this analysis: first 1,000 word families (West, 1953), used to assess students' uses of high-frequency words; and the Academic Word List (Coxhead, 1998), used to assess students' uses of low-frequency, sophisticated words. The Academic Word List consists of 570 word families (e.g., theory, evidence, hypothesis, approach, challenge, clarify, identify, expand, adjust, 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 words are typical of academic discourse, allowing writers to write in an academic way, referring to others' work and working with data and ideas. They are hard to learn and use, and mainly developed late through secondary and higher education (Corson, 1997).

Results

Engagement in Knowledge Forum

We calculated the number of notes contributed, the percentage of notes read and the percentage of notes linked to other notes by each student in Knowledge Forum and examined the gender differences on the above indicators across three content areas: living things, Medieval Time, and light (Figures 1 to 3).

Insert Figure 1 about here

In terms of note writing, no significant gender difference was found in the numbers of notes written across the three content areas (F (1, 20) = .19, p >.05). Both boys and girls wrote more notes in the light inquiry than in the inquiries of living things and Medieval Time (F (2, 19) = 69.42, p < .001).

Insert Figure 2 about here

Boys read more notes than girls in the three content areas (F (1, 20) = 8.11, p < .05). Both boys and girls read a larger proportion of notes in the inquiry of living things than in the other two inquiries (F (2, 19) = 3.70, p < .05).

Insert Figure 3 about here

The percentage of notes linked to other notes in the inquiry of living things was significantly higher than in the other two inquiries (F (2, 19) = 29.67, p < .001); while no significant gender difference was found in note linking across the three content areas (F (1, 20) = .369, p > .05).

Then, we compared the distinct words and total words written by boys and girls in Knowledge Forum notes across the three content areas. As shown in Figures 4 and 5, both boys and girls wrote significantly more distinct words and total words in the light inquiry than in the other two inquiries (F (2, 19) = 74.81, p < .001; F (2, 19) = 30.23, p < .001), with no noticeable gender difference across the three content areas (F (1, 20) = .008, p > .05; F (1, 20) = .145, p > .05).

Insert Figure 4 about here

Insert Figure 5 about here

Word Use in Knowledge Forum Notes

We looked at the Lexical Frequency Profiles of students' notes in each semester by analysing their uses of two bands of words: the 1st 1000 words families and the academic words (see Figures 6 and 7). As far as the 1st 1000 words are concerned, there was a noticeable interactive effect between gender and content areas ($F(2, 19) = 4.95$, $p < .05$), indicating that boys used significantly higher proportion of the 1st 1000 words than girls in the inquiry of living things, with no significant gender difference found in the other two inquiries. When it comes to the academic words, both boys and girl used significantly lower proportion of the academic words in the inquiry of medieval time than in the other two inquiries ($F(2, 19) = 50.63$, $p < .001$), with no significant gender difference across the three content areas ($F(1, 20) = .45$, $p > .05$).

Insert Figure 6 about here

Insert Figure 7 about here

Discussion and Conclusions

To investigate whether boys and girls can equally engage in and benefit from knowledge building work across different content areas, this study analyzed elementary students' engagement (e.g., noting writing, note reading, and note linking) and the level of vocabulary use (e.g., the proportions the 1st 1000 word families and academic words) in online knowledge building discourse across three content areas: living things, Medieval Times, and light. Results showed that in most of the indicators there was no significant gender difference, either in the science or social study initiatives. Among the few differences observed, boys had a higher rate of note reading in all three inquiries. In the inquiry of living things—an important topic in the science curriculum, girls used a lower proportion of the 1st 1000 word families and included more less-frequent, sophisticated words in their writing.

We also found some differences in students' engagement and vocabulary use across the three content areas. In the inquiry of light, students contributed largest number of notes, distinct words and total words, which may due to the time and efforts allocated to this area were much more than the other two areas. In the inquiry of living things, the percentage of note reading and note linking are significantly higher than the other two inquiries, suggesting that the interaction among students in this inquiry is more active than in other two inquiries. According to our early research, the use of academic words was significantly correlated with the complexity level achieved from inquiry (Sun et al, 2006). In the inquiry of medieval time, the proportion of academic words is the lowest, indicating that students' discussion in this inquiry did not go as deep as in the other two inquiries. More background information such as teaching methods, strategies, special designs and activities in and out of classroom will be helpful to better understand the meaning and cause of these differences in the content learning.

The above results suggest that boys and girls can be equally engaged in knowledge building work in different subject areas, including science and social studies, and develop their productive written vocabulary along the process. Driven by students' authentic problems, knowledge building in different curriculum areas focuses on deepening understanding and sustained idea advancement through interactive discourse in a communal space. Although it is still too early to arrive at any closing conclusion, the present and our earlier study (Sun, Zhang & Scardamalia, 2007) imply that learning designs of the above nature provide a possible approach to addressing gender-related gaps that have been disturbing in traditional classrooms, helping engage girls productively in scientific inquiry and boys in literacy practice.

References

Alloway, N., Freebody, P., Gilbert, P., & Muspratt, S. (2002). Boys, literacy and schooling: Expanding the repertoires of practice. Canberra, ACT: Commonwealth Department of Education, Science and Training.

Applebee, A. N. (1996). Curriculum as conversation: Transforming traditions of teaching and learning. Chicago, IL: University of Chicago Press.

Bakhtin, M. M. (1981). The dialogic imagination: Four essays (C. Emerson & M. Holquist, Trans.). Austin, TX: University of Texas Press.

Cummins, J., & Sayers, D. (1995). Brave new schools: Challenging cultural illiteracy through global learning networks. New York, NY: St. Martin's Press.

Gorman, T., White, J., Brooks, G., Mclure, M., & Kispal, A. (1988). Language performance in schools: Review of APU language monitoring 1979-1983. London: HMSO.

Greenfield, T. A. (1997) Gender and Grade-Level Differences in Science Interest and Participation. Science Education, 81, 259–276.

Jones, M. G., & Wheatley, J. (1990) Gender differences in teacher–student interactions in science classrooms. Journal of Research in Science Teaching, 27, 861–874.

Jovanovic, J. & King, S.S. (1998) Boys and girls in the performance-based science classroom: who's doing the performing? American Educaional Research Journal, 35 (3), 477-496.

Labudde, P. Herzog, W. Neuenschwander, M. P. Violi, E. & Gerber, C. (2000) Girls and physics: Teaching and learning strategies tested by classroom interventions in grade. International Journal of Science Education, 22(2), 143–157.

Lorenzo, M., Crouch, C. & Mazur, E. (2006) Reducing the gender gap in the physics classroom. American Journal of Physics, 74(2), 118-122.

Millard, E. (1997). Differently literate: Boys, girls and the schooling of literacy. London: Falmer.

Nystrand, M. (1997). Opening dialogue: Understanding the dynamics of language and learning in the English classroom. New York, NY: Teachers College Press.

Ofsted (1993). Boys and English. London: HMSO.

Scardamalia, M. (2003). Crossing the digital divide: Literacy as by-product of knowledge building. Journal of Distance Education, 17 (Suppl. 3, Learning Technology Innovation in Canada), 78-81.

Scardamalia, M. (2004). CSILE/Knowledge Forum®. In A. Kovalchick, & K. Dawson (Eds.), Education and technology: An encyclopedia (pp. 183-192). Santa Barbara, CA: ABC-CLIO, Inc.

Scardamalia, M., & Bereiter, C. (1994). Computer support for knowledge building communities. Journal of the Learning Sciences, 3, 265-283.

Scardamalia, M., & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In K. Sawyer (Ed.), Cambridge Handbook of the Learning Sciences (pp. 97-118). New York, NY: Cambridge University Press.

Scardamalia, M., Bereiter, C., Hewitt, J, & Webb, J. (1996). Constructive learning from texts in biology. In K.M. Fischer, & M. Kirby (Ed.), Relations and biology learning: The acquisition and use of knowledge structures in biology (pp. 44-64). Berlin: Springer-Verlag.

Sun, Y., Zhang, J., & Scardamalia, M. (2006). Literacy as a by-product of knowledge building: An analysis of vocabulary growth. Paper presented at the Annual Meeting of American Educational Research Association, San Francisco, CA.

Sun, Y., Zhang, J., & Scardamalia, M. (2007). Addressing Gender Gap in Literacy through Knowledge Building: An Analysis of Vocabulary Growth. Paper presented at the Annual Meeting of American Educational Research Association, Chicago, IL.

Swain, M. (2000). The output hypothesis and beyond: mediating acquisition through collaborative dialogue. In J. Lantolf (Eds.), Sociocultural theory and second language learning (pp. 97-114). Oxford, UK: Oxford University Press.

Warschauer, M. (2004). Technology and writing. In C. Dvison & J. Cummins (Eds.), Handbook of English Language Teaching. Dordrecht, Netherlands: Kluwer.

Zhao, Y., Englert, C.S., Chen, J., Jones, S.C., & Ferdig, R.E. (2000). The development of a Web-based literacy learning environment: A dialogue between innovation and established practices. Journal of Research on Computing in Education, 32(4), 435-454.

Zohar, A. & Sela, D. (2003) Her physics, his physics: Gender issues in Israeli advanced placement physics classes. International Journal of Science Education, 25(2), 245–268.

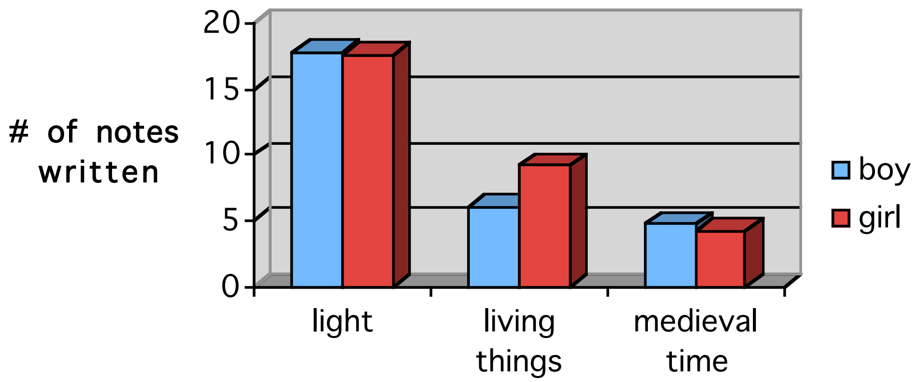

Figure 1: The number of notes written by boys and girls in the three content areas.

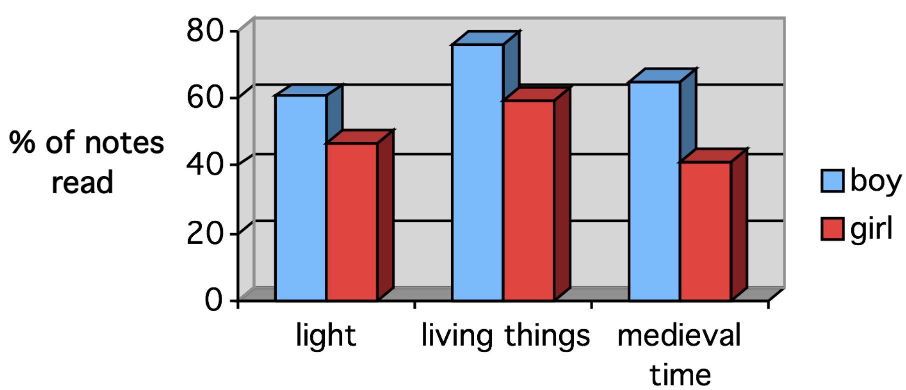

Figure 2: The percentage of notes read by boys and girls in the three content areas.

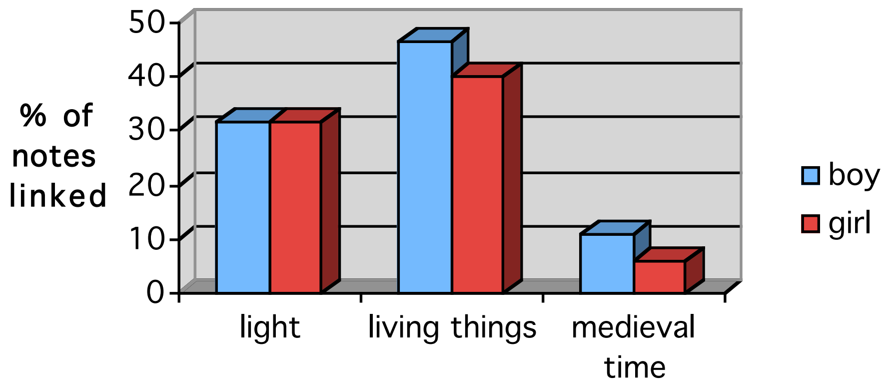

Figure 3: The percentage of notes linked by boys and girls in the three content areas.

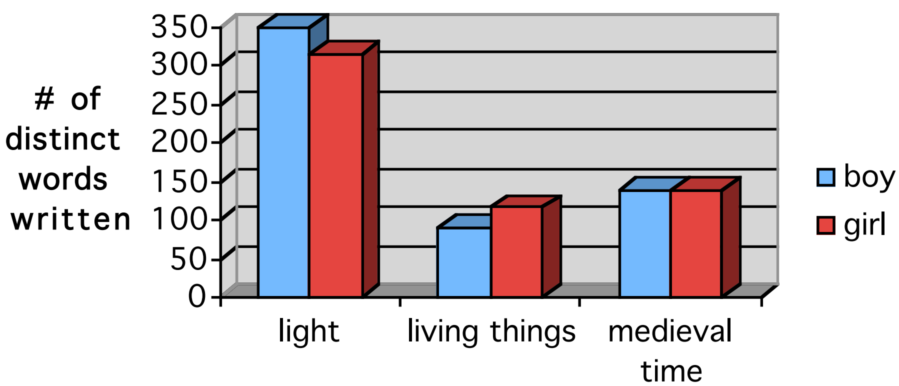

Figure 4: The number of distinct words written by boys and girls in the three content areas.

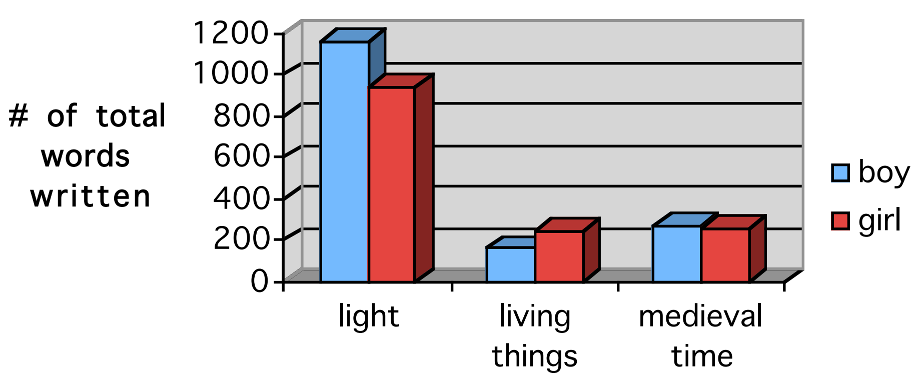

Figure 5: The number of total words written by boys and girls in the three content areas.

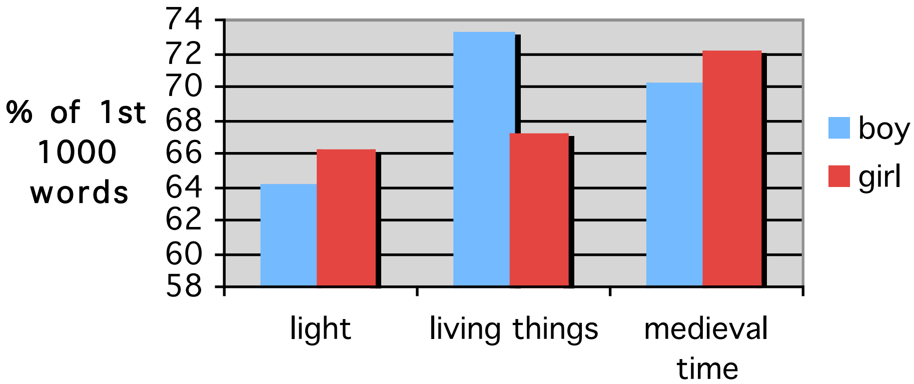

Figure 6: The percentage of the 1st 1000 words in students' notes in the three content areas.

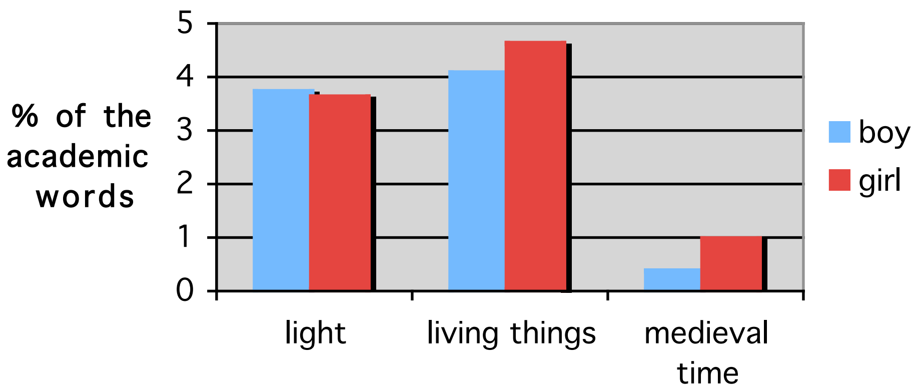

Figure 7: The percentage of the academic words in students' notes in the three content areas.