Assessing ELLs' Reading Comprehension and Science Understandings Using Retellings

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Abstract

This article explores the use of alternative assessments as a way to determine the impact of science instruction on English Language Learners' (ELLs) abilities to comprehend an informational trade book text, both at the level of reading comprehension and at the level of science understanding. This multi-cohort comparison study of 47 fifth grade ELLs in a large urban district in the southwest compared students' retellings of an informational text on the science topics of wind energy and wind turbines. All students received 14 days of intensive, hands-on instruction on science concepts with the experimental group studying wind energy and wind turbines and the control group studying genetics and DNA. Findings from data analysis reveal that students who received instruction on the science concept of wind energy and wind turbines (experimental group) had more accurate retellings of the related text at the reading comprehension level. Students in the experimental group also demonstrated stronger conceptual understanding of the science concept of energy transfer. This study has implication for science teachers as it provides evidence to support retelling as an assessment method in the science classroom.

Key words: comprehension, science learning, trade books, ELLs, retelling, energy conversion, assessment

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Introduction

For over a century, science educators have recommended that classroom environments be constructed in ways that provide opportunities for students to experience real phenomenon (i.e., hands-on) as a way of exploring the natural world (Dewey, 1902, 1938; Schwab, 1962). In addition, educators have endorsed the notion that content integration provides a more realistic way in which the world works and in which students learn (Berlin & White, 1994; Czerniak, Weber, Sandmann, & Ahern, 1999; Stoddart, Pinal, Latzke & Canaday, 2002; Weinburgh, Silva, Smith, Groulx, & Nettles, 2014). However, finding methods to assess ways in which experiential, integrated lessons change the learning of students has been difficult.

Using informational trade books to introduce or enrich concepts has been recommended as instructional strategies to be used in science classrooms (Ford, 2006; Rice, 2002; Royce & Wiley, 1996; Short & Armstrong, 1993). Several researchers have examined trade books for accuracy or images (Abd-el-Khalick, 2002; Magnusson & Palincsar, 2004; Milne, 1998); however, there is a paucity of research on how the informational trade books benefit students in science classes and how conceptual understandings can both be strengthened and assessed with the integration of the two. The research of some literacy scholars (Duke, 2014; Duke & Bennett-Armistead, 2003) highlights the use of informational texts as part of inquiry-based learning in elementary classrooms, but the focus of their research is on literacy understandings rather than conceptual understandings of science. Having student 'retell' what they have just read has been used for several purposes within the literacy research (Gambrell, Pfeiffer, & Wilson, 1985; Kucer, 2011, Moss, 2004) and remains an alluring measure due to efficiency and relevancy to comprehension instruction (Roberts, Good, & Concoran, 2005). However, retelling has not specifically been explored as a means to assess reading comprehension and conceptual understandings of scientific concepts.

Since the purpose of science instruction is to develop deep conceptual understanding, it is important to distinguish between retellings that are reading comprehension of the text and retellings that provide evidence of levels of science (conceptual) understanding. These two ways are similar in that they both provide evidence of 'knowing' the science topic. First, the reader is able to recall or "retell" basic information from the text (e.g., how hard the wind blows). Second, the reader is able to retell conceptual understandings (e.g., how wind energy is converted to electricity), thus capturing the reader's ability to identify and retell important scientifically-accurate information. The specific research questions guiding this study were:

1. To what *extent* does retelling at the reading comprehension and levels of science knowledge (conceptual) differ for students who did and did not receive instruction in the specific science content of wind energy?
2. In what *ways* does retelling at the reading comprehension and levels of science knowledge (conceptual) differ for students who did and did not receive instruction in the specific science content of wind energy?

We hypothesize that inquiry into the science content will allow for deeper understanding as measured by the differences between groups on two measures of understanding: recalling basic information from text and recalling scientifically-accurate conceptual understandings. We also hypothesize that the two groups will differ in the ways in which the retellings demonstrate scientific content understanding of the topic presented in the trade book.

Science as a Context

Science Standards

The integration of science, mathematics, and language (NGSS Lead States, 2013) and experiences with real phenomenon (Dewey, 1938; National Research Council (NRC), 2012, Schwab, 1962) are major themes in the science education community. Science, as a subject, requires active participation in an experience that transforms the students and the environment in the course of practical activity (Roth & Jornet, 2014). Both canonical wisdom and scientific practices are seen as outcomes that are vital to scientific literacy (NRC, 2012; NGSS Lead States, 2013).

Within the science canon, the United States science education community agrees that there are certain science disciplinary core ideas and crosscutting concepts that are important for students to know. At the 5th grade level, one of the core ideas within the physical science strand is the transfer and conservation of energy. Among the concepts outlined are (1) energy can be moved from one place to another and (2) mechanical energy can be transformed into electrical energy. Two of the crosscutting concepts are the understanding of (1) cause and effect and (2) energy and matter. Equally important is the ability to engage in scientific practices that can be described as habits of mind that are "used to establish, extend, and refine that knowledge" (NRC, 2012, p. 26). Students are to develop the disciplinary ideas and crosscutting concepts by engaging in scientific parctices.

Misconception About Electricity and Energy

The topic of energy and energy conversion is not an easy topic for elementary students to grasp (Tatar & Oktay, 2007) and some misconceptions seem to persist over many grade levels (Goldring & Osborne, 1994; Herrmann-Abell & DeBoer, 2011). Part of this may be attributed to the literal use of the term 'energy' (Millar, nd) and that, in science, energy is an abstract, mathematical idea (Millar, nd). Additionally, students tend to use common terms (e.g., weight for mass or heat for temperature) which actually convey incorrect scientific ideas.

A common misconceptions with elementary students is that energy is a "thing" and that "energy" and "force" are interchangeable. Within the broad topic of 'energy', the concept of transformation from one form to another may be difficult due to a lack of knowledge about the forms energy can take (Herrmann-Ablell & DeBoer, 2011). Past research has shown that students often think that energy can be created or destroyed (Brook & Driver, 1984; Loverude, 2004; Papadouris, Constantinou, & Kyrats, 2008), thus making the idea of transformation seem unimportant. Further, studies which examined learning progressions for energy (Liu & McKeough, 2005) have provided evidence that students start with an understanding that energy has different sources (even if they do not know the sources) and move into the understanding of energy transfer.

The Importance of Disciplinary-Specific Literacy in Science Instruction

The Role of Literacy in Science

The purpose of science education is to foster knowledge of science that enables students to be careful consumers of scientific information and potentially to develop the skills and knowledge necessary to enter STEM related fields (National Research Council, 2012). Literacy then is an essential tool for learning and communicating about science. Literacy often refers to just reading and writing. However, literacy defined by the Common Core State Standards (CCSS; National Governors Association & Council of Chief State School Officers, 2010) more broadly includes reading, writing, speaking, and listening (Ehren, 2005). The role of literacy in learning is to support learner acquisition, storage and expression of ideas (e.g., Schumaker & Deshler, 2006). Regardless of science discipline (e.g., Biology, Life Science, Chemistry, Physics), student understanding is mediated through literacy skills of reading, speaking, listening, and writing about different scientific phenomena. Specifically, literacy skills support student building of essential background knowledge including the vocabulary, concepts and links between science topics and the world beyond classroom walls. Moreover, generic literacy skills become foundational in the development of scientific literacy that complements, records, advances, and communicates the process of scientific inquiry. Finally, scientific literacy is then an essential way for students to participate in STEM driven 21st century career opportunities.

Defining Disciplinary-Specific Literacy

Disciplinary-specific literacy is a theoretical model for how literacy progresses across the K-12 continuum in which specific skills are emphasized in three successive and hierarchical levels (Shanahan & Shanahan, 2008). First, in the primary grades (K-3) foundations of literacy are emphasized including building decoding skills and knowledge of high-frequency words. Second, in upper elementary and middle school (4-8), literacy instruction focuses on the instruction of generic reading comprehension strategies, common word meanings, and basic fluency. Comprehension strategies are intended to aid in the understanding of content area texts at a beginning level. Finally, in high school (9-12) disciplinary-specific literacy focuses instruction of the specialized strategies and perspectives of each individual discipline or content area (e.g., history, science, mathematics, literature, etc.).

In the case of specialized skills, the reader learns disciplinary-specific strategies that are *not* intended to be generalized to other content areas, but rather are solely taught to enhance mastery and deepened understanding of the discipline under study (Shanahan & Shanahan, 2008). For example, in a biology course a disciplinary-specific strategy might include instruction in predicting possible outcomes of various genetic combinations (e.g., monohybrid crosses, dihybrid crosses, or non-Mendelian inheritance). Such a skill is necessary for developing a cogent understanding of the discipline, but is likely not generalizable for literacy tasks in math, English, or even chemistry. In science, the discipline-specific strategies enable theory development, reasoning, hypothesis testing, and the necessary communication to build knowledge within a scientific learning community.

Retelling

The goal of reading is comprehension, or making meaning from text, for without meaning the process of reading is merely an act of word calling. Educators employ a variety of assessments to determine if students are, in fact, comprehending the text. One such assessment is retelling. Retellings are "oral or written post-reading recalls during which children relate what they remember from reading or listing to a particular text" (Moss, 2004, p. 711). Retelling is helpful in discerning if students focus on essential or non-essential information (reading comprehension or big ideas). Retellings provide slightly different information than traditional comprehension questions (Moss, 2004) wherein the recall captures what the reader remembers from the text, including the inferences and interpretations (Irwin & Nichols, 1983). While some researchers (Reed & Vaughn, 2012) have found retellings to be limited as progress monitoring instruments, retellings are commonly used in classroom to assess reading comprehension (Kucer, 2011). Additionally, retellings can be used to support comprehension rather than simply assessing it by encouraging students to summarize sections of the text as they read (e.g., Gambrell, Pfeiffer, & Wilson, 1985; Koskinen, Gambrell, Kapinus, &Heathington, 1988; Kucer, 2010).

Retellings can be scored by counting the percentage of idea units retold as in in the retelling portion of the Qualitative Reading Inventory (QRI; Leslie and Caldwell, 2011). For the QRI, both recall of explicit details and summary or "gist statements" can be used to determine a student's overall comprehension. Kucer (2010) employed a more detailed scoring system, implementing a "retelling taxonomy" which included exact matches, substitutions, additions, summary statements, and conflicts.

While the use of retelling to assess comprehension of narrative texts has a long history in the literature, over the last decade in particular, researchers have used it in assessing informational text comprehension (Best, Floyd, & Mcnamara, 2008; Kucer 2010, 2011; Moss, 2004). As students engage in reading and writing in the different content areas, they encounter different text structures. Narratives present personal experiences and often develop a story with a problem-solution structure. In contrast, analytical genres tend to present factual information and argue for a particular interpretation of events (Schleppegrell, 2004). Additionally, vocabulary tends to be more specific and more complex in informational texts. Educators today recognize the challenges students—particularly ELLs —face in developing the more advanced literacy skills needed to engage in informational text. This, along with the fact that narrative continues to be the genre that predominantly appears in the lower elementary classrooms, continues to be one of the reason for students having a difficult time with informational text.

Recent research examining reading comprehension through the use of retelling using informational text ascertain that in addition to the lack of familiarity with informational text structure, retellings are also affected by the readers' lack of background with the content of the text (Kucer 2011). Being able to read a passage and then retell it depends greatly upon productive language ability of the child (Johnston, 1981) and on prior knowledge. In addition, Snyder, Caccamise and Wise (2005) posit that cultural-linguistic difference might influence the outcome of oral retelling. Therefore, the exploration of retelling as a measure of reading comprehension and science-specific content is warranted.

Methods

This research is part of a larger project examining the academic language and conceptual understanding acquisition for ELL students. For this phase of the study, the research team used retelling of informational trade book text as an indicator of reading comprehension and scientific understanding.

Participants

All participating students were ELL 5th graders who were refugees or immigrants to the United States. Students ranged from 10 to 12 years old. Although all were classified as 'Advanced High' by the state language proficiency criteria, the language proficiency varied greatly. The student demographics are summarized in Table 1.

Table 1
Demographics of Students

Year	N (47)	Condition	Languages (L1)	Years in US
Year 1 2012	M = 25 F = 7 T = 32	Experimental with turbine unit	Arabic, Burmese, French, Karenni, Nepali, Spanish	Mean of 2.5 years
Year 2 2013	M = 11 F = 4 T =15	Control with genetics & DNA unit	Arabic, Burmese, Chin, French, Hindi, Karenni, Kibembe, Kirundi, Kifulero, Kiswahili, Menda, Nepali, Spanish, Soso, Swahili, Thai	Mean of 2.5 years

Context

Students exiting elementary newcomer, English-language classrooms attended a three-week summer program held on a university campus. The summer program was conducted by three university professors (science education, bilingual/ELL education and mathematics education) who had a history of co-teaching emerging bilingual 5th and 8th grade students (Weinburgh, Silva, & Smith, 2014). The program began the day after school was dismissed for the summer in early June and ended just before the July 4th holiday. The district provided transportation from designated stops to the university and two meals (breakfast and lunch) to all students. Busses arrived at the campus at 7:40 and departed at 12:30. Attendance in the program was voluntary.

Both groups engaged in hands-on experiential learning with the focus on science as an investigative discipline. Only the science content differed. The students in the experimental group studied wind turbine construction through models and measured the conversion of wind energy to electricity using volt meters. The students in the control group also received instruction focused on science as inquiry from the same teachers and researchers but the content focus was on DNA and genetics. The activities of inquiry for this group centered around experiments with genetics and "blood" tests.

Experimental group. Students in the experiment group had 14 days of instruction around the theme of wind power/wind turbines. On the second day, students were presented with the problem to determine the best wind turbine design for one of the participating professors to build at her home. During the next several days, students used a model of a wind turbine to systematically manipulate variables to determine the effect on the voltage produced by the turbine. Manipulated variables included number of blade, position of blades, shape of blade, and tilt of blades. Controlled variables included the relationship of the tower to the wind and the speed of the wind. In addition to the hands-on aspects, the students wrote/drew in their journals, read books during sustained silent reading about wind energy, examined GoogleEarth maps for locations of wind turbines, book clubs, and calculated energy use.

Control group. Alternatively, students in the control group had a different topic for their summer program but maintained equivalent instruction time. Specifically, students in the control group engaged in 14 days of instruction in science content between probes. For the control group, science instruction focused on the topic of genetics and DNA using a Crime Scene Investigation theme. Control students were asked to use evidence collected at the scene to determine who "stole" a box of T-shirts. Similar to experimental students, control students engaged in the literacy activities of journaling, book clubs, and sustained silent reading, but with books related to DNA, genetics, and crime scene investigations, not wind energy. Further, both the experimental and control group came from the same district program having qualified based on student status as determined by the state's language proficiency criteria. Specifically, the target students for this intervention in both conditions were ELL designated by the district for exiting the newcomer program.

Data Collection

Researchers assessed each student's ability to retell on day 1 (pretest) and day 14 (posttest) of the program. A portion of the interview included reading *Chapter 3: How Wind Power Works* (4 pages) from a trade book entitled *Wind Power* (Benduhn, 2009). This trade book on Wind was selected from a pool of grade-appropriate and topic appropriate trade books intended for use with fourth graders. Fourth grade readability was chosen based on the reading abilities of the target student population while maintaining sufficiently sophisticated science content. Further, prior to instruction a pool of appropriate trade books (n=4) was then sampled by a comparable group of ELL students in a local public school system to identify student preference. The *Wind Power* trade book was selected by this jury of students. Researchers then selected the *How Wind Power Works* chapter for assessment as it was most closely associated with the topic of instruction.

Students in both the experimental and control group were assessed for retell ability using Chapter 3 at pre- and posttest. The text was held constant from pretest to posttest for both groups to ensure consistent level of difficulty and to directly measure the influence of instruction on retell ability. The fourteen day span between probes was considered sufficient to avoid recency effects. Students were asked to read all four pages and were told that the interviewer would not be able to help them with the reading. When the student completed the oral reading, the interviewers used an established protocol which included prompting a retell by saying "Pretend that I didn't hear you read this book. Tell me about what you read." The only prompts the interviewers used were "Can you tell me more?" and "Is there anything else you want to add?" The readings and retelling were audio and videotaped. The audio file was sent to a professional transcription company and returned to the research team as text.

Data Analysis

Coding. Data were coded in two phases. First, the word documents were divided into clauses as suggested by Morrow (2005). In establishing what could be counted as an unprompted retelling, the researchers listened to the audio and marked each transcript at the point of interviewer prompting. Any prompting beyond "Can you tell me more?" and "Anything else you want to add?" marked the end of the retelling. Only unprompted responses were coded for this research but the remainder of the interview was saved for another phase of the research. Prior to coding, all retellings were combined so that a random coding sequence resulted and coders could not distinguish between pre/post retellings. Students' names were then removed and the retellings were assigned a number, insuring a 'blind' coding. Further, pretest and posttest data from both the experimental and control groups were mixed prior to coding to minimize bias. Coding scores were then entered into a spreadsheet by a graduate student who had the master list of the name-number and group match.

In establishing ways to answer the research questions, the research team decided to code the retelling clauses two ways: (1) examining the clauses for a reading comprehension retelling as often used in elementary classrooms and (2) examining the clauses for evidence of conceptual understanding of conversion of energy from wind to electricity. To practice and perfect the coding methods, the team used student artifacts from students who did not have a pre- and a post- example.

Reading comprehension retelling. For the reading comprehension retelling, the team divided the selected text (Benduhn, 2009) into clauses, indicating main text and picture captions. A scoring system similar to Kucer (2010) was used (Appendix A). The scoring team met weekly and was comprised of four to seven scorers (always two or three professors and two to four graduate students). After several trial methods for coding, the team agreed that each member would code independently and then report to the group. When there were conflicting codes, the team discussed the reason for the miss-match, and consensus was achieved on all items. The conversations about coding resulted in 'rules' being added to Appendix A and B. Each student retelling was scored.

Level of science understanding retelling. Using an inductive model, the research team independently read the target text and identified all of the concepts contained within the text. Independent lists were then compared to identify consensus concepts by ensuring that at least three out of four members agreed on the identified concept (e.g., Wind energy is converted by the turbine into electricity). All disagreements were juried by the team to ensure a final consensus.

Based on guidance from the science expert on the research team, the list of concepts was further sorted into three related categories: (a) conceptually important disciplinary core ideas of energy conversion; (b) practical context for wind turbines; and (c) descriptive features of a typical turbine (see Appendix B).

To test the validity of the three related categories, the reading/retelling data from students who did not have both pre- and post-retellings (i.e., students whose data we could not use in the analyses) were coded and the research team discussed areas of confusion and disagreement. Rules including examples and non-examples were generated to support the analysis process and improve interrater reliability. For example, when we looked at 'tall' and 'big', we had to decide whether the word use was sufficiently distinct from 'tall to catch wind'; from other levels of understanding; to merit its own code.

Results

For research question one, we found a difference between the two groups of student. These differences are pointed out more specifically below. Having established that the control group and experimental groups' retellings differed, we focused on a more in-depth analysis in order to answer the second research questions. This revealed difference in the types of information provided by the students.

Reading Comprehension Retelling

Employing Kucer's (2011) scoring scheme for retellings, each clause was identified as a match, a substitution, a summary, a conflict, an addition, or not able to be scored (see Appendix

A). Results indicated differences between the control and experimental group when examining the retellings at the clause level. Matches and substitutions allowed for the assessment of reading comprehension as the ideas presented in these types of scores were captured at the word level. Conversely, additions were ideas which went beyond the literal meaning of the text, requiring an inference based upon a student's background knowledge. Summary statements included general statements about the main idea of the chapter as well as statements that combined two or more ideas presented in a clause. Conflicts varied in terms of literal or inferential comprehension. Some conflicts were at the literal level (e.g., the exact speed of the wind) while others presented conflicts at the inferential level (e.g., misrepresenting wind farms as places where animals were also raised).

Matches. This category included ideas expressed in the retelling that directly matched the text. Included in this category were statements that contained the same words but differed in word order (e.g., "Wind blows stronger…" retold as "Stronger wind blows…"). In terms of matches, the experimental group had more matches between the text and the retelling with the experimental group 1.8 times more likely to provide a match to the text than the control group. For example, the text stated, "The spinning blades power a machine called a generator." While the experimental group tended to correctly retell that the "blades move a part called generator" whereas the control group was more likely to have stated, "blades make electricity."

Additionally, the experimental group displayed a higher gain score for matches from the pre to post assessment. Gain score represented the overall difference from pre to post assessment to account for possible bias associated with prior knowledge. The experimental group correctly used scientific words such as turbine, generator, energy, and electricity more often than the control group. These findings suggest that the increase in the number of direct matches from the experimental group may be related to their increased vocabulary for the science concepts of energy conversion and wind energy.

Summaries. When students condensed two or more separate clauses in the text into one general statement, the statements were coded as summaries. Sometimes the summaries were main idea statements while others were combinations of clauses. The experimental group was again 1.8 times more likely to provide summaries. For example, combining the two sentences "The electricity is then sent through cables to a power plant. The power plant sends electricity to houses, schools, and other buildings" into "blows energy to an energy machine and then the energy goes to wires that give to houses." Another student said, "It works [when] the blades move and powers a generator which sends energy to a power plant. Power plants send energy to homes and other places." A negative gain in the summary statements pre/post for the control group contrasted with a positive gain in the summary statements for the experimental group. As students in the experimental group gained background knowledge about wind energy, their abilities to summarize, combining scientifically relevant ideas, increased.

Substitutions. Substitutions were modifications of the text at the word level that were semantically acceptable, for example substituting the word "big" for "tall." The control group was 10 times more likely to provide a substitution than the experimental group. The control group substitutions tended to be adjectives of the features (e.g., high, big, tall). Of particular interest for the science education community is that the control group was ten times more likely to substitute less precise verbs (sends, makes, catches, gets), indicating a less sophisticated understanding of the scientific concepts. The most common substitutions occurred in relation to the use of, labels for, and comparisons of turbine features, and the location of wind farms. The substitution score favoring the control group may be evidence that the experimental group was able to use the appropriate terminology without substitution. In that way, students in the experimental group used language that was more precise.

Conflicts. Conflicts were defined as substitutions that were scientifically inaccurate. For example, retelling the statement "Wind turns the blades of the turbine." as "The blades *make* wind for the turbine." The experimental group was 1.85 times less likely to have a conflict in the retelling. The conflicts that were found most often in the control group were in the areas of scientific terminology and conceptual understanding. For example, using 'windmill' instead of 'wind turbine' or 'makes' instead of 'changes'.

Though limited, it is interesting to note that the conflicts found in the experimental group were most often around small details and common usage of terms rather than important scientific terminology and conceptual understanding. For example, experimental group errors included stating that the wind speed was 55 mph rather than 59 mph and calling wind turbines windmills. The data provides evidence that more conceptual understandings of the content presented in the text resulted in fewer conflicts in the retelling of ideas outlined in the book.

Addition. Additions were ideas expressed in the retelling that were not found in the text but were semantically and conceptually acceptable. Additions went beyond the text to include personal experiences, interpretations of information from the text's illustrations, and application to other situations. For example, the text explained that turbines are placed in "areas that have steady, fast winds." One experimental student stated, "Texas is number one of having wind turbines because in West Texas, there's a lot of wind, so there are most wind turbines." There were no significant differences in overall additions between groups. However, the experimental group was two times less likely to use a feature of text (bold, picture, etc.) as an addition. Moreover, the experimental group was 1.7 times more likely to make additions about the process of generating electricity. These "beyond the text" additions suggest that the by building on conceptual understandings from instruction, the experimental students comprehended the text beyond the literal level.

Levels of Science Understanding Retelling

From a science perspective, we were interested in whether the students were able to identify and retell the important scientifically-accurate information. During phase two of data analysis, data were analyzed for conceptual understanding of the science concepts and the big ideas of the text. Researchers identified the big science ideas in the text and arranged them into three categories: (A) generalization about the process of energy transfer, (B) understandings related to where wind turbines work best (context), and (C) information about or details related to the components of the wind turbine. The researchers reread the retelling transcripts not at the clause level, but at the sentence level and coded for conceptual understandings. For instance, if a child stated "turbines make electricity" or "turbines get their electricity from the wind," the statement was coded as a conceptual understanding of the big idea "the generator changes wind energy into electricity" and the unit was coded as generalization about the process of energy transfer (Category A). However, statements like “turbines make energy” were not coded as conceptual understandings because turbines do not *make* energy but convert it. (See Appendix B for coding scheme.)

Overall the experimental group showed more substantial gains in conceptual understanding. All three categories were big ideas about the topic of the structure and function of wind turbines and energy conversion, but Category A focused specifically on the process of energy conversion – a more scientifically dense aspect of the text. The experimental group showed a substantially higher gain (1.64 times more) than the control group in Category A.

Category B included the context in which wind turbines (especially, wind farms) are found and the conditions under which they operate best. The control group demonstrated just less than twice the gain (1.93) of the experimental in this section. The may be due, in part, to the linguistic demands of the Category B were less than for Categories A and C. That is, the students could use every day language such as *taller*, *faster,* and *bigger* to describe the context where wind turbines work best rather than the specialized vocabulary related to energy transfer and wind turbine features. The concepts of Category B area were not as cognitively demanding as those in Category A, making for easier recall by the control group. In addition, the pictures depicted in the text showed the location as situated in areas of fast wind. In fact, some (8/15) students in the control group spontaneously looked at the book while the experimental students were explicitly told to close the book when providing the retelling. Students who looked back were able to use the pictures to recall the context in which wind turbines work bets but not the big ideas about how energy is converted and used.

Category C included the specific details related to the three features of wind turbines (blades, tower, and generator). Students in the experimental group had more substantial gains (4.9 times more) than the control group. This may be explained by the group who engaged with the model of the wind turbine developed a functional use of vocabulary because of the hands-on experiences in the classroom. Their focus for the inquiry was which model worked best, therefore the experimental group spent more time with the language specific to the discipline and concepts (e.g., blades, generators, towers) as well as the details of those features (e.g., length of the blades and number of blades mattered). This created a situation in which the students manipulated physical objects as well as manipulated ideas about wind turbines.

Implications

Our research has important implications for science teachers who are teaching ELLs. We stress that we begin with the assumption that the science teacher will select trade books that are scientifically accurate. With that as a given, we see two important outcomes in this research. The first outcome deals with alternative assessments for ELL science understanding while the second deals with situated learning within an inquiry-base science class as an avenue to develop content and language.

An important implication of this study is seen in science teachers often expressing the desire to have a way to assess the content understanding of students in their classes. Using the language arts strategy of retelling may be a solution. For ELLs who may not readily produce conventional writing in English, retellings offer an alternative way of assessing understanding. By engaging in a retelling, students can demonstrate their comprehension of not only the text but their conceptual understandings of the science content. Matches, substitutions, additions and summaries all point to different aspects of understanding – allowing for a more holistic picture of the student's learning. The retelling also allows the teacher to find misunderstandings and/or misconceptions in terms of the material presented in the text by identifying and examining retelling conflicts. This latter finding is significant as science teachers strive to meet the needs of the academically diverse classroom. That is, retelling assessments may provide critical data to guide instructional decision-making as teachers monitor student progress throughout a unit. Specifically, teachers may prove more successful in meeting the needs of all learners by using periodic retellings to monitor student progress toward mastery of critical content.

We understand that time constraints and the ability to find a suitable trade book may hinder this form of assessing ELLs' understandings. However, we found it to be very helpful as one way of capturing change in students' understandings. We also recognize that elementary science teachers may use trade books and retelling more easily than secondary teachers. Oral retelling can use valuable in-class time as they are typically one-on-one assessments. We suggest, as an alternative, written retellings that can be conducted as a whole-class activity. As another alternative, students could audio record their retellings. These recordings could then serve as progress-monitoring measures of reading fluency and expression.

This research also points out the importance of situated learning within the science class. The results indicate that hands-on experiences using the language of the discipline may improve students' abilities to use the precise science language of the topic being investigated. Language development does not occur in isolation, but is part of the community and develops in context. As posited by Gee (2002),

> There is no such thing as language (e.g. English) or literacy (e.g. reading and writing) in general. People do not learn English. Rather, they learn a specific 'social language' (variety or register of English) fit to certain social purposes and not to others (p. 162).

Finally, science teachers have historically seen their job as teaching the content of science and ELA teachers as teaching reading/writing and speaking/listening. Findings from this study indicate a positive reciprocal relationship when informational trade books are utilized in conjunction with hands-on science learning. When students are engaged in instruction that provides emphasis on the big ideas using hands-on experiences, their abilities to draw the big ideas from a text may improve.

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Appendix A
Coding at the Clause Level for Reading Comprehension

CLAUSE: A group of words containing a subject and a verb	
Coding	**Example**
Match: Idea expressed in the retelling matches an idea in the text. The surface structure may be different, but the deep structure is the same.	See text
Substitution: The idea expressed in the retelling is a substitution for an idea in the text. A substitution represents modifications of an idea expressed in the text that is semantically acceptable.	Word level - if it is not at the word level it tends to be a summary.
Addition: The idea expressed in the retelling is not found in the text but it is semantically and conceptually acceptable. An addition may represent implicit text meaning or an inference which is feasible	Beyond text; Personal experience; Visuals from the text' Application to another situation. Conceptually acceptable in this case means scientifically acceptable/accurate for a 4th grader
Summary: At least two separate ideas in the text are condensed into one general idea in the retelling.	Often found early in the retelling. Summary overrides substitutions.
Conflict: The idea expressed in the retelling contradicts an idea expressed in the text.	
Rearrangements: The order of the ideas ante their relationships expressed in the retellings are at variance with the order of the ideas and their interrelationships expressed in the text.	
Not able to be scored: Clause is without idea as to be non-sensible	Make sure that they are clauses. Discard if they are not clauses.
General Rules	
Do not score repeated clauses	
If the child has initiated and the interviewer specifically refers back to the child's language, we code as retelling	

Appendix B
Coding for Conceptual Understanding

A. The Process of Energy Conversion	**Rules**
1. Turbine catches the winds energy	Accept "get" instead of "catch"
2. Spinning blades power a machine	
3. Generator changes wind energy into electricity	Accept produce, transform, convert, air , machine Accept "turbines make electricity" Accept "get their electricity from the wind" Do not allow "turbines make energy"
4. Electricity sent through cables to power plant	Accept wires Do not allow "energy" in place of "electricity"
5. Power plant sends electricity to houses, schools, and other buildings	Do not allow "energy" in place of "electricity"

B. Context (Where Wind Turbines Work Best)	**Rules**
1. Wind blows stronger when higher off the ground	
2. Turbines are very tall to catch more wind	Accept "get" instead of "catch" Doesn't have to say BECAUSE it will catch more wind; can just say "tall" Must have relationship of tall – more wind
3. More wind a turbine catches the more electricity made	Accept "get" instead of "catch"; "air" Do not allow "energy" in place of "electricity"
4. Works best in areas that have steady fast wind	Works best in areas with no blockage, no gusts, open spaces, ocean, coastal areas, no trees or buildings Do not accept "flat space" by itself Accept "air"
5. Wind must blow in a certain range	

C. Components of the Wind Turbine	**Rules**
1. Features of Blades	Must describe a feature Analogies (airplane propellers), multiple number of, large size, mobile
2. Features of Tower	Must describe a feature Hollow, must be strong, tall Must say tower Accept shaft
3. Generator	They state that there is one