The Development of Productive Vocabulary in Knowledge Building: A Longitudinal Study

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Abstract: We report a longitudinal study on the development of 22 students' productive vocabulary in knowledge building from Grade 1 to 6. Vocabulary growth was assessed based on the student discourse in Knowledge Forum, an online community space designed to support Knowledge Building. Analysis of lexical proficiency based on Lexical Frequency Profile and P_Lex indicated significant growth in productive written vocabulary, especially for words beyond the first two 1,000 word lists. By tracing the growth of vocabulary extracted from specific word lists, we found that the growth rate for different types of words varied across each year but correlated with each other. Correlation analyses between these lexical measures and Knowledge Building behavioral indicators revealed that note revisions are the strongest predictor of vocabulary growth rate, whereas note reading is related with lexical proficiency measures.

Keywords: Knowledge Building, literacy development, productive vocabulary, CSCL

Introduction

Language acquisition is considered a major milestone in child development and plays a critical role in shaping the child's participation in everyday practices. For example, the child's lexicon shares an interdependent relationship with school learning and performance. Studies in the classroom have shown that word knowledge plays a critical role in verbal and listening skills, reading comprehension, and learning of new concepts (e.g., Biemiller, 2005; Cunningham & Stanovich, 1997; Stahl, 1991; Steahr, 2009). Additionally, the more words the student knows, the easier it is for them to access new resources and learn more (Stahl, 1991). Over the last few decades, a body of research in literacy education has been devoted to improving student learning and reading through explicit vocabulary instruction (for a review see Rupley, 2009). However, there is evidence that explicit vocabulary instruction leads to a decontextualized understanding of words. For example, teaching new vocabulary through dictionary definitions and spelling lists can lead to misuses of the true meaning of words; rather, learning new words through emergent use in authentic contexts can support a more holistic understanding of them (Miller & Gildea, 1987).

Recognizing the limitations of explicit vocabulary instruction, developmental psychologists propose a social-pragmatic view of language development (Akhtar & Tomasello, 2000), which argues that language acquisition is driven by social interaction and the child's need to connect with others. In other words, the child's lexicon is acquired through social experiences and conversational interactions wherein they are exposed to language (Hoff, 2002). Words and sentences do not exist as islands by themselves; thus, explicit vocabulary instruction that presents word definitions and exemplary sentences as self-contained "pieces" of knowledge would not be sufficient (Brown, Collins, & Duguid, 1989). Sociocultural theorists further add that child development, which extends across social, conceptual, linguistic, and cultural competencies, must be understood within the cultural context that the child develops (Vygotsky, 1978; Hedegaard, 2009). According to this perspective, learning is a social and collaborative process, and classroom environments must support peer-to-peer interaction (Hakkarainen, Paavola, Kangas, & Seitamaa-Hakkarainen, 2013). Integrated educational contexts for literacy allow students to participate in meaningful activities related to novel and challenging words through a variety of encounters and are effective for promoting depth of world knowledge, writing quality, and vocabulary expansion (Stahl, 1991). Benefits have been shown from the earliest grade levels of engaging students in authentic settings for vocabulary learning (e.g., Juel, 2006).

Knowledge Building (KB; Scardamalia & Bereiter, 2006), a principle-based pedagogy that engages students directly in sustained creative work with ideas, provides such a context for vocabulary development. Knowledge Building is "productive work that advances the frontiers of knowledge as these are perceived by a community" (Bereiter & Scardamalia, 2003, p. 1370). Knowledge Forum (KF)—technology designed to support Knowledge Building—immerses students in literate environments extensible to the broader world on the Internet and beyond. It aims to optimize opportunities for knowledge creation, mirroring conditions of the

surrounding open, innovation-driven, knowledge society—a complex world of ideas requiring that users create knowledge out of information fragments. In Knowledge Building classrooms, all students take collective responsibility for generating and advancing ideas that "live in the world"—most immediately, the public community knowledge spaces of Knowledge Forum, where efforts to advance the frontiers of their community knowledge require continuous reading, writing, and multimedia productions to contribute and improve ideas. Students read each other's entries, search for information to answer questions, design and report experiments, and so forth. Conceptual advances are mirrored in vocabulary growth in online and offline exchanges between students, with vocabulary advances appearing as a by-product of their knowledge work (Sun, Zhang, & Scardamalia, 2008). The Knowledge Building proposition is that immersion in complex literate worlds from early ages of schooling will lead to advances in both basic and advanced competencies. This hypothesis has been tested in previous studies, but within a shorter time frame (Resendes, Chen, Acosta, & Scardamalia, 2013; Sun, Zhang, & Scardamalia, 2008).

Knowledge Building is compatible with the social-pragmatic and sociocultural perspectives on how the social environment plays a crucial role in facilitating the acquisition and productive use of new words. The current study aims to explore the phenomenon of vocabulary growth within a student cohort across the elementary years. Such longitudinal studies of the development of the productive vocabulary are almost non-existent (Laufer, 1994), needless to say its scarcity in the Computer-Supported Collaborative Learning (CSCL) context. Of equal importance is future work to connect vocabulary development and the advancement of community knowledge in CSCL, as well as to elicit lexical measures to assess productive work with ideas in CSCL. Our major research questions concerning the development of productive vocabulary in Knowledge Building are:

1. How did students' lexical proficiency, as indicated by their written discourse in KF, change over the span of six years?
2. Did the rate of productive vocabulary growth remain consistent over time? Which words were used most frequently for each year?
3. To what extent was productive vocabulary growth related to students' Knowledge Building behaviours?

Methods

Participants and the knowledge building context

The participants were a student cohort of 22 students from the Dr. Jackman Institute of Child Studies (JICS) of the University of Toronto, where Knowledge Building pedagogy and technology has been used extensively for over a decade. Indeed, JICS has been highlighted as a school that continuously engages in Knowledge Building practices, due to sustained collaborative efforts made by its teachers, principals, and students (Zhang, Hong, Scardamalia, Teo, & Morley, 2011). At JICS, Grades 1 to 4 are taught in separate classes, and Grades 5 to 6 are taught in mixed classes. Each class is taught by one teacher, so students were taught by 5 different teachers in total. The students started Grade 1 and finished Grade 6 at the same time; however, two students left the school before Grade 4 and five students left before Grade 5.

Over the course of six years, students in the present study assumed collective cognitive responsibility to improve their ideas (Scardamalia, 2002): They shared the consistent goal of advancing their collective understanding about authentic problems they cared about through face-to-face discussions and online interactions in KF. They carried out explanation-seeking discourse propelled by their collective efforts to improve their ideas through various means, such as observation, experimentation, and constructive use of authoritative sources. A detailed account of classroom dynamics is beyond the scope of this article, but can be found in the Knowledge Building literature (e.g., Scardamalia & Bereiter, 2006; Zhang, Scardamalia, Lamon, Messina, & Reeve, 2007). The student cohort in the present study examined topics in: science, such as "Butterflies," "Invertebrates," "Ecology," "Rocks and Minerals," and "Astronomy"; engineering, such as "Structures" and "Toys That Move"; and social science, such as "Medieval Times" and "Canadian Issues."

One important component of students' Knowledge Building work was their extensive use of Knowledge Forum (KF), an online community space for them to document ideas. Students wrote extensively about their ideas, collectively making sense of difficult concepts, building coherent explanations, and carrying out "metadiscourse" (Resendes et al., 2013). While Knowledge Building discourse took place in multiple media, KF served as the central workspace for idea development. During face-to-face discussions, students would constantly refer back to artifacts, such as texts, drawings, and videos in KF and would return to KF afterwards to

revise their notes. As a result, reading and writing in KF is a meaningful literacy practice and an integral aspect of Knowledge Building (Sun, Zhang & Scardamalia, 2008).

Data Sources and Analyses

The primary data sources in the present study were KF log data produced by the participants over six years. The dataset mainly included: (1) students' KF *notes*, as well as their metadata, such as time, title, view, and authors; and (2) students' activity log, which involved three types of actions—*reading*, *creating*, and *modifying* a note.

To study the longitudinal development of students' productive vocabulary, our analysis focused on a set of established lexical measures and their changes over time. KF notes were exported and grouped by school year. The following lexical measures were computed for each unit of analysis (i.e., KF notes produced by each student in each school year):

(1) **Lexical richness measures**. We first counted the total word tokens and word types (i.e., unique words) produced by each student each year as two basic measures of lexical richness.

(2) **Lexical Frequency Profiles**. Vocabulary proficiency can be measured in various ways. Lexical frequency profile (LFP) is a quantitative index proposed by Laufer and Nation (1995) to measure the vocabulary richness of a text based on its proportions of frequent versus infrequent vocabulary. The underlying assumption of LFP is that "a large number of infrequent words would make a text more difficult to understand" (Laufer, 2013, p. 1). Based on this assumption, a student's vocabulary proficiency can be inferred from the percentage of frequent and infrequent words they use in their written text. LFPs were built for each student in each year, based on three word lists from a software program developed by Paul Nation: first 1000 word families, second 1000 word families, and the Academic Word List (Coxhead, 2000). A student's LFP was presented by percentages of words from these three word lists.

(3) **P_Lex.** Recognizing LFP's ineffectiveness with shorter text—text shorter than 200 words in particular (Laufer & Nation, 1995), Meara and Bell (2001) created another measure for vocabulary proficiency, *P_Lex*, which was claimed to work well for text as short as 90 words. This measure is based on the same assumption as LFP, (i.e., the use of infrequent vocabulary indicates higher proficiency). However, P_Lex differs from LFP on how vocabulary proficiency is calculated and represented. To calculate P_Lex of a piece of text, we first divide the text into segments of 10 words. Then, for each segment, we count "infrequent" words beyond the first 1000 word families. For an imagined paragraph containing 108 words, we may get a vector: [0, 0, 2, 1, 1, 1, 2, 1, 0, 0]. Then, we would feed the counts of each possible value (i.e., {0:4, 1:4, 2:2, 3:0, … 10:0}) into a Poisson distribution model. A λ (lambda) coefficient in the Poisson distribution model (ranging from 0 to about 4.5) is computed to represent the lexical proficiency represented by the text, with a higher lambda score corresponding to a higher proportion of infrequent words (for details see Meara & Bell, 2001).

(4) **Rate of vocabulary growth.** Both LFP and P_Lex are solely concerned with the makeup of frequent versus infrequent vocabulary in texts and do not provide information about the *growth* of productive vocabulary size. Thus, for each student we also traced new vocabulary that appeared during each year. Using the same word lists as those used for LFP, we further distinguished frequent and infrequent vocabulary acquired by each student in each year. This analysis would help us pinpoint the words students acquired each year and the distribution of these words in different word lists.

To determine whether there were changes within these lexical measures across the six years, Mann-Kendall tests of trends and multivariate analysis of variance (MANOVA) was further conducted on each measure. Meanwhile, to investigate the relationship between lexical development and Knowledge Building activities, correlation analyses were conducted between the frequencies of Knowledge Forum behavioural indicators, such as reading a note, creating a new note, and modifying an existing note, and the lexical measures describe above. Additional correlation analyses were conducted among lexical measures for validity purposes.

Finally, in order to uncover the context in which vocabulary learning occurs, we tracked a number of "difficult" words identified from students' entries. Content analysis of related discourse was conducted to shed light on the interpretation of aforementioned analyses.

Findings

Note writing and reading across six years

Table 1 shows the number of notes written, modified and read per student during six years. Over the six years, the average student created 88.67 notes, revised 63.43 notes, and read 601.48 notes, indicating substantial

literacy practices in Knowledge Forum throughout the years. However, there were considerable variations across the years and among students, which were also found in previous studies (Sun, Zhang & Scardamalia, 2008). At the class level, students were most active in Grade 3 and 4, while in Grade 6 their KF activities dropped to the lowest. This drop could be partially attributed to the increased adoption of other learning technologies when students entered higher grades, as reported by teachers. At the individual level, detailed analysis uncovered substantive variations potentially linked to individual differences worth further investigation.

Table 1. Mean and standard deviation of student activities in Knowledge Forum

Activities	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
Reading	63.10 (24.9)	73.95 (25.1)	182.00 (94.5)	235.63 (115.5)	67.38 (52.1)	48.17 (41.0)
Creating	15.10 (5.2)	18.43 (9.3)	19.71 (10.6)	21.74 (8.8)	12.85 (8.9)	10.17 (7.3)
Revising	12.33 (4.3)	9.33 (4.2)	14.76 (9.7)	18.89 (8.5)	8.38 (6.1)	8.25 (6.3)

Vocabulary use reflected by Lexical Frequency Profiles and P_Lex

Table 2 presents the total word tokens and total word types (unique tokens), two lexical richness measures, in each year. Regardless of fluctuations across years, Mann-Kendall trend tests on both measures were significant ($\tau = 0.18$, $p < .01$ for both), indicating a trend of increase of produced tokens and unique tokens over the years.

Table 2. Mean and standard deviation of Lexical richness of student writing

Measures	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
Total tokens	208.10 (115.4)	159.48 (129.6)	114.48 (108.3)	176.53 (119.3)	498.38 (394.9)	366.23 (274.2)
Total types	98.90 (38.0)	72.38 (39.5)	65.10 (32.6)	85.21 (41.8)	146.69 (75.8)	122.85 (43.1)

Table 3 presents the P_Lex scores of student writing in each grade. A Mann-Kendall test confirmed a significant trend of increase, $\tau = 0.24$, $p < .001$ (see Figure 1). Repeated measure ANOVA also revealed significant changes in P_Lex over the six years, $F(5, 82) = 12.2$, $p < .001$, $\eta^2 = 0.42$. However, it should be noted that P_Lex dropped in Grade 6, which corresponded to the drop of writing activities in Grade 6.

While P_Lex provided a more robust measure of lexical profile in this specific context, lexical frequency profiles offered a more detailed depiction of the composition of vocabulary in student writing. Table 3 reports the lexical frequency profiles of students across the six years. Trend analysis revealed a significant decrease with the percentage of the first 1,000 words, $\tau = -0.24$, $p < .001$, and a significant increase with the percentage of words not in the lists, $\tau = 0.27$, $p < .0001$. However, no trend was discerned from the percentages of the second 1,000 words and the Academic words.

Table 3. Mean and standard deviation of word tokens, types, lexical frequency profiles, and P_Lex in each student's notes across the six years

Measures	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
P_Lex	1.07 (0.3)	1.23 (0.4)	1.95 (0.5)	1.77 (0.7)	1.76 (0.4)	1.37 (0.4)
% 1st 1,000 words	89.2% (2.9%)	87.1% (3.2%)	80.6% (4.4%)	82.2% (7.1%)	82.4% (3.8%)	86.1% (3.7%)
% 2nd 1,000 words	4.21% (2.5%)	6.43% (2.4%)	6.76% (2.7%)	6.82% (2.8%)	4.47% (2.2%)	1.53% (2.7%)
% Academic words	2.31% (1.1%)	0.54% (0.9%)	4.50% (2.7%)	2.80% (1.8%)	1.35% (1.1%)	2.72% (1.8%)
% Other words	4.28% (2.7%)	5.96% (3.0%)	8.14% (3.3%)	8.23% (6.1%)	11.8% (3.5%)	6.77% (3.0%)

Vocabulary growth across years

While P_Lex and LFP helped us determine the quality of student writing based on the percentage of different kinds of words, we were also interested in examining students' vocabulary growth based on the productive use of new words, so we traced vocabulary use for each individual student, focusing on new words they picked up in each grade.

Text mining of the entire collection of student notes over the six years revealed the following overall distribution of terms: 1091 first 1,000 words, 331 second 1,000 words, 105 academic words, and 635 words not in these three lists. We then traced each student's acquisition of words in these four lists in each year. As presented in Figure 2, the growth of word types from these four lists of words were uneven. First of all, in each year most new words acquired by students were from the first 1,000 word list. Noticeably, the growth rate of the

first 1,000 words was consistent across years, whereas the Academic words and words out of the lists grew more rapidly in Grade 5 and 6. Mann-Kendall tests confirmed these trends—the first 1,000 words: $\tau = -0.16$, $p < .05$; the Academic words: $\tau = 0.12$, $p = .08$; words out of the lists: $\tau = 0.26$, $p < .001$. No significant trend was found with the second 1,000 word list.

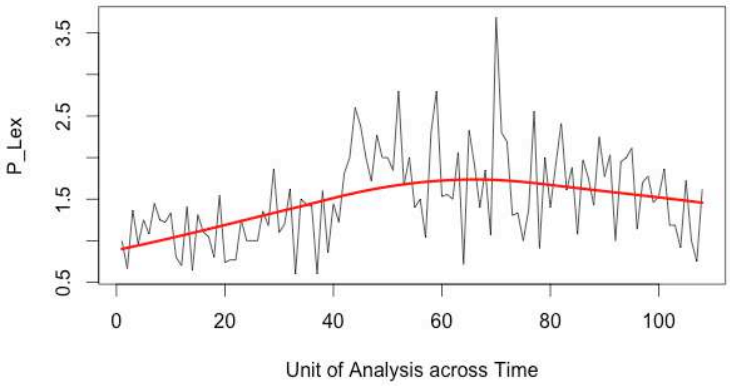

Figure 1. Trend analysis of P_Lex

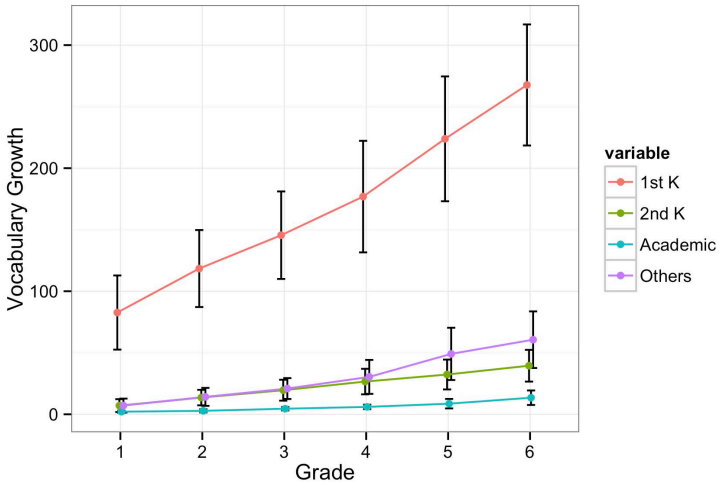

Figure 2. Growth of productive vocabulary over the six years

Relationship between vocabulary growth and KB interactions

Table 4 presents the results of correlation analysis of lexical measures and Knowledge Building measures (i.e., note reading, writing, and revisions). First of all, lexical proficiency measures (i.e., P_Lex and percentages of four different word categories) were not significantly correlated with the total numbers of word tokens and word types, implying that the lexical proficiency measures we used were not significantly affected by the length of student writing. Meanwhile, P_Lex was negatively correlated with the percentage of the first 1,000 words ($r = -.75$, $p < .001$) and positively correlated with the percentages of words from the other three lists. These results confirmed the validity of using these measures to assess lexical development of students in the present study.

Second, the number of total word types was correlated with note writing ($r = .29$, $p < .001$) and note revisions ($r = .42$, $p < .001$). In addition, the vocabulary size indicated in students' six years of writing was found significantly correlated with all KB behaviours: reading ($r = .55$, $p < .01$), writing ($r = .81$, $p < .001$), and revisions ($r = .77$, $p < .001$). These correlations indicated that students who write and read more in Knowledge Forum are likely to demonstrate greater growth in productive vocabulary. Interestingly, note modification appeared to be the most significant predictor for vocabulary growth—more strongly correlated with the yearly growth rate of vocabulary ($r = .35$, $p < .001$) when compared with the other two KB measures. This finding revealed a potentially fruitful linkage between idea improvement in Knowledge Building, indicated by note revisions, and vocabulary development. Connecting with individual variations identified earlier, it would also be

worth further investigating whether there were any student-level background variables affecting both Knowledge Building behaviour indicators and lexical measures.

Finally, we found vocabulary growth in all four word categories positively correlated with each other, which suggests that basic and advanced vocabulary may have developed in tandem throughout the years, regardless their different growth rates in each year.

Table 4. Correlation analysis of lexical measures and KB behavioral indicators

Measures	1	2	3	4	5	6	7	8	9
1. Word tokens	-								
2. Word types	.85***	-							
3. P_Lex	.08	.09	-						
4. 1st 1,000 words	.00	.04	-.75***	-					
5. Academic words	-.12	-.07	.27***	-.36***	-				
6. New words used	.80***	.94***	.04	.09	-.11	-			
7. Note reading	.07	.17*	.16*	-.15†	.22**	.07	-		
8. Note creating	.15†	.29***	.08	-.01	-.03	.23**	.62***	-	
9. Note revision	.23**	.42***	.11	-.02	.07	.35***	.69***	.79***	-

Note. † $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Examples of integrated practice for literacy in knowledge building

While Knowledge Building discourse itself represents a natural literacy practice, we were still interested in dialogues specifically focusing on acquiring new vocabulary. Content analysis of student discourse identified plenty of such examples. In correspondence with one lower level of vocabulary learning, one cluster of examples could be best described as "definition seeking" discussion. For example,

Student A: I need to understand: what is *velocity*?

Student B: Speed.

In this example, Student A might had incidentally heard the new word *velocity*, and the conversation between him and Student B focused on the definition of this new concept. Such definition-seeking conversation can extend from one term to another, and could be fruitful for vocabulary learning. As another example,

Student C: What is *horizontally*?

Student D: *Horizontally* is sideways. Vertical is up and down.

When Student D attempted to explain the definition of the adverb *horizontally*, they used the adjective form of its antonym. In this case, students were exposed to rich morphosyntactic environments for learning new words and word families.

In other cases, the definition of a word could not be easily attained; rather, meaning was achieved by piecing together snippets of the definition contributed by more than one student. Take the following conversation for example, neither Student F or G's notes alone provides an accurate definition of *claymore*, but each contains specific information about this vocabulary.

Student E: What is a *claymore*? My theory is that it is a type of [pottery] wheel.

Student F: I think a *claymore* was a type of big expensive sword that only the richest nobles or "earls" owned.

Student G: My Theory [is] its a very big Scottish [sword].

The second type of literacy practice could be characterised by "active use of vocabulary" with evolving meaning. In this case, students did not explicitly seek the definition of a word and were capable of using it in specific contexts. However, by continually engaging with a concept, students were able to construct and reconstruct the scientific meaning of it over an extended period of time. One interesting example from the student discourse was the concept of "gravity." In the Water Cycle unit during Grade 1, students mentioned the role of gravity in the formation of rain: "*Then the water droplets make clouds and when the clouds get too heavy with water droplets it can't hold it any more so the gravity pulls all the water and it rains!*" Another example: "*My theory is that it's all about gravity. The groundwater stays down by gravity!*" Then, in the engineering unit about Flight, students were engaged with gravity from a different angle: "*Because the plane is so big and heavy it is hard to reduce gravity because gravity can be taken away better if there are lighter, stronger materials.*" It was not until the Astronomy unit in Grade 5/6 when students started to clearly articulate the concept of gravity:

Student H:	How does *gravity* work? Is it a force in the ground that pulls you down or something in the air that pushes you down?
Student I:	I think *gravity* comes from the core of the Earth or the core of other planets.
Student J:	How does *gravity* work in the middle of the earth?
Student K:	Gravity is: the downward pull of the earths *gravitational* field. The more *gravity* pulling an object the more the mass of the object is.
Student L:	I need to understand: first you say that you think that you would weigh more on Jupiter because it has more *gravity* and then you say that you think that you would weigh less on Pluto because it's farther away from the sun. Are these two different theories about how much you weigh on a planet?

These conversations highlight students' various conceptions of gravity, as well as the gradual conceptual change underlying their collective discourse. Over the course of six years, even though few explicit efforts were made to define gravity, students were able to use this term in meaningful ways to support explanations in their Knowledge Building work.

In summary, as students progressed through the grades, they demonstrated considerable literacy practices in Knowledge Building through their reading, writing, and revision activities in KF. Knowledge Building also enabled students to engage with vocabulary in sophisticated ways, representing different types of literacy practice. Connections between vocabulary knowledge and scientific understanding could be observed, which point to the notion of vocabulary knowledge—knowledge about word meanings—being a subset of general knowledge (Nagy & Herman, 1987, p. 28) and the richness of the Knowledge Building approach towards literacy development.

Conclusions and implications

This study explored the development of productive vocabulary in a group of Knowledge Building students across the elementary school years. Results of lexical analysis indicated that students tended to produce more tokens, more unique word types, and text with an increasingly higher proportion of infrequent words with every year. In the absence of a control group, one may argue that this phenomenon simply reflects the natural cognitive development of school children. However, correlation analyses between lexical measures and Knowledge Building behavioural indicators identified significant correlations between students' productive vocabulary size and reading, writing, and revisions on Knowledge Forum. Moreover, note revisions emerged to be the strongest predictor of the rate of vocabulary growth in each year. Further content analysis uncovered interesting moments when vocabulary learning happened naturally through Knowledge Building discourse. Overall, the present study highlights the potential benefits of Knowledge Building for vocabulary growth. Our findings support the socio-pragmatic and sociocultural notion that the acquisition of new vocabulary is more meaningful in authentic social contexts, in our case, the KB classroom. When cognitive responsibility is handed over to students, not only do they willingly help one another in grappling with new vocabulary, they also do so successfully. Instead of waiting for the teacher to provide them with a new vocabulary list, students sought out new words to learn as they worked toward improving their community knowledge; students collectively owned their vocabulary. In other words, vocabulary learning is an authentic and integrated practice of KB. Sustained work with ideas and knowledge advancement led to the progressive growth of the students' collective lexicon.

Of special interest to the authors is the potential of applying lexical indicators in the development of future Knowledge Building analytics, so that individual and collective conceptual development could be detected. Previous work has highlighted this link between literacy skill and knowledge advancement in Knowledge Building (Zhang & Sun, 2011). Future work should seek to model knowledge advancement in the current dataset, as well as devise new analytic tools dedicated to literacy learning in Knowledge Building.

References

Akhtar, N., & Tomasello, M. (2000). The social nature of words and word learning. In *Becoming a word learner: A debate on lexical acquisition* (pp. 115–135). Oxford University Press.

Biemiller, A. (2005). Size and Sequence in Vocabulary Development: Implications for Choosing Words for Primary Grade Vocabulary Instruction. In E. H. Hiebert and M. L. Kamil (Eds.), *Teaching and learning vocabulary: Bringing research to practice* (pp. 223–242). Mahwah, NJ: Lawrence Erlbaum.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher, 18(1)*, 32–42. doi:10.3102/0013189X018001032

Coxhead, A. (2000). A New Academic Word List. *TESOL Quarterly, 34(2)*, 213–238.

Cunningham, A. E., & Stanovich, K. E. (1997). Early reading acquisition and its relation to reading experience and ability 10 years later. Developmental psychology, 33(6), 934.

Hakkarainen, K., Paavola, S., Kangas, K., & Seitamaa-Hakkarainen, P. (2013). Sociocultural perspectives on collaborative learning: Toward collaborative knowledge creation. In C. Hmelo-Silver, Chinn, C., Chan, C.K.K., & O'Donnell, A. (Eds.), The international handbook of collaborative learning (pp. 57-73). New York, NY: Routledge/Taylor & Francis.

Hedegaard, M. (2009). Children's development from a cultural–historical approach: Children's activity in everyday local settings as foundation for their development. *Mind, Culture, and Activity, 16(1)*, 64-82.

Juel, C. (2006). The impact of early school experiences on initial reading. In D. K. Dickinson & S. B. Neuman (Eds.), *Handbook of early literacy research* (Vol. 2, pp. 410–426). Guilford Publications.

Laufer, B. (1994). The Lexical Profile of Second Language Writing: Does It Change Over Time? *RELC Journal, 25(2)*, 21–33. doi:10.1177/003368829402500202

Laufer, B. (2013). Lexical Frequency Profiles. In C. A. Chapelle (Ed.), *The Encyclopedia of Applied Linguistics*. Blackwell Publishing Ltd.

Laufer, B., & Nation, P. (1995). Vocabulary size and use: Lexical richness in L2 written production. *Applied Linguistics, 16(3)*, 307–322.

Meara, P., & Bell, H. (2001). P_Lex: A Simple and Effective Way of Describing the lexical Characteristics of Short L2 Tests. *Prospect, 16(3)*, 5–19.

Miller, G. A., Gildea, P. M. (1987). How children learn words. *Scientific American. 257, (3)*, 94-99.

Nagy, W. E., & Herman, P. A. (1987). Breadth and depth of vocabulary knowledge: Implications for acquisition and instruction. *The nature of vocabulary acquisition*, *19*, 35.

Resendes, M., Chen, B., Acosta, A., & Scardamalia, M. (2013). The Effect of Formative Feedback on Vocabulary Use and Distribution of Vocabulary Knowledge in a Grade Two Knowledge Building Class. In N. Rummel, M. Kapur, M. Nathan, & S. Puntambekar (Eds.), *To See the World and a Grain of Sand: Learning across Levels of Space, Time, and Scale: CSCL 2013 Conference Proceedings Volume 1 - Full Papers & Symposia (pp. 391–398)*. International Society of the Learning Sciences.

Rupley, W. H. (2009). Introduction to direct/explicit instruction in reading for the struggling reader: Phonemic awareness, phonics, fluency, vocabulary, and comprehension. *Reading & Writing Quarterly, 25(2-3)*, 119-124.

Scardamalia, M. (2002). Collective cognitive responsibility for the advancement of knowledge. In B. Smith (Ed.), *Liberal education in a knowledge society* (pp. 67–98). Chicago, IL: Open Court.

Scardamalia, M., & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 97–115). Cambridge University Press.

Stahl, S. A. (1991). Beyond the instrumentalist hypothesis: Some relationships between word meanings and comprehension. In P. Schwanenflugel (ed.), *The psychology of word meanings, pp. 157-178*. Hillsdale, N.H.: Lawrence Erlbaum Associates.

Steahr, L. S. (2009). Vocabulary knowledge and advanced listening comprehension in English as a foreign language. *Studies in Second Language Acquisition, 31(4)*, 577-607.

Sun, Y., Zhang, J., & Scardamalia, M. (2008). Knowledge building and vocabulary growth over two years, Grades 3 and 4. *Instructional Science, 38(2)*, 147–171. doi:10.1007/s11251-008-9082-5

Vasta, R., Younger, A. J., Adler, S. A., Miller, S. A., & Ellis, E. (2009). *Child psychology (2nd ed.)*. Mississauga, Ontario: John Wiley & Sons Canada.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, Massachusetts: Harvard University Press.

Zhang, J., Hong, H.-Y., Scardamalia, M., Teo, C. L., & Morley, E. A. (2011). Sustaining Knowledge Building as a Principle-Based Innovation at an Elementary School. *Journal of the Learning Sciences, 20(2)*, 262–307. doi:10.1080/10508406.2011.528317

Zhang, J., Scardamalia, M., Lamon, M., Messina, R., & Reeve, R. (2007). Socio-cognitive dynamics of knowledge building in the work of 9- and 10-year-olds. *Educational Technology Research and Development, 55(2)*, 117–145. doi:10.1007/s11423-006-9019-0

Zhang, J., & Sun, Y. (2011). Quantified measures of online discourse as knowledge building indicators. In H. Spada, S. G., N. Miyake, & N. Law (Eds.), *Connecting computer-supported collaborative learning to policy and practice: CSCL2011 conference proceedings (Vol. 1, pp. 72–79)*. Hong Kong, China: ISLS.