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THE EFFECTIVENESS OF GENRE-BASED PEDAGOGY IN IMPROVING GRADE FOUR LEBANESE LEARNERS' CONCEPTUAL KNOWLEDGE AND EXPOSITORY WRITING IN SCIENCE AND THE CHALLENGES THEY FACE

by
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AN ABSTRACT OF THE THESIS

Nesrine Ghazi Yamout for Master of Arts

Major: Teaching English as a Foreign Language

Title: The Effectiveness of Genre-Based Pedagogy in Improving Grade Four Lebanese Learners’ Conceptual Knowledge and Expository Writing in Science and The Challenges They Face

This study adopted a mixed research design in order to identify the effectiveness of genre-based pedagogy in improving grade four Lebanese learners’ conceptual knowledge and expository writing in science and to identify the challenges they articulate when completing a writing task intended to elicit exposition. The purpose of this study was to: (a) investigate whether genre-based pedagogy approach improves the quality of grade four Lebanese English Language Learners’ expository writing text, (b) examine whether genre-based pedagogy approach improves grade four Lebanese English Language Learners’ conceptual knowledge in science, and (c) explore the challenges that grade four Lebanese English Language Learners articulate when completing a writing task intended to elicit exposition. Data was collected using: (a) a paper and pencil measure where students were provided with a question prompting them to write an expository text both before and after the intervention to test the effectiveness of genre-based approach on students’ expository writing, (b) conceptual knowledge assessment adopted from *Science Fusion* assessments sheets and modified by the researcher to identify the effectiveness of genre-based approach on students’ conceptual knowledge in science, and (c) a think a loud protocol was also followed as students were asked to think aloud while writing to learn in order to identify the challenges they articulate when writing a task intended to elicit exposition. The sample consisted of approximately, 37 grade four students from a private school in the area of Beirut. This study has shown that the genre-based approach did improve the quality of grade 4 students’ expository writing in most of its aspects. However, while students in both groups improved substantially in their conceptual knowledge, there was no significant difference between the control and experimental groups in the gain in conceptual knowledge from before to after the intervention. Finally, even though most students who participated in the think aloud sessions found the task very challenging, some challenges were identified such as translating thoughts to written sentences, generating ideas, hesitating, and translating from their native language of Arabic to the language of instruction, English.

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CHAPTER I

INTRODUCTION

In recent years, there has been an increased interest in integrating science and language arts instruction (Gunel, Hand & Prain, 2007; Lee & Buxton, 2013). Such integration can enhance students' English proficiency as well as improve their content area knowledge. This integration has been implemented in different ways. One of these ways is writing to learn science which has also been claimed to enhance students' conceptual knowledge in science and their language skills (Lee & Buxton, 2013). In this research study students' conceptual knowledge means their achievements in the content of the subject matter; in other words, students' conceptual content knowledge in science. A piece of writing can be characterized by its genre, which is the way that language is used in different contexts and for different purposes (Halliday & Martin, 2003). Thus, it is important to identify the challenges that the students face when completing a writing task intended to elicit the genre of exposition and to evaluate the effectiveness of genre-based instruction on improving the quality of students' exposition text and their conceptual knowledge. Moreover, there are several factors that affect students' writing to learn science, and one of them is the language of instruction. This study examined what type of challenges Lebanese students, who are not native speakers of the language of instruction, face when writing an expository text in science and the effectiveness of the genre-based instructional approach for these students.

Background

Integrating science education and language instruction is increasingly being acknowledged as an important instructional strategy (Lee & Buxton, 2013). Science is now considered an important context for developing English proficiency. When students improve their English skills, their comprehension of science and its processes are facilitated and enhanced as well. Given the attention to this issue of integrating science and language, it is important to state that there are different ways of thinking about the relationship between writing and learning such as learning to write and writing to learn science (Oliveira & Lan, 2014). The first is described as the initial step for students to learn the skills needed to write well, while writing to learn is the pedagogical approach that enables students to use writing as a means to facilitate the learning process of a content area such as science (Fry & Villagomez, 2012; Sampson, Enderle, Grooms, & Witte, 2013). There are four different writing to learn approaches that have been investigated: the science writing heuristic (SWH), writing across the curriculum (WAC), argument driven inquiry (ADI), and most importantly genre-based pedagogy.

Genre-based pedagogy is an approach to teaching writing that focuses on the genre characteristics of types of texts and supporting learners in becoming aware of, and skilled in, using these characteristics. In fact, the genre-based approach is considered very important for students as a number of studies examined the effects of using such an approach on students' science and language achievements. Researchers found that not only does this approach enhance students' attitude towards science, but it also improves their proficiency in both language and science (Bradbury, 2014; Cavagnetto, Hand & Norton-Meier, 2010; Emerson, MacKay, MacKay & Funnell, 2006; Gunel et al.,2007; Jammoul, 2016; Jani & Mellinger, 2015; Lee & Buxton, 2013; Nam, Choi & Hand, 2011; Oliveira & Lan, 2014; Sampson et al., 2013). When students are familiar with school science genres, they produce better and more effective texts. The most recognizable school types of genres in science are: reports, explanations, experimental reports (procedural and recounts), and exposition. The last is the most beneficial and significant for students' academic success and the more challenging one as well (Beck et al., 2013, Jammoul, 2016). It is used to provide arguments in order to defend the position that is being investigated. Expositions show only one side of the argument (Brisk, 2014). Erduran and Aleixandre (2008) stated that argumentation in science classrooms supports the achievement of scientific literacy and empowers students to talk and write the language of science.

A theoretical framework that justifies the increased interest among science education researchers in using the genre-based approach is Systemic Functional Linguistics (SFL) (Halliday, 1994). SFL is a view of language that focuses on its function and its various features that are used to perform certain tasks. This view of language has been specifically applied to the language of science and has described its specialized characteristics. Among these is that scientific texts can be categorized into a variety of genres such as explanation, classification, reports, exposition etc.

There are several factors that can affect students' writing to learn which can be related to personal, social, and cultural conditions. The factors that are mentioned in the literature include effort, support (such as feedback and direction, students' perceived self-efficacy), metacognition, sociocultural aspects (Fry & Mellinger, 2012; Gunel et al., 2007; Jani & Mellinger, 2015), and the language of instruction (Beck et al. 2013). In fact, some studies examined the challenges that both native English speakers and English Language Learners (ELLs) face when writing to learn and found that the former mostly face less challenges compared to the latter. Therefore, whether or not the language of instruction is the students' native language is another factor that influences the outcomes of writing to learn activities. Thus, one of the purposes of this study is to investigate the challenges that Lebanese English Language Learners face when writing to learn science.

Statement of the Problem

Teachers must provide upper elementary students with specific kinds of instructional support for them to become successful writers in science. Several approaches to teaching students writing to learn skills have been described in the literature. In many countries, research has explored the effects of these approaches, including the genre-based approach (Gebhard & Harman, 2011; Hyland, 2003; Reppen, 1994; Tardy, 2006). It was found that such an approach has several positive effects on students' conceptual content knowledge in science and their language skills (Bradbury, 2014; Cavagnetto et al., 2010; Emerson et al., 2006;Gunel et al., 2007; Hyland, 2007; Lee & Buxton, 2013; Nam et al., 2011; Oliveira & Lan, 2014). Therefore, the first objective of this study is to investigate whether genre-based pedagogy would have similar effects on Lebanese students who learn science in English even though this is not their native language.

Moreover, the focus now is increasingly shifted towards written texts and genres which are more cognitively demanding and linguistically complex beyond the students' recognizable text types such as personal narratives or stories. These genres can be more challenging for ELLs, as they will have to exert further linguistic and cognitive efforts, especially when science is the content area (Oliveira & Lan, 2014). Such efforts are evident when students are required to explain and describe phenomena in science-specific genres, as well as code-switching between their everyday language use and the language of science (Lee, Quinn, & Valdés, 2012). More specifically, this study focuses on grade four students whose content areas become more specialized than previous classes and involve written texts using unfamiliar and specialized genres. Grade four is considered a critical period where learning to read and write start shifting to reading and writing to learn which is linguistically more complex. In Lebanon, English or French are the medium of instruction for science and mathematics in most schools and can cause problems for students who are not native English or French speakers. Considering the fact that the language of instruction can be a factor affecting students' writing, another aim of this study is to identify the challenges Lebanese students face when completing a writing task intended to elicit a specific genre in science.

Research Questions

Three questions guided the current research study:

1. Does a genre-based pedagogy approach improve the quality of grade four Lebanese English Language Learners' expository writing?
2. Does a genre-based pedagogy approach improve grade four Lebanese English Language Learners' conceptual knowledge?
3. What challenges do grade four Lebanese English Language Learners articulate when completing a writing task intended to elicit exposition?

Significance

Identifying the challenges that English Language Learners face when writing to learn science and the effect of genre-based pedagogy on their writing quality and conceptual knowledge can have a number of implications for both theory and practice.

With regards to implications for theory, the results of this study will show whether there are differences in the kinds of challenges that students in Lebanon face compared to students in other parts of the world. Moreover, the results of this study will contribute to the development of the genre-based pedagogy by adding information on whether this approach has similar positive effects on Lebanese students compared to the results of previous studies.

In relation to practical implications, acknowledging and identifying the challenges that Lebanese ELLs face when writing to learn will help other researchers, teachers, and curriculum developers design new strategies for writing to learn science. These strategies take into consideration the issues which students face by preparing lessons that suit their needs and ensuring a better learning outcome in science and language arts. Another practical implication is related to documenting the effectiveness of the genre-based pedagogy. If this approach shows any positive effects, it would justify the recommendation that Lebanese teachers use it in their classroom in order to enhance Lebanese students' writing and science learning.

CHAPTER II

LITERATURE REVIEW

Purpose of Integrating Science and Language

The combination of science and language arts instruction has been gaining popularity in recent years. According to Bradbury (2014), language arts skills such as reading and writing are fundamental to the work of scientists and also beneficial to elementary students. Bradbury mentioned that science and language arts share similar cognitive processes such as “making predictions, assessing evidence, and drawing conclusions” (Bradbury, 2014, p.465). Bradbury reviewed articles published over the past 20 years which investigate the impact of integrating science and language arts, and compared the outcome of the different types of instruction teachers used on students’ academic achievement and attitude at the elementary level. The results showed a positive achievement in both disciplines (science and language) and more positive attitude for students whenever they participated in integrated instruction of science and language. Moreover, Lee and Buxton (2013) stated that science is considered an important context for developing English proficiency. When students acquire and improve their English skills, their learning of academic processes and content are enhanced. In order to encourage science learning and literacy development for the learners, effective science teachers should integrate reading and writing strategies in their instruction as the improvement of writing and reading skills should not be assigned only to language arts teachers (Knipper & Duggan, 2006). Lee et al., (2012) mentioned the importance of having science teachers who are knowledgeable about language and language learning as it can support the overall science experience of all students, and more specifically of English language learners. It is rather considered essential for effective classroom practices to explicitly incorporate academic content and English composition skills (Lee & Buxton, 2013; Lee et al., 2012). Norris and Phillips (2003) stated that reading and writing are considered essential elements of science and therefore should be seen as constitutive parts of it and not just used as tools to teach and learn science. Moreover, they mentioned that reading and writing are strongly tied to the nature and learning of science. Gunel et al. (2007), also highlighted that students' writing is a primary support to their science learning. This is also in parallel with the findings of Sampson et al. (2013) who noted that writing enhanced students' understanding of core scientific ideas and is considered an important scientific practice. Thus, students will need to learn how to write so that they are able to use writing as part of learning science.

Learning to Write Versus Writing to Learn

Early literacy instruction such as learning to write and read as well as content area literacy instruction such as writing and reading to learn academic content areas are the main constituents of literacy of school education (Oliveira & Lan, 2014). Early literacy and content area literacy instruction are embedded in our societies as learning and writing are inevitably linked and one cannot be efficient without the other.

Learning to write. In learning to write, the teacher helps his/her students practice several skills that are required in order to write well (Christie & Derewianka, 2010).). According to Knipper and Duggan (2006), students keep on learning how to write throughout their school years. They mentioned that at the elementary level, students start to learn how to "encode words, spell, construct sentences, figure out the mechanics of paragraphs, and develop understanding of grammar" (Knipper & Duggan, 2006, p.462). At an older age, students improve and develop these skills further until they start focusing on the "process of writing: prewriting, writing, reviewing, revising, editing, and preparing the final draft" (p.462). In learning to write, students will neither have the opportunity to learn core scientific ideas nor utilize writing as a way to express what they do or see inside a science classroom. Hence, the students' attitude towards writing will be negatively affected and their performance and motivation to write will decrease since they will be viewing these activities as "doing school" instead of "doing science" (Sampson et al. 2013).

Writing to learn. Writing to learn is a pedagogical method in which writing is used as a tool to facilitate learning and make the subject or topic clearer through reasoning (Fry & Villagomez, 2012). Similarly, Sampson et al., (2013) state that the purpose of writing to learn is to develop the students' understanding of the content of their writing tasks. This can be achieved by helping them explicate, reflect, elaborate and implement the laws, principles and guidelines to which they were introduced in class. According to Knipper and Duggan (2006), writing to learn serves as a catalyst for students' additional and enhanced learning and their development of meaning making. Students have the opportunity to recall relevant aspects, clarify the ambiguities, and raise questions related to the subject matter when writing to learn. They will also have the ability to reveal their knowledge about their content focus, present linguistic and communication skills to different audiences, and even discover personal traits as related to the subject at hand. Moreover, Gunel et al., (2007) conducted a complementary analysis of six different writing to learn projects in order to identify the effectiveness of using such strategies within science classroom. They found that students in the writing to learn treatment groups had higher scores than the students in the control groups in terms of conceptual understanding. This secondary analysis proved the effectiveness of using writing to learn activities in science classroom.

Approaches Used When Writing To Learn Science

There are several writing to learn teaching approaches that have been investigated to determine whether they enhance students' conceptual knowledge in science and their language skills. Some of these approaches are: the science writing heuristic, writing across the curriculum, argument driven inquiry, and the genre-based approach.

The Science Writing Heuristic (SWH). This approach is an instructional technique developed by Keys and Hand in 1997 that combines inquiry tasks, collaborative work, and peer argumentation. According to Cavagnetto et al., (2010),

> "The SWH approach is a series of scaffolds that require students to use different forms of language (reading, writing, talking) in various settings (individually, in a small group, as a whole class) as they engage in scientific inquiry leading to the generation and defense of a science argument." (p.428).

Moreover, this dynamic concept focuses on building the students' own knowledge through multiple activities such as allowing them to inquire about the subject, express their opinion, and provide evidence instead of directly "spoon feeding" them with information and instructions. The SWH also provides students with templates that guide them during their laboratory studies and writing activities, in addition to offering teachers templates to promote learning from such activities.

In a study with fifth graders from a Midwestern state in the USA, Cavagnetto et al., (2010) examined students' interactions in small groups while utilizing the SWH. During four units of study, students were audio-recorded while working in small groups; first they had to conduct a student-directed investigation to come up with an inquiry question and then generate a knowledge claim. The authors noticed that the demands of the writing task require the students to reflect, at a deeper level, on the argument that they did during the generative talk. Nam et al., (2011) conducted an experimental study in which the experimental group was implementing the SWH and the control group was involved in traditional lecture-centered activities measured by the Reformed Teaching Observation Protocol (RTOP). RTOP is an instrument designed to measure reformed teaching by identifying the degree to which classroom instruction uses engaged learning and student-centered practice. They employed the summary writing test (SWT) as a method to compare students' performances. The participants were 8th grade students from three middle schools located in the second biggest city in Korea. The students were provided with a template of the SWH approach which aims at scaffolding their understanding and reasoning about the assigned laboratory investigation through a semi-structured writing form. The teachers on the other hand had a template that aided them in organizing class group discussions during which the students were conducting scientific inquiry analysis. The study showed that students who were implementing the SWH were able "to frame big ideas, construct science concepts, develop arguments on a particular scientific topic, and develop writing skills" in contrary to students of the control group (Nam et al., 2011, p. 1130). This illustrates the effectiveness of using such an approach in enhancing students' science achievements and writing skills.

Writing across the curriculum (WAC). The writing across the curriculum approach incorporates the essential features of teaching writing into specific academic disciplines (Emerson et al., 2006). Its general purpose is for the students to use writing in order to promote learning, and its main focus is for them to master the mechanics of writing (Jani & Mellinger, 2015). Moreover, WAC stresses on the importance of shifting the responsibility of developing the writing skills in the various educational institutes towards multiple disciplines rather than being exclusively the responsibility of English departments. This approach also assumes that both practice in specific fields and the act of writing are elements of the learning process, and that the writing activity can promote better communication skills and substantive learning. Jani and Mellinger proposed a WAC program in which they tried to bring together the specialist writing teachers and the discipline-specialized staff to work collaboratively. This study's writing project was done in the horticultural and agricultural sciences program in a university located in New Zealand. Students' writing projects included journals, reports in which students were required to focus on diverse audiences by using multiple genres, and written reports on in-class and practical activities. The results of this study showed that students' attitude towards writing and their writing competencies increased.

Argument-Driven Inquiry (ADI). Argument-driven inquiry is an instructional approach to laboratory teaching that is both students centered and writing intensive. Samspson et al. (2013) state that this approach offers students the knowledge to learn how to write in science since it requires them to perform serious writing practices while inquiring about scientific information and complete a realistic writing assignment. The study focused on the progress in students' writing skills, specifically the science-specific argumentative ones, and their understanding of the content throughout the year while participating in several science laboratory sessions utilizing the ADI instructional approach. In the study, the ADI instructional model is divided into 8 stages which are: "identification of the task and the research question, collect and analyze data, develop a tentative argument, argumentation session, write an investigation report, double blind group peer review, revise and submit the report, and explicit and reflective discussion" (Sampson et al. 2013, p.651). Students were required to recognize and combine the structural fundamentals (claims, counterclaims, supporting evidence, etc) in order to understand how to craft the argument prior to employing the integration of knowledge of science content into those argument structures. The results of this study showed that students who were conducting science lab activities using the ADI model enhanced their understanding of scientific content, their capability of writing in a scientific style, and their scientific-argumentative writing skills.

Genre-based approach. In recent years, more attention has been given to the notion and application of genre in teaching and learning language (Hyland, 2007). In fact, Hyland (2007) stated that the genre-based pedagogy is the result of the increased focus on "planning, writing, and reviewing framework" which encourages students to focus more on the strategies they have to use while writing rather than on expressing themselves effectively (p. 150). Reppen (1994) mentioned in her research that most writing research show that it is important for students to be exposed to (and practice) different genres and not just be exposed to narrative writing. According to Gebhard and Harman (2011), genre is one of the most important and influential concepts in language education. Halliday and Martin (2003) stated that scientific knowledge can be communicated in different ways, such as in diagrams and texts, which can appear in different genres. Moreover, it is considered important for students to learn reading and writing various genres in science in order to become more proficient in this content area. One of the reasons why the genre-based pedagogy is considered important is that it supports the academic writing skills of all ELLs (Oliveira & Lan, 2014). The findings of Oliveira and Lan's study showed that when students are familiar with school science genres, they produce better and more effective written science texts. In addition, upper elementary school students, and specifically ELLs, benefit from inquiry-based science integrated with explicit writing instructions that include classroom talk to write. They mentioned that students were able to record events more precisely and with a detailed chronological order using lexical and grammatical resources such as temporal connectors and field-specific vocabulary.

A theoretical framework that justifies the increased interest among science education researchers in using the genre-based approach is Systemic Functional Linguistics (SFL) (Martin & Rose, 2008). SFL is a view of language that focuses on its function and the various features of language that are used to perform certain tasks. This view of language has been applied to the language of science specifically, and has described the specialized characteristics of the language of science (Halliday & Martin, 2003; Coffin, 2001). Eggins (2004) describes SFL as being "a very useful descriptive and interpretive framework for viewing language as a strategic, meaning-making resource" (p.2). In addition, according to Brisk (2014), SFL's essential principle is that language should not be considered as isolated words or sentences, rather it should be perceived as a whole text. In fact, every writing practice is characterized by its genre, which is the recurrent form of texts that are used for specific purposes with their appropriate language features and discourse organization (Martin & Rose, 2008). The most identifiable writing genres in elementary school include procedures, reports, explanations, recounts, and expositions. These writing genres can be used in different contexts and for different purposes. Therefore, SFL is an appropriate framework for understanding the use of genre writing for an academic context such as science as it supports science writing instruction in typical elementary classes, and considered as an effective approach that enables researchers to identify the changes that students perform in their writing (Gebhard et al., 2010; Schleppegrell, 2010).

The most recognizable school types of genres in science are reports, explanations, experimental reports (procedural and recounts), and exposition (Brisk, 2014; Halliday & Martin, 2003; Oliveira & Lan, 2014). To begin with, a report's main function is to organize information by stating properties, decomposing, categorizing, and describing functions (Halliday & Martin, 2003). Explanation is another genre where subjects are required to explain specific phenomenon using action verbs and organizing the actions in a logical sequence. As for the experimental reports, they are of two types: procedural and recounts. The first one is known for its use of imperative sentences/phrases that aim to direct the activity of the students whereas the second utilizes past tense verbs to recount what happened in order to retell or show how a scientific experiment or process was done (Halliday & Martin, 2003). Both have a clear structure that is defined by the aim, method, result, and the conclusion.

The last genre is exposition (argument), which is used to provide arguments in order to defend the position that is being investigated. Expositions show only one side of the argument (Brisk, 2014). It is valued as a vital element in young people's education, specifically being an important and constitutive element in science itself as it can help make scientific reasoning and thinking visible (Duschl & Osborne, 2002; Zembal, 2009). This genre is the most beneficial and significant for students' academic success and the more challenging one as well (Beck et al., 2013). Erduran and Aleixandre (2008) stated that argumentation in science classrooms supports the achievement of scientific literacy and empowers students to talk and write the language of science. Zembal (2009) mentioned in his literature review that the National Science Education Standards (NRC 1996) highlighted the significance of inquiry in science learning as it emphasizes that students should develop their science understanding actively by combining their thinking and reasoning skills with their scientific knowledge. More recently, the Next Generation Science Standards (2013) emphasize the importance of scientific practices, which include argumentation. Accordingly, science education has undergone a major shift from being an exploratory and experimental subject towards scientific inquiry relying on argumentative methods (Duschl & Osborne, 2002; Zembal, 2009). Hence, it has become more important science education to put more attention on the method to coordinate data to claims via an argument. Moreover, the utilization of interpretation enhances the top-level cognitive skills of reasoning and analysis rather than those of memory and comprehension. Coming up with an explanation for a certain phenomenon requires the students to think and come up with appropriate evidence that supports their claim and use the theories and concepts they learned to connect the data they found to the claim (Duschl & Osborne, 2002). Finally, Jammoul (2016) investigated the impact of English proficiency and argumentation on Lebanese students' argumentation skills and conceptual understanding of genetics. The findings of this study indicated that explicit argumentation instruction improved high school students' argumentation skills and conceptual understanding of the science unit being taught. Thus, this highlights the positive impact of such a genre on English Language Learners' writing and conceptual knowledge as well.

The stages of an exposition are the following: it includes a thesis statement, preview of the evidence, reasons that the evidence supports the claim, and a reinforcement of the position (or conclusion). The thesis statement or claim is a generalizable principle or conclusion where the person takes a specific position regarding a certain case. The claim should be supported by evidence, data collected from observations and experiments. The reasons usually explain and justify why the evidence supports the claim. Finally, in the conclusion the writer should rewrite the claim and position to reinforce it.

Factors that Influence Writing to Learn

The students' writing to learn process can be affected either positively or negatively by several factors related to personal, social, and cultural conditions. Jani and Mellinger (2015) conducted a study in which they investigated the factors that affect a group of social work undergraduates' writing to learn skills. From the data collected, they were able to identify several factors that influence students' writing skills, some of which are effort, support (such as feedback and direction), and students' perceived self-efficacy. In addition to the above, other factors identified in the literature include metacognition and sociocultural aspects.

Metacognition. According to Fry and Villagoez (2012), when students were explicitly introduced to certain cognitive and metacognitive strategies related to self-regulated learning, WTL had a positive effect on the learning process as a whole. Sampson et al., (2013) encouraged some students to be metacognitive as they write to learn over several iterations, which resulted in having them produce better written text.

Students' perceived self-efficacy. The students' belief in their ability to accomplish a task, i.e. students' self-efficacy, was found to impact their performance in writing to learn tasks (Jani & Mellinger, 2015). The authors found that the comments of students reflected their low self-efficacy regarding their understanding of the mechanics of writing and the content they were learning. Hence, the students should have a better level of confidence regarding writing and content knowledge, or any other aspects related to their education such as time management or the application of critical thinking, as this could improve their writing outcomes.

Effort. Jani and Mellinger (2015) showed that students were not applying their effort on the appropriate aspect of the task, which resulted in poor written texts. They explained this finding by stating that students were putting more effort on the presentation of ideas rather than on the content itself. Students reported that they had to put more focus on meeting the expected and required format and style rather than focusing on understanding, integrating, and analyzing the content subject due to the limited time they had to complete their assignments.

Support, feedback, and direction. Jani and Mellinger (2015) also point out that students requested clear direction and clear expectations on writing assignments from their professors. The teachers may use different educational tools such as well conceived rubrics or checklists aiming to achieve writing goals and a good final product. These tools guide students' writing as they self-monitor and assess their product while being immersed in the writing to learn process (Knipper & Duggan, 2006). Moreover, they need to be given the opportunity to write argumentative texts to learn more about them as well as to develop a perception of guidelines used to evaluate how good the argumentative writings are in relation to science (Sampson et al., 2013). Instructors should guide their students by providing them with the standards of a good piece of science writing (known as modeling), showing them the norms of judgment of the quality of science through reminders (scaffolding), and giving them feedback about their performance (coaching).

Sociocultural factors. A variety of factors influence students' relationship with the learning process and their engagement with learning specific genres of science (Gunel et al., 2007). Among these factors are the social and group affiliations embedded in the learners' self- identity and their representational and perceptual resources. Gunel et al., (2007) focused on broad sociocultural aspects as being a factor which makes a writing task meaningful and important for writers and consequently serve the learning outcome. Hence, the presence of social, cultural, and representational resources can affect the achievement of a learner when learning to write in science.

Language of instruction. Native English learners are students whose English is their native language. English Language Learners (ELLs) are classified as students whose native language is other than English; students are using English as a foreign language of instruction. Students worldwide are being taught various subjects in an international language such as French or English, which is different from their native language. The delay in the development of cognitive academic language proficiency (CALP) is the reason behind the lag of achievement of non-native speakers when compared to native speakers (Cummins, 2000). According to Richards and Renandya (2002), usually writers whose English is their second language face more difficulties as they might have problems not only in generating and organizing ideas, but also in translating these ideas into comprehensible text as they will have to focus on spelling, word choice, and punctuation in addition to the skills mentioned previously. Upper elementary school students, and specifically ELLs, benefit from inquiry-based science integrated with explicit writing instructions that include classroom talks and commands to write (Oliveira & Lan, 2014). Teachers who use writing to learn strategies as part of their pedagogy are anticipating that writing promotes students' learning. To promote ELLs' academic achievement, teachers must prepare the type of instruction that facilitates the integration of language and content. The content area, such as science, is considered a significant context for ELLs to develop English proficiency, in addition to improving English skills that are needed for learning academic content and processes (Lee & Buxton, 2013).

Additionally, the task of learning science is similar to learning a new language; this can impose problems on both native and non-native speakers of English. Therefore, identifying the specific challenges that students may face when writing to learn is essential to their development and learning.

Challenges that Affect Students' Writing to Learn

The focus has increased on disciplinary-based written tasks and genres which are characterized by being linguistically complex and cognitively demanding beyond students' familiar text types (stories or personal narratives) (Oliveira & Lan, 2014; Schlepegrell, 2004). Fang (2005) discusses the challenges that some key linguistic features of scientific writing present to the composition of science texts in schools. Students have to be familiarized with specialized grammar that helps them develop and present science information, since everyday language is not sufficient. Accordingly, the challenge emerges when students have to code-switch from everyday spoken language to that of science (Lee, et al., 2012). One of the challenges mentioned by Fang (2005) is the high density of information that scientific writing has (a linguistic feature of scientific writing). Thus, students may be challenged by the large amount of content words that are grouped into scientific written clauses in contrary to the daily spontaneous writing language. This was also mentioned by Seah, Clarke, and Hart (2014) who stated that high lexical density that science language possesses can pose difficulties on students compared to the everyday English. Other linguistic features of scientific writing are technicality and authoritativeness which are essential to comprehend science's specialized content. The first feature includes the utilization of technical vocabulary and verbs, whereas the second involves the use of passive voice and declarative sentences. Not being familiar with these linguistic resources may impose difficulties on students who are trying to comprehend scientific knowledge and writing scientific information properly. Moreover, the process of learning science genres is a challenge for both fluent English speakers and second language writers, even though it is a bigger challenge for the latter since it requires them not only to develop the content knowledge through language but also to improve the language itself.

Beck et al., (2013) conducted a comparative study in which they examined the challenges that both secondary ELL and native English learners face when performing the exposition type of writing. In order for the authors to identify the challenges that students face when writing expository text, a primary set of codes was developed which drew on previous studies of the writing process. These codes included challenges with “generating, structuring, evaluating, revising, and translating” (Beck et al., 2013, p.364). The authors then were able to identify 22 challenges: “analyzing/interpreting/synthesizing, audience needs, cohesion, evaluating, fulfilling task demands, generating, goal setting, graphomotor abilities, internal focus, interpreting task demands, introduction/conclusion, length, managing writing process, memory, revising, structuring, topic choice, topic engagement, translating, writing environment, writing off topic” (Beck et al., 2013, p.366) and found that there were similarities and differences between the challenges that ELL and native English learners face when writing in the genre of exposition. For example, generating, which was one of the challenges that the authors identified is a frequent and common challenge that is articulated by both ELLs and native English learners. However, translating, which is another challenge that is articulated by both ELLs and native English learners, is experienced differently by both groups. The ELLs were having a problem in finding the words as their vocabulary usually lags behind that of their native speaking colleagues, whereas the native English learners were struggling in selecting from several alternative wordings. Finally, the findings of the study showed that the majority of ELLs faced more challenges than native English learners in relation to genre knowledge which was not only limited to exposition in composing the genre, but also included acknowledging the genre which the writing prompt was asking for in the first place.

Seah (2016) conducted a study to examine grade four students' use of linguistic resources to understand their conceptual and language challenges when constructing scientific explanations. The research analyzed students' written explanations on a content and linguistic level; the results showed that students found difficulty in understanding the task requirement and in communicating their information through writing. Sampson, Enderle, and Grooms (2013) stated that students usually face challenges when they are asked to write an 'evidence-based argument in science'. As explained earlier, expository text is a writing genre where students should present a point of view and support it with evidence and reasons (Schlepegrell, 2004). Sampson et al., (2013) mentioned that the biggest challenge for students when writing a scientific argumentation is justifying their evidence. Most students are not capable of translating their thoughts explicitly to others or fail to back up their analysis by appropriately discussing the theory, concept or law behind it. Consequently, students end up justifying their evidence by only interpreting them or simply announcing that their evidence verifies their claim.

Methods Used in Identifying Writing Challenges.

In order to identify writing challenges, researchers have used several methods such as collecting learners' written texts and think aloud protocols.

Most studies that aim at identifying students' writing challenges collected their written texts for analysis (Beck et al., 2013; Sampson et al., 2013; Seah, 2016). For example, Sampson et al. (2013) provided the students with a science-specific argumentative writing assessment in which they had to refute a specific scientists' claim (provided by the researchers) using gathered information and data and then support their counterclaim with evidence and rationale. Students' written texts were then collected and analyzed using a base rubric. Seah's study (2016) aimed at identifying the difficulties that students face while composing scientific explanations in order to design the proper intervention. In Beck et al.'s (2013) study, students had to compose an expository written text to respond to a prompt. The researchers collected these written texts and analyzed them by using an initial set of codes and then supplemented them with additional codes that emerged from the texts. Analyzing written texts allows researchers to identify challenges that learners faced when writing an expository text.

Thinking aloud requires students to verbalize their thoughts immediately while they are performing a cognitive task (Ericsson & Simon, 1993), thus revealing what they are thinking without justifying or analyzing. According to Ericsson and Simon (1993), most students at school have to explain to their fellow friends their solutions of problems aloud. Hence, the ideal scenario for gathering information about student's data processing is by asking them to "think aloud" while achieving a task. Accordingly, participants will be expressing their thoughts verbally as they are perceived. They stated that when students think aloud while performing a task, their cognitive processes, speed of performance, and methods they use do not differ compared to when completing the task silently. This was also mentioned by Beck et al. (2013) who utilized this method in their study. Students were asked to think aloud as they wrote an expository writing text responding to a prompt. Their verbal reports were recorded and transcribed for analysis. Donker and Markopoulos (2002) conducted a comparative assessment involving 45 children aged between 8 and 14 to test the usability of three testing methods. These three methods are interview, questionnaire, and concurrent think-aloud. It aims to identify what the children perceive as problems when completing a semi-educational game about biological facts. The researchers asked several questions and used the three methods to obtain their data. The effectiveness of the three methods was measured by counting the number of problems the children had mentioned.

Talking more leads to reporting more; the children who used the think aloud protocol in their study uncovered and reported significantly more problems than the other children who used the questionnaires and interviews. It was found that the best way to identify the challenges that children face is for them to report their problems as they encounter them. This was also emphasized by Bowles (2010) who stated that participants reporting their thoughts directly during a task will not risk memory decay and will have a complete and accurate statement unlike those who have to report their thoughts a while after carrying out their task. Thus, the current study will utilize both written text and think aloud methods as tools to identify students' challenges when writing an expository text in science.

According to Amin (2009), there is little research addressing the language challenges and language of instruction in science education in the Arab region. More research should be done to identify the challenges that ELLs face when writing different types of texts, especially in the Lebanese context where there is a dearth of studies that address this issue. Identifying these challenges will help teachers and curriculum developers to prepare lessons that suit the needs of their students and ensure a better learning outcome in science and language.

CHAPTER III

METHODOLOGY

The purpose of conducting this research study was to investigate the challenges that Lebanese elementary students, who are non-native speakers of English, articulate when writing to learn science. Moreover, this study examined whether the genre-based approach improves the quality of students' expository writing and their conceptual knowledge. Thus, the following questions were addressed:

1. Does a genre-based pedagogy approach improve the quality of grade four Lebanese English Language Learners' expository writing?
2. Does a genre-based pedagogy approach improve grade four Lebanese English Language Learners' conceptual knowledge?
3. What challenges do Lebanese English Language Learners articulate when completing a time-compressed writing task intended to elicit exposition?

Research Design

In this study, fourth grade students covered the unit "Energy" of the Lebanese Science Curriculum using American books (Fusion). The researcher was limited to a specific selection of science units planned for this grade level following the science curriculum. However, the unit "Energy" was the most relevant among these units as it allows students to take positions and support their claim with theories and evidence. This unit also includes several experiments that suited the purpose of this study. While this is not the general case, many schools use books other than those proposed by the Lebanese Education Ministry and Higher Education, especially at the elementary level. Students were introduced to genre-based writing using a genre-based pedagogical approach, which consists of a teaching-learning cycle composed of three phases: deconstruction, joint construction, and independent construction (described in more detail below). This study adopted a quasi-experimental design with two groups (experimental and control) to test the effectiveness of the genre-based approach on improving students' conceptual knowledge and their expository writing. In order to identify the effect of the genre-based pedagogy on students' conceptual knowledge, students in both groups completed a pre-test that assessed their knowledge about the unit that was covered and then at the end of the intervention the same test was done to compare their improvements. The tests were created according to the school standards and its questions include and require different levels of thinking (See Appendix I). To evaluate whether the genre-based pedagogy approach improves the quality of fourth grade Lebanese English Language Learners' expository writing skills, students were provided with a writing prompt to which they responded before the intervention begins. These responses were considered as pre-test. Students' expository texts before (pre-test) and after the intervention (independent construction) were analyzed using a quantitative approach. In addition, students were asked to use a think aloud procedure to articulate the challenges they face when completing their expository texts. This aspect of the study utilized a qualitative research design in order to gain in-depth understanding of the challenges that the Lebanese elementary students face when writing expository text.

Participants

Sample. The sample of students for this study was selected from a private elementary school in Beirut that offers two programs: The Lebanese and American curriculum. In this study, we focused on fourth grade students. The reason behind choosing this grade is that students are expected at this age level to apply reading and writing skills that they have learned in earlier years (learning to read and write) to apprehend academic subjects, including content area writing (writing and reading to learn) (Oliveira & Lan, 2014). During the upper elementary grades (grade 4 or 5, ages 9-11), the content areas become more specialized. The focus increasingly shifts towards written texts using genres which are more cognitively demanding and linguistically complex beyond the students' recognizable text types such as personal narratives or stories. As discussed in the literature review, these genres can be more challenging for ELLs, especially when science is the content area, as they will have to exert further linguistic and cognitive efforts (Oliveira & Lan, 2014).

Sampling Procedure. This study followed a non-random sampling method that relies on selecting fourth grade students to be part of the researchers' investigation. Students were divided into two classrooms, one of which was considered an experimental group and the other a control group. These students were considered as "convenience sample" as the researcher had access to this school and these two intact classes. The researcher planned the intervention on the students who were part of the experimental group in order to identify the difference and the effect on the genre-based approach on their writing.

Procedure

The intervention was approximately four weeks, where instruction took place during four periods per week (See Table 1). The researcher trained the teacher before implementing this model. The researcher explained the genre-based pedagogy approach and the teaching learning cycle with its three phases, the roles of the teacher, and the role of the students, in addition to describing the materials and the way they should be used.

Table 1

Overview of the Procedure

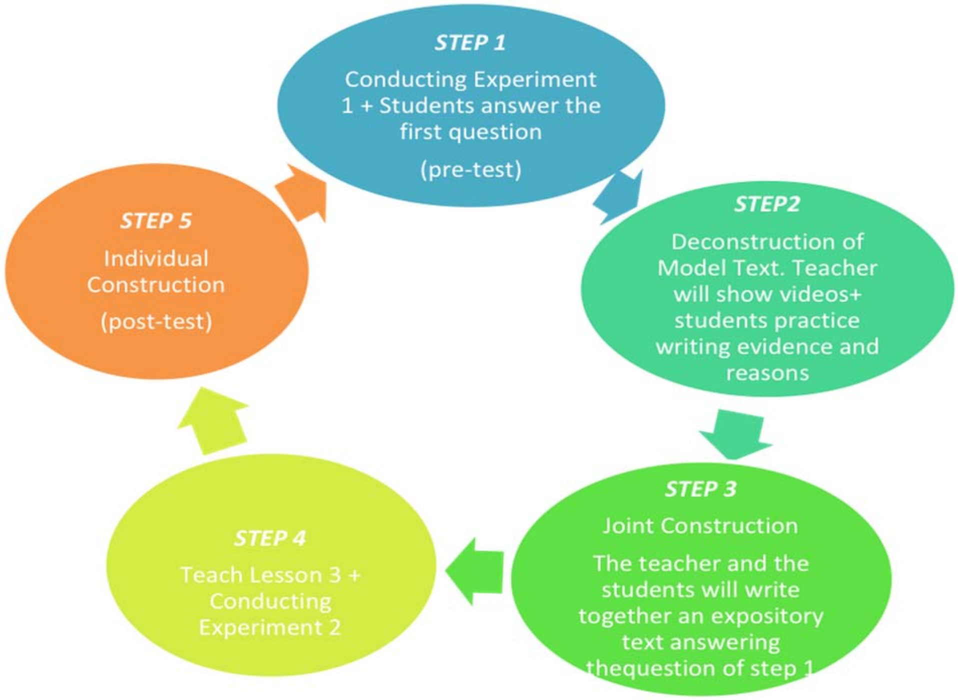
Periods	Experimental Group	Control Group
1	Unit 9: Conceptual Knowledge Pre-test (See Appendix I)	Unit 9: Conceptual Knowledge Pre-test (see Appendix I)
2-5	Teaching lesson 1: What Are Some Forms of Energy?	Teaching lesson 1: What Are Some Forms of Energy?
6	Lesson 2: Where Does Energy Come From? Conduct an experiment (see Appendix II)	Lesson 2: Where Does Energy Come From? Conduct an experiment (see Appendix II)
7	Demonstration of Thinking aloud for students	Demonstration of Thinking aloud for students
8	Pre-Test	Pre-Test

9	Deconstruction: the teacher will provide the students with model text, teach the language features of the genre, and watch a video about argumentation.	Students elaborate more on what they have learned previously by watching a video and completing an online activity that enables them to identify and differentiate between kinetic and potential energy.
10	Joint Construction: The teacher and the students will write together an expository text (answering the same prompt asked in the pre-test)	Students will complete an activity on Brainpop to identify and differentiate between kinetic and potential energy. Then, students will watch a video about the different forms of energy and complete a worksheet adapted from their Science Fusion textbook.
11-13	Teaching lesson 3: What is Heat?	Teaching lesson 3 What is Heat?
14	Lesson 4: How is Heat Produced? Conduct an experiment (Appendix V)	Lesson 4: How is Heat Produced? Conduct an experiment (Appendix V)
15	Independent construction (considered as a post-test) (Appendix VIII)	Post-test (Appendix VIII)
16	Unit 9: Conceptual Knowledge Post-test	Unit 9: Conceptual Knowledge Post-test

Before starting the intervention, students in both groups completed a 50 minutes' test that covers the whole unit (pre-test) (see Appendix I). The test was created by the science teacher according to the school standards and curriculum and modified by the researcher. At the end of the intervention, the teacher repeated the same test in order to compare the improvements of the students in both groups (post-test). The results of the control group were compared to those in the experimental group in order to identify the effect of the genre-based pedagogy on students' conceptual knowledge. When the study ended, students in the control group were instructed using the genre-based approach as the study outcome was positive, as expected, so that all students benefit. After that, all students had their regular graded test which was not included in the study. Then, the teacher implemented the genre-based pedagogy using the teaching-learning cycle which included three phases: deconstruction, joint construction, and independent construction (Brisk, 2014; Oliveira & Lan, 2014). The three phases were integrated in the intervention following the five steps illustrated in Figure 1.

Figure 1

Teaching-Learning Cycle



During these periods the teacher addressed the question "What are Some Forms of Energy?" which is the first lesson of the unit. Students in both groups learned about the different uses and sources of energy, described the uses of chemical and mechanical energy and how chemical energy can be transformed to other forms of energy, and finally to differentiate between potential and kinetic energy. Students in both groups followed the regular grading system that the school adopts which is the following: the first quiz was completed before the intervention begins, so the intervention did not influence students' grades. After lesson 1 was completed students had a quiz assigned by the school for their report cards. After that, the teacher and the students conducted an experiment where they exerted different intensity of compression on the springs and answered the following question: "Will a more compressed spring rise higher than a less compressed one?" The experiment took one period to be completed. The students were able to identify that a more compressed spring would rise higher than a less compressed one because the fully compressed spring stores more potential energy, which in turn produces more kinetic energy when the spring is released (see Appendix II). After this experiment, students in both groups were asked the following prompt: “Would an arrow travel a longer distance if the bow is fully or partially stretched? Support your answer.” Students responded to this prompt and their responses served as a pre-test to evaluate the quality of their expository writing before the cycle starts. Moreover, three randomly chosen students from each group, having given permission to be audio-taped, were asked to use a think aloud procedure to articulate the challenges they face when completing their expository texts during their pre-test. The think aloud procedure had low risk in that students were alone with the researcher and not overheard by members of the staff or other students. Each student was thinking aloud during one 50 minute class period in a private meeting room in the school. Students were informed about the purpose of the think aloud and were reminded that both their identity and answers remained confidential and that they could withdraw from the study at any time.

Next, during the deconstruction phase, only students who were in the experimental groups were introduced explicitly to features of the genre that is in focus (the genre of exposition in our case) for one period. The teacher set guidelines for their learners to deconstruct model texts by discussing several aspects related to the text structures, their purpose, and the genre-based language features (Appendix III). Then, the teacher explained the components of an expository text (claim, evidence, and reason) using a Power Point presentation, before showing the students a video about the subject (see Appendix IV). Afterwards, students received a small prompt: “Are skew dice fair?” and they were provided with two types of dice (skew and fair) for data collection. Then, they were required to reflect, through reasoning, their scientific knowledge precisely to connect the evidence to the claim with the appropriate scientific theory or rule with the guidance of the teacher (see Appendix IV Lesson Plan Period 9: Deconstruction Phase)

In the second phase, joint construction, both students and teacher shared the responsibility of writing (with the focus always being on the expository genre) along one period. Both students and the teacher wrote an expository text to answer the same first prompt that the students were given and had to answer as a pre-test: “Would an arrow travel a longer distance if the bow is fully or partially stretched? Support your answer.” The teacher wrote the expository text on the board and the students had to interact together to identify the claim, evidence, and reason to support their answers (See Appendix IV: Lesson Plan Period 10: Experimental Group). The students began to apply linguistic features of the selected genre which they are learning (see Appendix III). They were introduced afterwards to the rubric (Appendix V) to be able to see what should be included in their expository writing text.

Throughout the previous two periods, the teacher and the students in the control group worked together to elaborate more on what they have learned previously (see the lesson plans for periods 9 and 10 in Appendix VI). During the first period (period 9), students watched an interesting video that helped them differentiate between potential and kinetic energy. It provided them with some real life examples of how energy can shift from potential to kinetic. Then, students completed a short online quiz in which they were required to apply what they have learned. Afterwards, the teacher divided the students into pairs and came up with another example of how potential energy can shift into kinetic energy and presented it to their classmates. Each pair was given the freedom to choose who they want to present their example, and agree on how to do it. In the following period (period 10), students were grouped as pairs to complete an activity on Brainpop to check if they can identify and differentiate between both types of energy. Finally, they watched a video about the different forms of energy and completed a worksheet adapted from their Science Fusion textbook.

After that, both groups were taught a new lesson for a duration of three periods “What is Heat?” During these three periods, the students learned to define temperature and heat, describe three ways to transfer heat, and identify sources of heat. Then, the teacher and the students conducted a new experiment in one period testing how heat is produced (see Appendix VII).

Finally, in the final phase of the activity, the students in the experimental group got ready to write their own texts in the selected genre by working independently. That is the reason why this phase is referred to as “independent construction”. Accordingly, the teachers provided minimal support, guidance and scaffolding, while the students decided independently on how to write their texts for the specific genre. The students were asked to answer the following: “Walid’s mom was baking a cake. Walid was playing and made a spiral using a sheet of paper. He held the spiral next to the oven. Would the oven cause the paper spiral to turn? Support your answer. Both groups of students answered the same prompt and their answers and texts would be considered as a post-test. These tests were analyzed and compared to the pre-test first within the same group and then within both groups in order to check whether the genre-based approach had any positive effects on students’ expository writings.

Instruments

There are two parts for this study. The first part aimed to test the effect of the genre-based approach on students’ expository texts by using the paper and pencil measures with open-ended prompt as a data collection tool. Moreover, students in both groups completed a test before and after the intervention in order to identify the effect of the genre-based approach on students’ conceptual knowledge. The researcher attended the class noting down observations to document the implementation of the intended approach. The second part of the study aimed at producing a thick and in-depth description of the challenges that the participants articulate when writing an expository text. The researcher utilized a think-aloud protocol to identify students' challenges.

Expository Writing Task (Individual Construction). The students were provided with the following questions prompting them to write an expository text both at the beginning (step one in the cycle: pre-test) and at the end (step five in the cycle: post-test) (Appendix VIII). The first prompt was "Would an arrow travel a longer distance if the bow is fully or partially stretched? Support your answer." The second prompt was "Walid's mom was baking a cake. Walid was playing and made a spiral using a sheet of paper. He held the spiral next to the oven. Would the oven cause the paper spiral to turn? Support your answer." All students in both groups were given the same open-ended prompts. The prompts were similar to what they have tested during the experiments in the previous sessions (see Appendix II and G experiments 1 and 2). The students were given a session (approximately 50 minutes) to answer each prompt.

Conceptual Knowledge Assessment. Before and after the intervention, students in both groups completed a test for 50 minutes each. The same test was given to both control and experimental groups. The test was adopted from the science fusion assessment sheets and modified by the teacher (see Appendix I). The test consisted of 15 closed ended multiple choice questions for which each item is over two points (overall 30 points). There are also four short answer questions; two open ended ("Identify a heat source in your home. Then give an example of how this heat source transfers heat energy" and "Describe an example of an object where its potential energy changes to kinetic energy")and two closed ended (Identify which object has more potential energy. Explain why." and "Write the kind of heat transfer that takes place in the following situations: warm wind reaching the city, tanning under sunlight, adding hot water to cold water in glass.") Both the open and closed ended question were scored over 5 points each. Students' tests were corrected following the answer key created by the researcher (Appendix IX). In accordance to Blooms Taxonomy, the test covered the following levels of thinking: comprehension, knowledge, application, and synthesis. The teacher read the questions to students without helping them any further. The researcher observed the students when completing the test and then they were collected and corrected by the teacher.

Think-Aloud Protocol. The researcher used the think aloud protocol as another tool for data collection. In this study, the researcher chose randomly three participants from each group, having given permission to be audio-taped, to think aloud while writing the expository text. Thinking aloud requires students to verbalize their thoughts immediately while they are performing a cognitive task (Eriscson & Simon, 1981), thus revealing what they think without justifying or analyzing. According to Donker and Markopoulos (2002) the best way for children to report their problems is to articulate them as they are encountered. Hence, the purpose of incorporating the think aloud was to provide students with the opportunity to share their challenges. The think aloud procedure has low risk in that students will be alone with the researcher and not overheard by members of the staff or other students. Therefore, in this study, the teacher demonstrated first how to think-aloud while writing for the students in both groups. Then, each of the six chosen students was taken out of the class individually to let them think aloud while writing their pre-test during one 50 minute class period in a private meeting room in the school. The researcher sat next to the participants. Charters (2003) mentioned that the researcher is advised to sit beside the participants not across from them to minimize intimidation (Nunan, 1992). Their thinking-aloud was tape recorded and the researcher remained silent, nodding from time to time in response to students' questions and comments. When the participants forgot to verbalize their thoughts (after 15 sec to 1 minute), the researcher reminded them occasionally to verbalize or asked them questions such as "what are you thinking now?" and "keep talking" to keep them on track (Ericsson & Simon,

1993) Students were informed about the purpose of the think aloud and were reminded that both their identity and answers remained confidential and that they could withdraw from the study at any time.

Data Collection Procedure

The researcher first acquired the Institutional Review Board (IRB) approval. Then, a permission from the school principal to approach students was obtained. Upon obtaining the approval of the principal, the researcher proceeded by informing the teacher responsible for the students. The teacher was given a consent form to consider signing, which informed her about the study. The teacher's participation was completely voluntary. A parental and child consent forms were also sent before introducing them to the project. Students' consent forms were shared with their parents or legal guardian. Students were then introduced to the purpose of the study and general information regarding their rights and expectations during data collection. They were assured that their answers are confidential and will not be part of their school assessment. They were also informed that they can stop and withdraw at any time. There were 2 parents that refused their children participate in the investigation, these students were placed in the control group, as this group followed the regular science scope and sequence adopted in the school.

In this study, thirty-seven students consented to participate. To answer the research questions, students whose parents/guardians gave consent about their participation were part of the study. Students were divided into two classrooms, one of which were considered randomly an experimental group and the other a control group. Only their regular science teacher and the researcher were approaching the students' participants. Their individual privacy was protected as the recordings were accessed only by the researcher and the principal investigator of the study. A list was prepared with all participant names and a number code associated with each name. Only the code was used to identify the assessments and transcripts.

Moreover, three students from each group were randomly selected to think aloud separately during one 50-minute class period. These interviews took place in a private room in the school and were compensated for the missed class hour the following day during an allocated free period or during the physical education period. Their thinking aloud was audio taped. The audio recording of the think aloud was transcribed for later analysis. The transcript was labeled using the student code; the student's name did not appear on the transcript.

Data Analysis

In this study, the researcher conducted a quantitative and qualitative analysis.

Quantitative Analysis. The researcher collected the writing samples of the participants in both groups before and after the teaching and learning cycle to identify the impact of the genre-based instruction on their expository writing. The researcher first compared the results of the pre-test of students in both groups and did the same for their post-test. A scoring rubric has been created for the purpose of this study (adapted from Figure 4 in Cope, B., Kalantzis, M., Abd-El-Khalick, F., & Bagley, E. (2013). Students' expository writings were evaluated according to the presence of the following criteria: claims, support, reason /justifications, conventions/ organization, linguistic features, academic vocabulary, and concluding statement. Students' scores followed a scale between 0 and 3, 3 being the best score. For example, regarding students writing of a "claim", it was coded at four levels: level 0 "no claims are included", level 1 "a claim is included but it is not relevant to the topic" level 2 "a general claim is present", and level 3 "a precise developed claim is present". Students' writing of "support" was coded at four levels as well: level 0 "provides no support to the claim", level 1 "support is wrong, repetitive, or irrelevant", level 2 "provides one support to the claim (either evidence or principle)", and level 3 "the support is relevant, accurate, and thoroughly explained; provides both evidence and the principle as support to the claim." Regarding "reason/ justification," this aspect of the students' writing was coded at four levels: level 0 "provides no reasoning or justification at all", level 1 "specific reasoning for the claim is not stated. It refers to the support without explaining it", level 2 "explain why the support was included or how it supports the explanation but not both", and level 3 "explains why the support was included and how it supports the explanation" Students' use of "academic vocabulary" was coded at four levels: level 0 "science vocabulary not used", level 1 "science vocabulary not used correctly" level 2 "one to two science vocabulary used", and level 3 "uses a variety of science vocabulary words correctly (three or more)" (see Appendix V for more detailed description of the rubric for writing a scientific expository paragraph). Using SPSS while applying an ANCOVA, the researcher analyzed the difference between the pre-test and post-test of both control and experimental groups to identify the effect of the genre-based approach on each aspect of the expository writing and their overall writing. To make sure that the coding was reliable, the researcher assessed the interrater agreement on a sample of the written texts (20%). A grade five science teacher in the school, with a BA in Elementary Math and Science, was given the written texts of 16 students from both groups (eight students from control group and eight students from the experimental group) to check the interrater agreement. First, both the researcher and the other rater met to discuss the coding and they coded a number of participants together. Afterwards, 20% of the written samples were coded independently by the science teacher (the other rater) and the researcher. There was 100% agreement in coding the "claim" and "reason", 93.75% agreement in coding "support", "conventions/ organization", "linguistic features", and "concluding statement", and finally, 81.25% agreement in coding the "academic vocabulary". A meeting was then held between the researcher and the other rater and discussed the discrepancies in order to reach total agreement. The researcher then analyzed the rest of the data by herself.

The researcher collected the unit tests of the participants in both groups before and after the intervention in order to compare their improvements. The researcher used SPSS while applying an ANCOVA to analyze whether students in the experimental group scored higher than the students in the control group taking into consideration their scores in the pre-test. Students' pre-tests were treated as a covariate while the post-tests were the dependent variable.

Qualitative Analysis. Corbin and Strauss (2008) stated that "qualitative research allows researchers to get at the inner experience of participants, to determine how meanings are formed through and in culture, and to discover rather than test variables" (p.12). During students' thinking aloud, the researcher recorded in order to identify the challenges by comparing them to a primary set of codes that were developed from previous studies on writing processes (Beck et al., 2013; Flower & Hayes, 1981) (See Appendix X). These primary tentative codes include challenges with "generating, structuring, evaluating, revising and translating" (Beck et al., 2013, p.364). Then, in order to identify all types of challenges that students articulate, the researcher supplemented the primary codes using inductive analysis. In this phase, two researchers coded the data and the challenges that they identified were conceptualized and retained as codes. The strategy of constant comparison (Strauss & Corbin, 1998) was used to ensure that the codes are distinct and not repetitive. The guidelines of constant comparison included a comparison of conceptually similar segments of data and grouping them together according to their similarities or differences. Finally, the grouped data was compared to an existing set of categories to see if it fits. When it didn't fit, new categories emerged.

CHAPTER IV

RESULTS

The purpose of conducting this research study was to examine whether the genre-based approach improved the quality of grade four students' expository writing and their conceptual knowledge. This study also investigated the challenges that Lebanese elementary students, who are non-native speakers of English, articulated when writing to learn science. The results in this chapter are divided into three parts in order to answer the following research questions addressed in this study:

1. Does a genre-based pedagogy approach improve the quality of grade four Lebanese English Language Learners' expository writing?
2. Does a genre-based pedagogy approach improve grade four Lebanese English Language Learners' conceptual knowledge?
3. What challenges do Lebanese English Language Learners articulate when completing a time-compressed writing task intended to elicit exposition?

Effect of Genre-Based Pedagogy on Expository Writing

In this study, participants were given two writing prompts before and after the intervention, respectively: "Would an arrow travel a longer distance if the bow is fully or partially stretched? Support your answer" and "Walid's mom was baking a cake. Walid was playing and made a spiral using a sheet of paper. He held the spiral next to the oven. Would the oven cause the paper spiral to turn? Support your answer. The researcher collected the writing samples of the participants in both experimental and control groups before and after the teaching and learning cycle to identify the impact of the genre-based instruction on expository writing. As shown in Table 2, the participants in the experimental group outperformed the participants in the control group in almost all the aspects of expository writing (claim, support, academic vocabulary, conventions/organization, linguistic features, and concluding statement) and the overall quality of their writing (the average score of all the aspects together) after the intervention at 0.05 alpha level.

Table 2

Expository writing of experimental and control groups before and after the intervention: Descriptive statistics

		Pre Intervention		Post Intervention		ANCOVA	
		Mean	Standard Error	Adjusted Means	Standard Error	F test	Sig.
Claims	Cont.	2.32	0.17	2.42	0.13	5.48	.026
	Exp.	2.38	0.20	2.87	0.14		
Support	Cont.	1.79	0.12	1.56	0.13	5.48	.026
	Exp.	1.31	0.24	2.02	0.14		
Reason/Justification	Cont.	0.79	0.18	1.18	0.22	3.39	.08
	Exp.	0.50	0.20	1.79	0.24		
Academic	Cont.	1.95	0.05	1.59	0.15	8.03	.008
Vocabulary	Exp.	1.63	0.22	2.24	0.17		
Organization/	Cont.	1.47	0.19	1.28	0.13	14.43	.001
Conventions	Exp.	1.31	0.25	2.04	0.15		
Linguistic Features	Cont.	0.21	0.96	0.11	0.22	23.38	<.001
	Exp.	0.31	0.18	1.68	0.24		
Concluding	Cont.	0.37	0.18	0.37	0.25	8.59	.006
Statements	Exp.	0.19	0.14	1.44	0.27		
Writing Overall	Cont.	8.89	0.58	8.38	0.80	24.08	<.001
	Exp.	7.63	1.01	14.23	0.87		

In order to answer the first research question, a series of ANCOVAs were run to determine whether the genre-based approach had an effect on students' expository writing, using pre-intervention scores as a covariate. First, participants' performance on different aspects of expository writing (claim, support, reason, academic vocabulary, conventions, and concluding statements) were analyzed and compared before and after the intervention. Then, a general comparison for both groups' overall writing was made by calculating the average score of all the aspects together.

Assumptions. For each aspect of the expository writing, an ANCOVA was run and the following assumptions were checked and were found to be met: there was a continuous dependent variable and covariate variable, the independent variable was categorical with two independent groups. Moreover, the assumption of normality of post-test was not met across the control and experimental groups as revealed by the Shapiro-Wilk test for all the aspects except for the "overall writing". In addition, the homogeneity of variance assumption was also not met for some of the aspects as indicated by the Levene's Test. However, since ANCOVA's are robust to violations of normality and homogeneity of variances, the analysis could be carried out. There were no outliers in the data, as no cases with standardized residuals greater than ±3 standard deviations were found. Furthermore, the independence of covariate and treatment effect assumption was met and the homogeneity of regression slopes assumption was also met for all the aspects except "Support"; F (1, 31) = 9.68, p = .004 (see Appendix XI for more detailed description of the assumptions checked).

Main Analysis. The first aspect of the expository text is the claim or thesis statement which is a generalizable principle where the person takes a specific position regarding a certain case. Students writing in the experimental and control group varied with respect to this aspect and an ANCOVA revealed that after adjustment for pre-intervention claim scores, there was a statistically significant difference in post-intervention scores between the two groups, $F(1, 32) = 5.48$, $p = .026$. By referring to the adjusted means, it is evident that the experimental group (M_{adj}= 2.87, SE= 0.14) performed significantly better than the control group (M_{adj}= 2.42, *SE*= 0.13), indicating that the intervention was successful in improving the experimental group students' writing of claims. This aspect of the students' writing was coded at four levels: level 0 "no claims are included", level 1 "a claim is included but it is not relevant to the topic" level 2 "a general claim is present", and level 3 "a precise developed claim is present". In fact, 50% of students in the experimental group were categorized as level 3 "a precise developed claim is present" in their pre-test while 43.75% were categorized as level 2 "a general claim is present" (for example, simply saying "yes" or "fully" in response to the question in the prompt. However, after the intervention, now only 12.5% of the students wrote "a general claim is present" whereas the percentage of students who used "a precise developed claim is present" in their post-test increased to 87.5%. For example, after the intervention some students wrote "The oven would cause the paper spiral to turn", "The oven will cause the spiral to move", and "The spiral would spin if it is placed on top of the oven". In the control group, on the other hand, before the intervention, 50% of the students wrote "a general claim is present" and 44.4% wrote "a precise developed claim is present". After the intervention, the percentage of the students who wrote "a general claim is present" decreased to 33.3% while the proportion of those who wrote "a precise developed claim is present" increased to 61.1%.

In an expository text, evidence (such as observations, data analysis…etc.) or principle (state the rule, theory, etc.) should be used to support the claim. The homogeneity of regression slopes assumption was not met for this aspect, so the results of this ANCOVA should be analyzed with caution. However, similarly to the previous writing aspect, the results of students writing in the experimental and control group varied with respect to this aspect (support), and an ANCOVA revealed that after adjustment for pre-intervention support scores, there was a statistically significant difference in post-intervention scores between the two groups. The scores showed that the experimental group (M_{adj} = 2.02, *SE*= 0.14) outperformed the control group (M_{adj} = 1.56, *SE*= 0.13), indicating that the intervention was successful in improving the experimental group students' writing of support. This aspect of the students' writing was coded at four levels as well: level 0 "provides no support to the claim", level 1 "support is wrong, repetitive, or irrelevant", level 2 "provides one support to the claim (either evidence or principle)", and level 3 "the support is relevant, accurate, and thoroughly explained; provides both evidence and the principle as support to the claim." In fact, 31.25% of students in the experimental group were categorized as level 0 "provides no support to the claim" in their pre-test while 62.5% were categories as level 2 "provides one support to the claim (either evidence or principle)". However, after the intervention, now none of the students wrote "provides no support to the claim" whereas the percentage of students who used "provides one support to the claim (either evidence or principle)" in their post-test increased to 93.75%. For example, after the intervention some students wrote "I will use the experiment that we did in the lab that when the light bulb is hot it will make the spiral spin", "This can be supported from the experiment we did where we put a spiral above the light bulbs and it turned because of the heat", and "We saw the paper spiral going fast because the ordinary bulb give more heat to the paper spiral". In the control group, on the other hand, before the intervention, 5% of the students wrote "provides no support" and 83.3% wrote "provides on support to the claim (either evidence or principle)". After the intervention, the percentage of the students who did not write any support (level 0) increased to 16.6% and decreased to 77.7% who wrote "provides on support to the claim (either evidence or principle)".

Moreover, in order to write an expository text, students need to include an explanation of how the evidence or principle supports the claim by stating a reason or justification. In this study, ANCOVA revealed no significant between-group differences (F (1, 32) = 3.39, p= .08, *ns*), indicating that the intervention was not effective for reasoning and justification. Adjusted means showed that there was improvement in reason and justification for both groups, with the experimental group (M_{adj} = 1.79, *SE* = 0.24) performing slightly better than the control group ($M_{ad\,j}$= 1.18, *SE* = 0.22). Thus, there was improvement in reason and justification for both experimental and control and while there was more improvement in the experimental group the difference was not significant. This aspect of the students' writing was coded at four levels: level 0 "provides no reasoning or justification at all", level 1 "specific reasoning for the claim is not stated. It refers to the support without explaining it" level 2 "explain why the support was included or how it supports the explanation but not both", and level 3 "explains why the support was included and how it supports the explanation". In fact, due to the intervention, 31.25% of the students in the experimental group were able to "explain why the support was included and how it supports the explanation" compared to none being able to do that during the pre-test. For example one student wrote "…because in the experiment we did the spiral turned around the lamp with more heat. The more heat is in the air the faster the air particles will move so the spiral will turn around the oven". Another student wrote: "When the particles move quickly it produces more heat and the more heat there is the faster the spiral spins. So, whenever we put a spiral on top of an object with lots of heat, it will spin rapidly". On the other hand, none of the students in the control group was able to "explain why the support was included and how it supports the explanation" categorized as level 3 neither before nor after the intervention.

In addition, the study aimed at identifying whether the intervention would enhance students' use of academic vocabulary in their expository writing. Students' writing in the experimental and control group varied with respect to this aspect and an ANCOVA revealed that after adjustment for pre-intervention academic vocabulary scores, there was a statistically significant difference in post-intervention scores between the two groups, F (1, 32) = 8.03, p=.008. Estimates for adjusted means revealed that the experimental group (M_{adj} = 2.24, *SE* =

0.17) performed better than the control group (M_{adj} = 1.59, *SE* = 0.15). This aspect of the students' writing was coded at four levels: level 0 "science vocabulary not used", level 1 "science vocabulary not used correctly" level 2 "one to two science vocabulary used", and level 3 "uses a variety of science vocabulary words correctly (three or more)". In fact, taking into consideration their pre-test, students in the experimental group were more capable to "use a variety of science vocabulary words correctly" (level 3) than those in the control group. Thus, after adjusting for baseline scores, the experimental group performed better than the control group which means that the intervention was effective.

Students' conventions and organization, using appropriate grammar, spelling, punctuation, and capitalization) were also tested. Their writing in the experimental and control group varied with respect to this aspect as well and an ANCOVA revealed that after adjustment for pre-intervention conventions and organization scores, there was a statistically significant difference in post-intervention scores between the two groups, F (1, 32) = 14.43, p=.001. Estimates for adjusted means revealed that the experimental performed better (M_{ad} = 2.04, *SE* = 0.15) than the control group ($M_{ad\,j}$= 1.28, *SE* = 0.13).

Also, each aspect of the expository writing has appropriate language elements and features (See Appendix III). Students' appropriate use of expository linguistic features was tested to check the effectiveness of the intervention. Students writing in the experimental and control group varied with respect to this aspect and an ANCOVA revealed a statistically significant difference in post-intervention scores between the two groups (F (1, 32) = 23.38, p<.001) after adjustment for pre-intervention language features scores. Estimates for adjusted means revealed that the experimental group outperformed ($M_{ad\,j}$= 1.68, *SE* = 0.24) the control group ($M_{ad\,j}$= .11, *SE* = 0.22). This aspect of the students' writing was coded at four levels: level 0 "did not use any of the expository linguistic features", level 1 "linguistic features not used correctly" level 2 "used some of the expository linguistic features properly", and level 3 “used three or more of the expository linguistic features properly”. In fact, 81.25% of students in the experimental group did not use the expository linguistic features (ELF) in their pre-test while 12.5% used some or three and more ELF. However, due to the intervention, now only 8% of the students in the experimental group did not use ELF whereas the percentage has increased to 56.25% of students who used either one or more ELF in their post-test. On the other hand, all students in the control group did not use any of the ELF or did not use them correctly in both pre and both tests. Therefore, the intervention was effective for using appropriate expository linguistic features.

The final aspect of an expository text is the concluding sentence where the writer should rewrite the claim and position to reinforce it. Students writing in the experimental and control group varied with respect to this aspect and an ANCOVA revealed that after adjustment for pre-intervention concluding sentence scores, there was a statistically significant difference in post-intervention scores between the two groups, F (1, 32) = 8.59, p=.006. Adjusted means revealed that the experimental group (M_{adj} = 1.44, SE = 0.27) performed better than the control group ($M_{ad\,j}$= 0.37, SE = 0.25). This aspect of the students' writing was coded at four levels: level 0 “no conclusion”, level 1 “the conclusion is difficult to follow or repeating the claim”, level 2 “provides a sense of closure. Conclusion is present but the statement does not reflect the argument”, and level 3 “concluding statement supports the argument and explain the implications. Statements are not just repeated from the claim”. In fact, 87.5% of students in the experimental group did not write a concluding sentence (level 0) in their pre-test while 12.5% wrote “conclusion is difficult to follow or repeating the claim”, or only “provides a sense of closure. Conclusion is present but the statement does not reflect the argument” categorized as levels 1 and 2 respectively. However, after the intervention, now only 37.5% of the students did not write a conclusion (level 0) whereas the percentage of students who either “provides a sense of closure” (level 2) or “concluding statement supports the argument and explain the implications. Statements are not just repeated from the claim" (level 3) in their post-test has increased to 62.5%. On the other hand, 77.7% of the students in the control group did not write any concluding statement in their pre-teat and the percentage increased to 83.3% during their post-tests.

Finally, the overall writing of the students in both groups was analyzed and the average score of the different aspects of expository writing was calculated. The ANCOVA revealed that there were significant between group differences; F (1, 32) = 24.08, p<.001. Adjusted mean estimates revealed that the experimental group (M_{adj} = 14.23, SE = 0.87) performed better than the control group (M_{adj} = 8.38, SE = 0.87). Therefore, these results suggest that our intervention was effective and caused a significant change in students' pre, post, and overall writing performances.

To sum up, the results presented in this section show that genre-based pedagogy had a positive effect on students' expository writing. In fact, students in the experimental group performed significantly higher compared to the control group after the intervention. Due to the intervention, students in the experimental group improved in their ability to write a claim and support it with evidence. Moreover, students' academic vocabulary, writing conventions and organizations, linguistic features and concluding statement improved as well.

Effect of Genre-Based Pedagogy on Conceptual Knowledge

The second research question of this study asked if genre-based pedagogy would have an effect on students' conceptual knowledge. To answer this question, an ANCOVA was run to determine whether the genre-based pedagogy approach had an effect on students' conceptual knowledge, using pre-intervention scores as a covariate. Participants' science conceptual knowledge scores pre and post intervention were analyzed (see Table 4).

Assumptions. Before carrying out the ANCOVA, a number of assumptions of the analysis were checked and were found to be met: there was a continuous dependent variable and covariate variable, the independent variable was categorical with two independent groups. Moreover, the normality of conceptual knowledge post-test was met across the control and experimental groups as revealed by the Shapiro-Wilk test; W (19) = 0.97, p = .68, *ns,* W (16) = 0.94, p = .32, *ns* respectively. In addition, the homogeneity of variance assumption was met as indicated by the Levene's Test; F (1, 33) = 0.81, p = .37, *ns*. There were no outliers in the data, as no cases with standardized residuals greater than ±3 standard deviations were found. Furthermore, the independence of covariate and treatment effect assumption was met; F (1, 33) = 0.37, p = .55, *ns,* and the homogeneity of regression slopes assumption was met; F (1, 31) = 0.004, p = .95, *ns.*

Main Analysis. First, the ANCOVA analysis revealed that the co-variate was significantly related to the dependent variable (conceptual post-test); F (1, 32) = 7.48, p = .010. The ANCOVA analysis also revealed that after adjustment for pre-intervention conceptual knowledge scores, there was a no statistically significant difference in post-intervention scores between the experimental and control groups, F (1, 32) = .90, p = .35, *ns*. Adjusted means are presented; concept scores were greater in the experimental group (M = 31.00, SE = 1.04) compared to the control group (M = 29.66, SE = 0.95), yet the difference was not significant.

Table 3

Conceptual knowledge of experimental and control groups before and after the intervention: Descriptive statistics

		Pre Intervention		Post Intervention		ANCOVA	
		Mean	Standard Error	Adjusted Means	Standard Error	F-test	Sig.
Conceptual	Control	11.53	0.97	29.66	0.95	0.90	.350
Knowledge	Experimental	12.50	1.33	31.00	1.04		

Challenges Students Faced in Expository Writing

Six students were asked to think aloud while they carried out an expository writing task before the intervention begins. Thinking aloud requires students to verbalize their thoughts immediately while they are performing a cognitive task (Ericson & Simon, 1981), thus revealing what they think without justifying or analyzing. Each of the six chosen students was taken out of the class individually to let them think aloud while responding to the following prompt: “Would an arrow travel a longer distance if the bow is fully or partially stretched? Support your answer.” (Pre-test). The researcher sat next to the participants during the whole session and had to keep on reminding students to articulate their thoughts while writing. It was something they found very difficult as they did not really understand what it meant to sound out their thoughts. Basically, most students did not say what they are thinking and how they are approaching their writing. They were only saying the answer out loud before writing rather that sharing their thoughts that led them to come up with the answer. Even though most participants were not able to articulate their thinking while writing their expository texts, some challenges were identified and compared to a primary set of codes: “generating, structuring, evaluating, revising, and translating” (Beck et al., 2013, p.364).

“Translating” was one of the most articulated challenges by the students. In this context, students’ sentences were coded as “translating” when the students faced difficulties in grammar, spelling, and finding the appropriate words to express their ideas and thoughts – in other words, finding difficulties translating thoughts to written sentences. For example, while thinking aloud one student said: “If the bow was fully … because the more pressure … I don’t know how to write pressure it is with an ‘e’ and two‘s’”. This challenge is an example of a student who was facing difficulties in spelling the word correctly.

“Generating” is another challenge that was noticed as named by the primary codes. Students’ sentences were coded as “generating” if the student faced difficulties generating new ideas .For example, one student mentioned that he didn't know what he is supposed to write next: "Miss I don't have anything more to say".

Finally, in order to identify all types of challenges that students articulated, the researcher supplemented the primary codes using inductive analysis. In this phase, two researchers coded the data and the challenges that they identified were conceptualized and retained as codes. The strategy of constant comparison (Strauss & Corbin, 1998) was used to ensure that the codes are distinct and not repetitive (see Appendix X). Thus, the first additional challenge that was identified inductively in this way was when students were hesitating while talking or writing. Some students, while they seemed to be able to come up with ideas, often were hesitant and articulating their thoughts in incomplete sentences and that seemed like an obstacle, although they were eventually able to articulate them. For example some kept on humming before saying their thoughts and others repeated the same words twice and three times before completing their sentences. For example while thinking aloud one student said "So if I euh euh… if I pulled the arrow the arrow more harder the arrows will go wider will go wider because it is stori storing more potential energy". This student was hesitant and humming "euh euh" before he answers as he wasn't sure about his answer. Another example of a student hesitating is when he said "whether the more pressure you stretch it wait… the more you stretch it the more pressure you stretch it… wait wait… the more the more pressure you put on it the more pressure you pull it?" This student was hesitant and not sure about his answer so he kept on repeating the word "wait" and repeating what he wants to say several times. Also he ended his sentence in the form of a question as he was hesitant about whether his answer is correct or not: "the more pressure you put on it the more pressure you pull it?"

The second challenge that emerged was students' difficulties in converting their thoughts into written English. In fact, some students were facing difficulties translating their thoughts completely in English, and ended up using Arabic to explain what they wanted to say. In other words, they were challenged in translating from their native language of Arabic to the language of instruction, English. (Note: this use of the word "translate" is different from the code "translate" referred to above to mean translating thoughts to written text.) For example, while thinking aloud one student said: "because if you want to aim at something you aim on it like you you you like ... eno trakze alaya (you focus on it) **how do we say it**. Yeh and then we pull the arrow and we shoot." This student was aware that he wasn't finding the appropriate word he wanted to say in English and so he said it in Arabic. Another student said "I think eno (I mean) I think eno (I mean) the arrow will travel longer distance when it is fully because bikoon fi (there is) more potential in it. Bs tetreka lal (when you leave the) arrow the arrow will go when you throw it bikoon fi (there is) more kinetic and when it is falling." This student kept on using Arabic words to complete his sentences. So when articulating their thinking aloud orally at start it was a hard thing to stick to English and kept on using Arabic words, however, when students eventually started writing they were able to write completely in English.

In addition, student difficulties were identified implicitly by their inability to include certain aspects of expository writing in the texts they generated. The prompt immediately lent itself to generating a claim and all the students in the think aloud sessions were able to formulate one. With regard to evidence, most of the participants in the think aloud session stated and backed up their answer using the theory or principle that proves it, but didn't use evidence to support their claim. However, there was a case where one student provided a piece of evidence drawing from a similar experience when asked to support their answer: "It is mostly supposed to be fully because it is like the experiment we did in the lab the more you push it down the more the ball will go up." Regarding the academic vocabulary, all students used at least two scientific words with minor mistakes in how they used the words indicating that they did not fully understand the meaning. None of the students wrote a concluding sentence; they only answered the prompt with some kind of support.

Conclusion

To sum up, this study showed that the genre-based approach did improve the quality of grade 4 students' expository writing in most of its aspects. However, while students in both groups improved in their conceptual knowledge, there was no significant difference between the control and experimental groups in the gain in conceptual knowledge from before to after the intervention. In addition, this study aimed at identifying the challenges that students might face when writing to learn. Even though most students who participated in the think aloud sessions found the task very challenging, some challenges were identified such as translating thoughts to written sentences, generating ideas, hesitating and lacking confidence, and translating from their native language of Arabic to the language of instruction, English.

CHAPTER V

DISCUSSION

The purpose of conducting this research study was to examine whether the genre-based approach to teaching writing improved the quality of Lebanese grade four students' expository writing and their conceptual knowledge. Moreover, this study investigated the challenges that Lebanese elementary students, who are non-native speakers of English, articulated when writing to learn science. To achieve this purpose, 34 Lebanese grade four students were given two prompts during pre and post intervention. The writing samples of the participants in both experimental and control groups were collected before and after the teaching and learning cycle to identify the impact of the genre-based instruction on expository writing. Moreover, Participants' unit tests in both groups before and after the intervention were collected in order to compare their improvements. Finally, six students from both groups were randomly chosen to think aloud while completing their expository writing in order to identify their challenges. Based on the collected and analyzed data, the three research questions will be answered and discussed in this chapter. Limitations of the study, and implications for research and practice are also presented in this chapter.

Discussion of the Results

In this section, the results of this study will be discussed and analyzed according to the three research questions. First, the effect of genre-based pedagogy on expository writing will be discussed. Then, its effects on conceptual knowledge will be analyzed and finally, the challenges students' face when writing in science.

Effect of Genre-Based Pedagogy on Expository Writing. In order to answer the first research question the students were provided with the following questions prompting them to write an expository text both at the beginning (step 1 in the cycle: pre-test) and at the end (step 5 in the cycle: post-test) (Appendix VIII). The first prompt was "Would an arrow travel a longer distance if the bow is fully or partially stretched? Support your answer." The second prompt was "Walid's mom was baking a cake. Walid was playing and made a spiral using a sheet of paper. He held the spiral next to the oven. Would the oven cause the paper spiral to turn? Support your answer. All students in both groups were given the same open-ended prompts. The prompts were similar to what they have tested during the experiments in the previous sessions (see Appendix II and G experiments 1 and 2). The students were given a session (approximately 50 minutes) to answer each prompt. Students' pre and post writings samples revealed that genre-based pedagogy was effective and did enhance students' expository writing. Participants in the experimental group were able to perform better in most of the aspects of expository writing: claims, support, academic vocabulary, organization/conventions, linguistic features, and concluding statements, hence their overall writing improved after the intervention. In fact, the only aspect that did not show any significant difference between the two groups is "reason/justification" which requires students to include an explanation of how the evidence or principle supports the claim. One possible reason for this finding is that students may have needed more time to practice justifying as this requires students to engage in more critical thinking.

Several studies have tested the effect of different types of genres and explicitly teaching students the language features of genres on writing (whether in English literature or content areas like Science). The results of this study are consistent with the findings of Oliveira and Lan (2014)'s case study that presented the implementation of genre-based approach focusing on teaching procedural recounts for grade four English Language Learners in the content area of science. The results of this implementation showed that when students are familiar with school science genres, they produce better and more effective written science texts and the authors concluded that genre-based pedagogy can support academic writing development. Thus, even though each study was tackling a different genre (expository versus procedural recounts), both were applied on grade four ELLs students in the same content area: science, and both had positive effects on students' writing. Moreover, despite the fact that the previous study is just a case study, the current study is a quantitative one that looked at the effect and provided significant experimental evidence that genre-based approach enhances students' writing.

In addition, this study found that explicit focus on language helped grade four students write about science. This is similar to another study which investigated whether an explicit focus on language in literary genres would develop and enhance grade 5 students' writing (Harman, 2013). The outcomes of this research, which was conducted over a period of five months, revealed that it is crucial to focus explicitly on genre at the elementary school level. The researcher showed that grade five students wrote better in Literature when the teacher explicitly focused on language. It is important to mention that even though the previously mentioned studies had a longer period of intervention than the present study (3 and 5 months, respectively compared to 1 month) the results of this study were still positive. One additional reason why all these studies as well as the this one all showed improvements in students' expository writing may be due to the fact that these students received direct instruction on how to write an expository texts and all its linguistic features.

The results of the present study are also consistent with the findings of Jammoul (2016), who investigated the impact of English proficiency and argumentation (which is considered a genre) on Lebanese students' argumentation skills and conceptual understanding of genetics. The findings of Jammoul's study indicated that explicit argumentation instruction improved high school students' argumentation skills and conceptual understanding of the science unit being taught. Jammoul stated that even though the intervention period was relatively short, it was enough to promote students' argumentative skills. Therefore, it is important to mention that even a short duration of intervention applying genre-based approach in science classes is enough to promote grade four Lebanese English Language Learners' expository texts. This means that this instructional strategy can be applied in the Lebanese grade four science classes.

The results of the present study are also similar to those of Wisoothrachira (2002) who investigated students' writing and attitude toward English instruction when using a genre-based approach. The participants in this study were 60 secondary school students who were divided into two groups: experimental and control group. This investigation showed that students who were taught using the genre-based approach (experimental) had significantly better writing performance and attitude towards writing than those who were taught with the usual teacher's manual (control group).

Finally, Zare-ee (2009) also investigated the effect of teaching genre methods on English as a foreign language learners while writing 'letters' in two major universities in Iran. Based on the findings of the study, the explicit teaching of genres can help EFL learners to write better. This is also similar to the current study as both interventions were done on students whose English is not their native language, thus providing more evidence for the effectiveness of this kind of method and suggests that this generalizes it to English Language Learners in different contexts.

Effect of Genre-Based Pedagogy on Conceptual Knowledge. To answer the second research question, students in both groups completed two 50 minutes tests, one before and another after the intervention. The same test was given to both control and experimental groups. Students' pre and post unit tests revealed that genre-based pedagogy was not significantly effective as the improvement in conceptual understanding of both groups was almost the same. In fact, in the present study the test was adopted from the science fusion assessment sheets and modified by the teacher. The test consisted of 15 closed ended multiple choice questions for which each item is assigned a maximum score of 2 points (overall 30 points), in addition to four short answer questions; 2 open ended and 2 closed ended, scored over 10 points. In accordance to Blooms Taxonomy, the test covers the following levels of thinking: comprehension, knowledge, and application. Other studies have reported that using genre-based pedagogy enhances the top-level cognitive skills of analysis rather than those of memory and comprehension (Duschl & Osborne, 2002). Thus, this could be one reason why the results of the tests did not reflect any positive improvement as it was predicted. The conceptual assessment that was adopted in this study did not include any question that triggers students' analysis. "Analysis" is one of Blooms Taxonomy's thinking levels that highlights the organization of ideas, making inferences, and supporting a generalization by providing evidences.

Moreover, a substantial literature has found that integrating writing with content areas like science will improve students' conceptual knowledge in science (Gunel, Hand & Prain, 2007; Lee & Buxton, 2013). In fact, the idea of implementing the genre-based approach itself is a form of integrating language arts with other content areas. For example, the study conducted by Jammoul (2016) investigated the impact of English proficiency and argumentation (which is considered a genre) on Lebanese students' argumentation skills and conceptual understanding of genetics. The findings of this study indicated that explicit argumentation instruction improved high school students' argumentation skills and conceptual understanding of the science unit being taught. One possible reason why the findings of this study are not consistent with those of Jammoul (2016) is that the participants were older and thus more receptive to this genre (argumentation). Expository writing is a challenging genre, similar to argumentation, so this might have affected students' conceptual knowledge.

Moreover, Lee and Buxton (2013) stated that science is considered an important context for developing English proficiency. Moreover, integrating writing with content has been shown to have a positive effect on content instruction. However, not all of the approaches attempting to integrate writing with science have used the genre-based approach. In facts, some of those that were successful have used the "Science Writing Heuristic" and "Argument Driven Inquiry" that could arguably be less complicated for students. In addition, as mentioned earlier, expository writing is the most challenging genre so this might have affected students' grades as it was not beneficial or added any significant conceptual knowledge.

Finally, it is important to mention that the intervention period of this study was not enough to promote higher significant difference between the control and experimental groups in conceptual gain from before to after the intervention. For example, the intervention in this study lasted for almost 1 month, however, Oliveira and Lan (2014)'s case study that presented the implementation of genre-based approach focusing on teaching procedural recounts for grade four ELL students in the content area of science lasted over a three- month period.

Challenges Students Faced in Expository Writing. To answer the last research question, the researcher chose randomly three participants from each group, having given permission to be audio-taped, to think aloud while writing the expository text in order to identify the challenges they face. Each of the six chosen students was taken out of the class individually to let them think aloud while writing their pre-test during one 50-minute class period in a private meeting room at school. As mentioned in the results chapter, this was not an easy task for them, as they did not really understand what it meant to sound out their thoughts. Basically, most students did not say what they were thinking and how they were approaching their writing. They were only saying the answer out loud before writing rather that sharing their thoughts that led them to come up with the answer. Even though some of the students were able to articulate some of their thoughts, most of them were not able to think aloud. It is important to emphasize that the students who participated in the present study were requested to think aloud in English, which is not their native language. It was not an easy task to state what they are thinking and how they are approaching their writing in a language that was not their own. This was noticeable as some of the students faced difficulties in converting their thoughts into written English thus, ended up using Arabic to explain what they wanted to say.

The finding of this study contradicts other literature that showed that think aloud protocol is an effective way for students to articulate and report their problems while writing. Three possible reasons for the difference are the age group of sample being studied, the amount of practicing the think aloud prior to conducting the actual study, and language of instruction. To begin with, Donker and Markopoulos (2002) conducted a comparative assessment to test the usability of three testing methods, which are interview, questionnaire and concurrent think-aloud. The researchers of the study performed a semi-educational game about biological facts with the target of identifying the problems that 45 children between the ages of 8 and 14 encounter. During the game, they asked their students multiple questions and compared the answers obtained using the three methods; finally, they counted the number of problems that the students faced while answering. The results of this study showed that when the students used the concurrent think aloud they were able to articulate the most number of challenges. In addition, according to Beck et al. (2013), thinking aloud can be considered a useful tool for diagnostic assessment as it provided in their study some important insights regarding the challenges that students faced when writing an exposition. In fact, Beck et al. (2013)'s study aimed to identify the challenges that high school ELL and Non-ELL students face when writing expository texts. Also, in Caldwell and Leslie's study (2010), three questions were addressed for middle school students: "What kinds of think-aloud statements are made by middle school students reading expository text?" "Does thinking aloud affect middle school students' reading comprehension as measured by amount and quality of recall and answers to explicit and implicit comprehension questions?", and "Would thinking aloud add value to an assessment of reading comprehension that already included recall and answers to questions?" The difference between the present study and that of Donker and Markopoulos (2002), Beck et al. (2013) and Caldwell and Leslie (2010) is the age of the selected population. Students in the present study were younger (9 years old) than the participants in the other studies (45 children aged between 8 and 14 in Donker and Markopoulos (2002), middle to high school participants in Beck et al. (2013) and middle school in Caldwell and Leslie (2010)), hence might have lacked enough metacognitive awareness and found it difficult to articulate their thoughts while writing.

Second, the experimenter in Donker and Markopoulos (2002) initially demonstrated and explained to the students what they are supposed to do when they think aloud, then they had the chance to try it and the researcher made sure that they are doing it correctly and gave them some feedback. Moreover, the researcher started by modeling for students how to think aloud while reading nine different social studies texts in order to show the students the proper way of thinking aloud. Comparing both studies with the present study, the researcher in this study was restricted to a specific number of periods that couldn't be exceeded and thus students were just taught how to think aloud without having the chance to try it or be given any feedback and the researcher had only modeled one time before the intervention due to the restricted time provided to complete the study. Thus, as thinking aloud is not an easy task to do, students might have needed more examples and more time to practice to make sure they are doing it correctly.

Finally, it is also important to mention that the participants in Caldwell and Leslie (2010) and Donker and Markopoulos (2002) were native speakers of English, which also can be one of the factors responsible for the difference in the results since the students in the present study were ELL students. Native English learners are students whose English is their mother language, whereas English Language Learners (ELLs) are classified as students whose native language is other than English and are using English as a foreign language of instruction. The content area, such as science, is considered a significant context for ELLs to develop English proficiency, in addition to improving English skills that are needed for learning academic content and processes (Lee & Buxton, 2013). However, the task of learning science is similar to learning a new language; this can impose problems on non-native speakers of English. Thus, students in the present study might have found it difficult to articulate their thoughts in English which led them sometimes to express their thoughts in their native language of Arabic instead. In fact, some studies have suggested that using the native language in ELL classroom context can be considered helpful. Thus, one recommendation could be to allow students to articulate their thinking aloud in their native language. Arabic can be used as a resource in the context of the use of a foreign language of instruction in the Arab region as it has been pointed out by Amin (2009).

To sum up, the present study examined the effectiveness of genre-based pedagogy in improving grade four Lebanese Learners’ conceptual knowledge and expository writing in Science. The study also examined the challenges that Lebanese English Language Learners articulate when completing a time-compressed writing task intended to elicit exposition. Findings of this study indicate that genre-based pedagogy had a positive effect on students’ expository writing. Participants’ conceptual knowledge was not affected by the intervention as students’ scores did not change and differ between pre and post-tests for both groups (control and experimental). Finally, even though the challenges identified and articulated by the students while writing were not enough to generalize the finding, the researcher was able to highlight some challenges.

Limitations and Recommendations

There are a number of limitations to this study. One limitation is that the study was conducted with only grade four students and in one private school in Lebanon. The outcomes from the study may not be generalizable to other contexts. So the generalizability of the findings is limited to studies that would be done in an environment where the context and background of the students are similar to those of this study.

Another limitation is the number of students who participated in this study, which does not represent all Lebanese upper elementary students; it would be better for future research to include more participants for a better representation. In addition, sampling students from different proficiency levels (i.e., basic, intermediate, advanced) as identified by the New York State English as a Second Language Achievement Test was not part of the design of this study. Had this been implemented, a wider variety of challenges and writing categories would have emerged; thus future research should relate English proficiency, writing proficiency and ELL writers' challenges in a more comprehensive way.

It is important to mention that the duration of the intervention is a third limitation as it consisted of one month only due to the packed Lebanese curriculum in grade four scientific section. The duration of the intervention might not have been enough to promote better scientific conceptual knowledge among the students and to enable them to think aloud fluently their challenges while writing. In fact, there was not enough data about the challenges as students' think aloud were not extensive. Students as well were not provided with appropriate amount of time to practice thinking aloud. Therefore, future studies should be conducted over longer periods to identify whether grade four students would be able to think aloud and if genre-based pedagogy would have positive effect on students' conceptual knowledge when compared to other instructional approaches. In addition, a further recommendation would be to prepare enough activities for students to practice how to think aloud properly in order to be able to collect enough data regarding their challenges. Teachers must also model several times and allow students to practice thinking aloud and give them feedback to make sure they are doing it correctly.

Another limitation is the age-group which could be a reason that prevented the students from articulating their thoughts while writing. Therefore, future research should find another method that enables them to collect and identify the challenges that this age group face while writing.

In this study, multiple ANCOVAs were conducted which have implications for the significance levels. However, the significance levels for all the expository aspects, except for "reason and justification" were well below $p = .05$. In fact, most of the expository writing's aspects had a value $p = .026$ or less.

The last limitation of the study is that the conceptual assessment adopted did not enable the researcher to identify properly the effect of genre-based pedagogy on students' scientific conceptual knowledge. It is recommended for future research to come up with another conceptual assessment that would allow more insights regarding the effect of genre-based pedagogy on science conceptual knowledge.

Having stated all the mentioned limitations and constraints, the study highlights the value and importance of genre-based approach in enhancing students' expository written texts and maintaining the same level of conceptual gain.

Implications

Identifying the challenges that English Language Learners face when writing to learn science and the effect of genre-based pedagogy on their writing quality and conceptual knowledge had a number of implications and recommendations. According to the literature review, this study has made a distinctive contribution to the field by possibly being the first study conducted in the Arab region that has investigated the effectiveness of genre-based pedagogy in improving grade four Lebanese Learners' conceptual knowledge and expository writing in science and identified the type of challenges they faced.

With regards to implications for theory, the theoretical framework that justifies the increased interest among science education researchers in using the genre-based approach is Systemic Functional Linguistics (SFL), which is a view of language that focuses on its function and its various features that are used to perform certain tasks. This view of language has been specifically applied to the language of science and has described its specialized characteristics. Among these is that scientific texts can be categorized into a variety of genres such as explanation, classification, reports, exposition etc.

> "'SFL theories believe that explicit teaching of generic structures and their associated grammatical features can help learners (particularly non-native speakers of English) to master the functions and linguistic conventions of texts necessary for successful participation in the range of disciplines and professions" (Coffin, 2001, p.113)

Hence, the results of this study contribute to the current body of knowledge created by the systemic functional linguistics researchers who have investigated how genre-based pedagogy can support the academic writing developments of English Language Learners. This study sheds light on the importance of SFL as a method that supports science writing instruction in typical elementary classes, and considered as an effective approach that enables researchers to identify the changes that students perform in their writing (Gebhard et al., 2010; Schleppegrell, 2010). However, genre-based pedagogy did not have any enhanced effect on students' conceptual knowledge when compared to regular instruction, which was not consistent with other studies. Even though the results of this study are not enough to generalize the kinds of challenges that students in Lebanon face while writing, yet some challenges were identified and could be added to the literature. Two additional kinds of challenges emerged from this study compared to previous challenges that were articulated in other studies: hesitating and lacking confidence, and translating from their native language of Arabic to the language of instruction, English

Understanding and identifying the challenges that Lebanese ELLs faced when writing to learn can help other researchers, teachers, and curriculum developers design new strategies and instructions to foster writing improvement for grade four writers. These strategies take into consideration the issues which students faced by preparing lessons that suit their needs and ensuring a better learning outcome in science and language arts. Thus, it is recommended for future research to identify the challenges that English Language Learners face when writing to learn science in order to come up with the best plan for instruction in science classes and apply it effectively.

According to the finding of the research, teaching the expository genre to students is very beneficial. Research can explore other genres as well in order to create a rather better acknowledgement of the value of genre-based approach. Hence, it is recommended that the genre-based approach be implemented by starting with teaching a less complex genre (response or narrative) then move to higher complex ones (argumentative or discussion). Accordingly, students will be familiarized with the requirements of genres that enable them to manage with advanced and more complex demands of expository genres.

Moreover, the finding of this study showed that genre-based pedagogy has positive effects on students' writing. Thus, teachers are recommended to use this approach in their classroom and focus explicitly on genre and language in order to ensure better learning and improve students' writing skills. An interesting recommendation for future research would be to further investigate the effect of genre-based approach in improving reading for English Language Learners during the science classes.

Conclusion

The outcome of this study has shown several benefits for learning and teaching English in a Lebanese context. As the content areas become more specialized at the upper elementary grades, this study responds to recent calls for educators to implement the idea of genre to writing instruction (especially genre-based approaches informed by SFL) so that second language writers in mainstream content area classrooms get the necessary support they need to write better. (e.g., Gebhard & Harman, 2011). The implementation of such an approach results in a better writing outcome in a specific genre, such as expository genre, in a content area like science. Students in this study were able to write better expository texts after being taught the different writing aspects related to this specific genre and its linguistic features, which reveals the advantage of explicit teaching. Even though the students maintained the same level of conceptual gain, this study presents how a genre-based approach could be used as a possible means to enhance Lebanese students' writing in different content areas. Finally, although the challenges identified and articulated by the students while writing were not enough to generalize the finding, some challenges were highlighted by the researcher and could be used as a basis for future research.

APPENDIX I

CONCEPTUAL KNOWLEDGE ASSESSMENT

Name ________________________ Date ________________________________

Unit 5

Unit Test

Energy

Vocabulary

Fill in the circle of the best choice. *(2 points each)*

1. Lana buys a battery for her flashlight. Which type of energy does the battery have?
   - Ⓐ Light energy
   - Ⓑ Kinetic energy
   - Ⓒ Potential energy
   - Ⓓ Electrical energy

2. Objects may have potential energy and/or kinetic energy. How do potential energy and kinetic energy compare to each other?
   - Ⓐ Both describe objects at rest.
   - Ⓑ Both describe objects in motion.
   - Ⓒ Both are forms of mechanical energy.
   - Ⓓ An increase in one leads to an increase in the other.

3. Gasoline is a common source of energy. Which sentence is **false** about gasoline?
   - Ⓐ It is most of the vehicles source of energy.
   - Ⓑ It has chemical energy that changes to kinetic energy.
   - Ⓒ It has sound energy.
   - Ⓓ It burns to release energy.

4. Sara knows that conduction is a form of heat energy transfer. Which transfer of heat energy is made through conduction?
   - Ⓐ Hand heats a snowball
   - Ⓑ Radiator warms a home
   - Ⓒ Boiling water heats pasta
   - Ⓓ Sun warms a greenhouse

5. Objects can have potential energy because of their position. Which object has potential energy?
   - Ⓐ a parked car idling
   - Ⓑ a rocket on its way to space
   - Ⓒ a spinning top on the floor
   - Ⓓ a mango hanging from a branch

Science Concepts

6 Jad plugs a radio into an electrical outlet and turns it on. What change in energy takes place when he does this?

Ⓐ Light energy changes into sound energy.
Ⓑ Electrical energy changes into sound energy.
Ⓒ Sound energy changes into electrical energy.
Ⓓ Chemical energy changes into sound energy.

7 What type of energy change takes place as an airplane burns fuel to take off?

Ⓐ Electrical energy to light energy
Ⓑ Kinetic energy to potential energy
Ⓒ Chemical energy to kinetic energy
Ⓓ Mechanical energy to kinetic energy

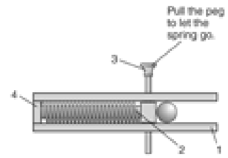
8 Which form of energy results from vibrations that travel through air?

Ⓐ Sound energy
Ⓑ Potential energy
Ⓒ Electrical energy
Ⓓ Chemical energy

9 Ali and his family sit around a campfire. What provides energy to keep the fire going?

Ⓐ flames
Ⓑ heat
Ⓒ matchstick
Ⓓ wood

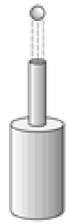
10 Look at the picture below.



If the spring is squeezed to half its length in the picture, what effect will that have on the ball?

Ⓐ The ball will create more energy.
Ⓑ The ball's kinetic energy will decrease.
Ⓒ The ball's potential energy will increase.
Ⓓ The ball's potential energy will decrease.

11. During an experiment, Aya uses a piece of equipment to send a ball into the air. The picture below shows Aya's equipment. It shows how the ball travels.



What type of energy will the ball have just before it comes down?

Ⓐ electrical Ⓒ magnetic
Ⓑ kinetic Ⓓ potential

12. Youssef has a pogo stick. When he jumps on it, the spring squeezes toward the ground and then moves back to its starting position. What type of energy does the pogo stick have as Youssef plays on it?

Ⓐ chemical energy
Ⓑ electrical energy
Ⓒ magnetic energy
Ⓓ mechanical energy

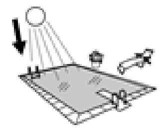
13. On a warm sunny day, a lizard sits on a rock. Which word explains why the lizard feels heat from the sun?

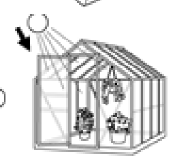
Ⓐ convection
Ⓑ friction
Ⓒ gravity
Ⓓ radiation

14. Jad recorded the average temperatures in Beirut, for four months from February through May. Which is **most likely** the temperature for February, knowing that February is the coldest?

Ⓐ 19° C Ⓒ 21° C
Ⓑ 25° C Ⓓ 16° C

15. Each picture shows a source of heat. Which picture shows heat transfer through convection?

Ⓐ 

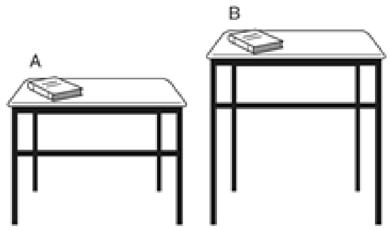
Ⓑ 

Ⓒ 

Ⓓ 

Apply Inquiry and Review the Big Idea

16 The picture below shows two objects, Book A and Book B, at rest.



Identify which object has more potential energy. Explain why. (2 points)

____

____

17 Identify a heat source in your home. Then give an example of how this heat source transfers heat energy. (2 points)

____

____

18 Write the kind of heat transfer that takes place in the following situations. *(3 points)*

a. Warm wind reaching the city

____

b. Tanning under sunlight

____

c. Adding hot water to cold water in a glass

⓳ Describe an example of an object where its potential energy changes to kinetic energy (3 points)

____

____

____

APPENDIX II

EXPERIMENT 1: WHERE DOES ENERGY COME FROM? TEACHER'S VERSION

Adapted from a lesson described in Science Fusion grade 4.

Guided Inquiry

50 minutes

Pairs

Objectives

- Identify how potential energy is transferred into kinetic energy.
- Investigate how energy has the ability to cause motion.

Inquiry Skills

- Communicate
- Gather, Record, Display, or Interpret Data

Materials (for each pair)

- Springs
- Tape measure
- Safety goggles (for each student)

Procedure

- Students will be provided with a spring and an empty data table to keep a record of their observations.
- Students must place the spring on the table or the floor.
- First, student should hold the spring and push on it slightly and then release it.
- Students must measure and record how high the spring will rise in their data table by sticking a measuring tape.
- Repeat this exercise by pushing the spring using different forces of compression each time.
- Connect how high the spring is rising to the intensity of the compression exerted on the spring.

STUDENT'S VERSION

EXPERIPENT 1: WHERE DOES ENERGY COME FROM?

Group Name: ________________________ Date: _______________________

Objectives

- Identify how potential energy is transferred into kinetic energy.
- Investigate how energy has the ability to cause motion.

Materials

- Springs
- Tape measure
- Safety goggles

Procedure

- You are provided with a spring and an empty data table to keep a record of your observations.
- Place the spring on the table or the floor.
- First, hold the spring and push on it slightly and then release it.
- Repeat this exercise by pushing the spring using different forces of compression each time.
- Connect how high the spring is rising to the intensity of the compression exerted on the spring.
- What do you notice?

Experiment 1: Where Does Energy Come From?

Group Name: ____________________ Date: ___________________

1. Measure and record how high the spring will rise in your data table.

Data Table

Intensity of compression exerted	Altitude of the jump

2. What did you learn from this experiment? Connect how high the spring is rising to the degree of compression of the spring.

____

____

____

____

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APPENDIX III

LANGUAGE FEATURES: EXPOSITORY WRITING

Parts and their functions	Language elements	Language examples
CLAIM: What is your claim? What is your position?	Specific and clear Objective (not an opinion) Present tense Third person	-There is good reason to believe that …
Evidence: Appropriate and sufficient scientific data that supports the claim	Past tense Use of technical vocabulary Third person Types of sentences: statements	-This is supported by… -This can be proven… -For instance -For example
Reason: Justification that connects the evidence to the claim and shows why the data counts as evidence by applying scientific principles.	Present tense Use of technical vocabulary Third person Types of sentences: statements	- One reason to believe that... is true is … - This shows that… because… - This is true because… - The reason for this is…

APPENDIX IV
LESSON PLAN (EXPERIMENTAL GROUP)
DECONSTRUCTION PHASE (PERIOD 9)

Objective:

- Students will be able to define claim, evidence and reason.
- Students will be able to differentiate between claim, evidence and reason.
- Students will be able to formulate a claim, use evidence to support it, and connect the evidence to the claim through reasoning.

Technology:

- PowerPoint Presentation (see next page)
- Video Links:

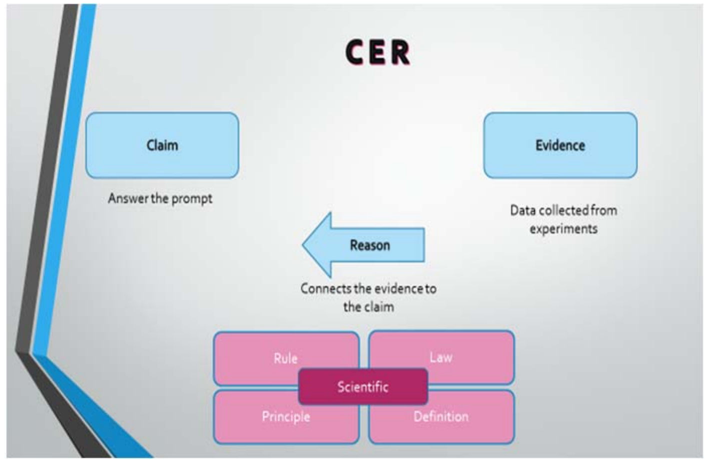
https://www.youtube.com/watch?v=tTSV694bE_Y

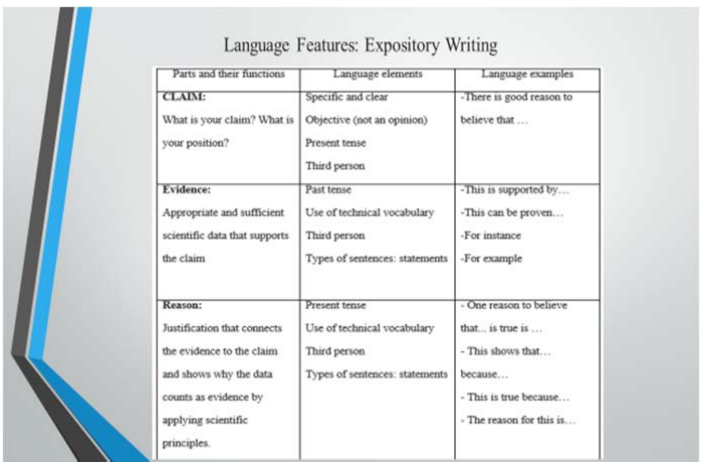
https://www.youtube.com/watch?v=5KKsLuRPsvU

Whole Class Instruction:

- First the teacher will start by projecting the PowerPoint presentation that includes the different components of an expository text.
- The teacher will explain the difference between claim, evidence and reason.
- Students will be introduced to the language features of the expository text and watch a video about this genre.
- Students will be divided into groups to answer the following question: Are Skew Dice Fair? Each group will be provided with two types of dice (skew and normal). They will have to experiment and throw the skew dice several times to see whether each side has equal chance to come on top (which makes it fair).
- Both the teacher and students will complete the graphic organizer and write the claim, evidence, and reason (see Appendix XII).

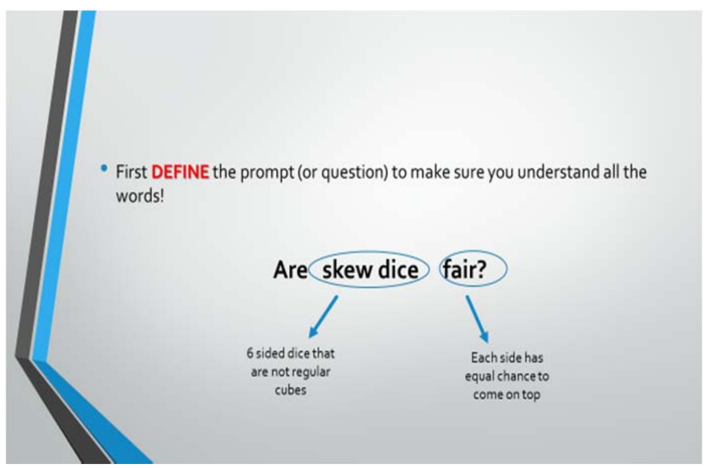
PowerPoint Presentation





Language Features: Expository Writing

Parts and their functions	Language elements	Language examples
CLAIM: What is your claim? What is your position?	Specific and clear Objective (not an opinion) Present tense Third person	-There is good reason to believe that …
Evidence: Appropriate and sufficient scientific data that supports the claim	Past tense Use of technical vocabulary Third person Types of sentences: statements	-This is supported by… -This can be proven… -For instance -For example
Reason: Justification that connects the evidence to the claim and shows why the data counts as evidence by applying scientific principles.	Present tense Use of technical vocabulary Third person Types of sentences: statements	- One reason to believe that... is true is … - This shows that… because… - This is true because… - The reason for this is…



LESSON PLAN (EXPERIMENTAL GROUP)

JOINT CONSTRUCTION (PERIOD 10)

Objective:

- Students will be able to formulate a claim, use evidence to support it, and connect the evidence to the claim through reasoning with the help of the teacher.

Whole Class Instruction:

- The teacher will start by projecting the prompt on the board: "Would an arrow travel a longer distance if the bow is fully or partially stretched? Support your answer."
- Students will have to come up with a claim. Then, both students and the teacher will come up with the evidence that supports this claim and the reason that connects the evidence to the claim. (see Figure 3: Example of the expository response to this prompt.)
- During the writing process, the students will be applying the linguistic features of an expository text. They will follow the rubric given to them regarding the linguistic features and writing properly an expository text.

Figure 3

Example of an expository response to the prompt

Would an arrow travel a longer distance if the bow is fully or partially stretched? Support your answer.

An arrow travels a longer distance if the bow is fully stretched. This can be supported using the experiment of the compressed spring. When we tested the relation between the spring compression level and the distance it would jump, we found that it jumps the highest when it is compressed the most. All of the potential energy that was stored while compressing the spring was transferred to kinetic energy which is the energy of motion when we released it. As we compress more, the spring will have higher potential energy, thus more energy to move. The reason behind this observation is that potential energy is stored energy of an object due to its condition or position. So, the bow will have more potential energy when it is fully stretched; this stored energy will be transferred to motion as soon as the bow is released thus travelling a longer distance.

APPENDIX V

RUBRIC FOR WRITING A SCIENTIFIC EXPOSITORY PARAGRAPH

Criterion	Description	Rubric Descriptions
Claims	Takes a position	0- No claims are included. 1- A claim is included but it is not relevant to the topic. 2- A general claim is present. 3- A precise developed claim is present.
Support	Use evidence to support the claim (develops ideas with examples (observations, data, analysis, research, etc.) Or/and Use principle to support the claim (state the rule, theory, etc.)	0- Provides no support the claim. 1- Support is wrong, repetitive or irrelevant. 2- Provides one support to the claim (either evidence or principle) 3- The support is relevant, accurate, and thoroughly explained. Provides both evidence and the principle as support to the claim.
Reason/ Justifications	Explains how the evidence or principle supports the claims.	0- Provides no reasoning or justification at all. 1- Specific reasoning for the claim is not stated. It refers to the support without explaining it. 2- Explains why the support was included or how it supports the explanation but not both. 3-Explains why the support was included and how it supports the explanation.
Academic Vocabulary		0- Science vocabulary not used. 1- Science vocabulary not used correctly. 2- One to two science vocabulary used. 3- Uses a variety of science vocabulary words correctly (three or more).
Conventions/ organization	To use appropriate grammar, spelling, punctuation, and capitalization.	0- Errors prevent the reader from following the argument. 1- Complete sentences are not used. Major grammatical mistakes. 2- Complete sentences are used but informal language is present Some

		grammatical mistakes. 3-Creats a logical structure with complete sentences and paragraphs. Focus is always on the claim. Grammar is used correctly.
Linguistic features of an expository text	To use appropriate expository linguistic features	0- Did not use any of the expository linguistic features. 1- Linguistic features not used correctly 2- Used some of the expository linguistic features properly. 3- Used three or more of the expository linguistic features properly.
Concluding statement	Statement that supports the claim without repeating it.	0- No conclusion 1- The conclusion is difficult to follow or repeating the claim. 2- Provides a sense of closure. Conclusion is present but the statement does not reflect the argument. 3-Concluding statement supports the argument and explains the implications. Statements are not just repeated from the claim.

APPENDIX VI

LESSON PLAN (CONTROL GROUP)
PERIOD 9

Objective:

- Students will be able to identify potential and kinetic energy.
- Students will be able to distinguish between potential and kinetic energy.
- Students will be able to originate other examples of how potential energy can change to kinetic energy

Technology:

https://www.brainpop.com/science/energy/potentialenergy/

https://www.brainpop.com/science/energy/potentialenergy/quiz/

Whole Class Instruction:

- Students first will be grouped as pairs and watch the Brainpop video about potential and kinetic energy.
- Students will complete an online quiz following the video on Brainpop (presented below).
- In pairs, students will have to come up with another example of how potential energy can shift into kinetic energy.
- Then, one representative from each pair will be randomly selected to come up and present their example to the whole class.

Potential Energy Quiz

Name: ____________________
Date: ____________________
Class: ____________________

1. What is potential energy?

a. The energy an object has due to its position or condition
b. The energy an object has due to its motion
c. The energy an object has due to its chemical composition
d. The energy an object has due to its atomic structure

2. What is kinetic energy?

a. The energy an object has due to its position or condition
b. The energy an object has due to its motion
c. The energy an object has due to its chemical composition
d. The energy an object has due to its atomic structure

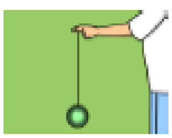
3. When does an object have no kinetic energy?

a. When it's at rest
b. When it's moving very slowly
c. When the only force that's acting on it is gravity
d. When it has no electrical charge

4. Which object has the most potential energy?

a. A ball resting on the ground
b. A ball being thrown at 100 miles per hour
c. A ball on top of a refrigerator
d. A ball resting on the edge of a cliff

5.



When does a yo-yo have the most potential energy?

a. When it's at its highest point
b. When it's at its lowest point
c. When it's moving between its highest and lowest points
d. When it's moving at its top speed

6. When is potential energy transformed into kinetic energy?

a. When an object at rest is lifted to a higher elevation
b. When an object at rest remains at rest
c. When an object at rest is put into motion
d. When an object in motion is stopped and put at rest

7. What do potential and kinetic energy have in common?

a. They're both related to density
b. They're both unrelated to mass
c. They're both related to volume
d. They're both related to motion

8. Four cars are positioned at the top of a hill. Which car has the most potential energy?

a.


b.


c.


d.


9. Which is the best synonym for potential energy?

a. Stored energy
b. Energy of motion
c. Energy due to gravity
d. Mechanical energy

10. Why do objects at high elevations have more potential energy than objects at low elevations?

a. Because the thinner air at higher elevations means objects have a greater potential to move very fast
b. Because objects at high elevations are closer to the sun, which is the source of all energy on earth
c. Because objects at high elevations tend to move slower than objects at low elevations
d. Because gravity gives objects at high elevations the potential to fall much further

LESSON PLAN (CONTROL GROUP)
PERIOD 10

Objective:

- Students will be able to identify different forms of energy.
- Students will be able to differentiate between different forms of energy.
- Students will be able to identify potential and kinetic energy.
- Students will be able to define potential and kinetic energy.

Technology:

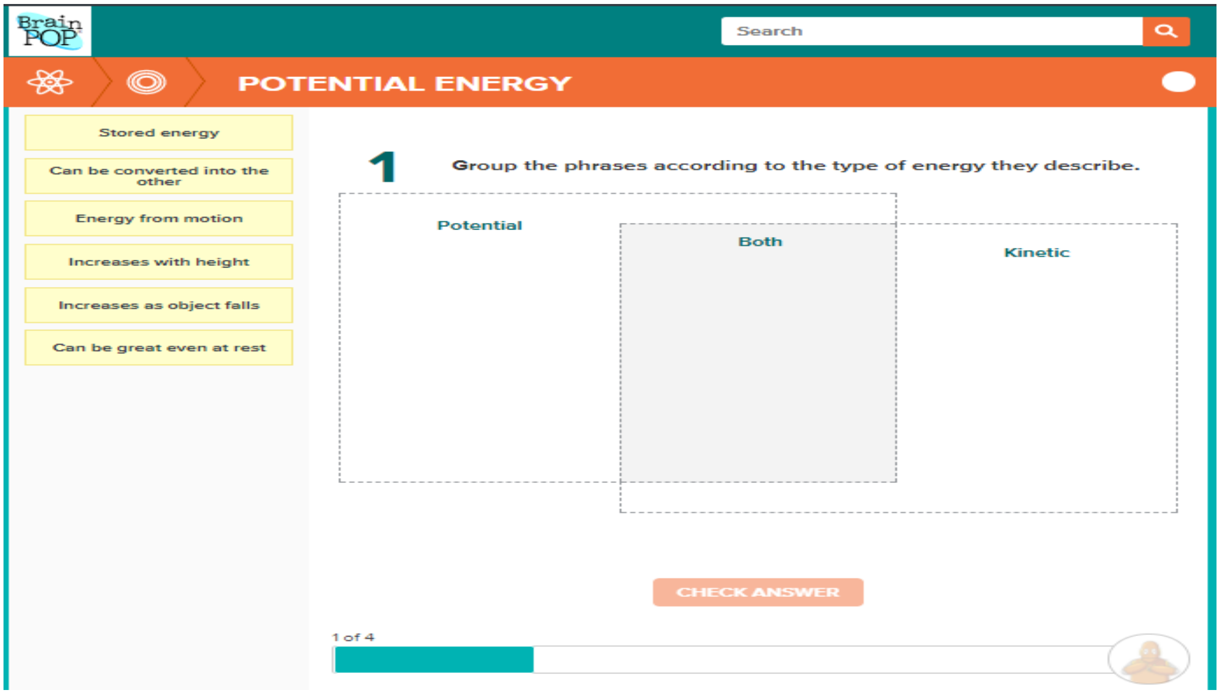
https://www.brainpop.com/science/energy/potentialenergy/challenge/

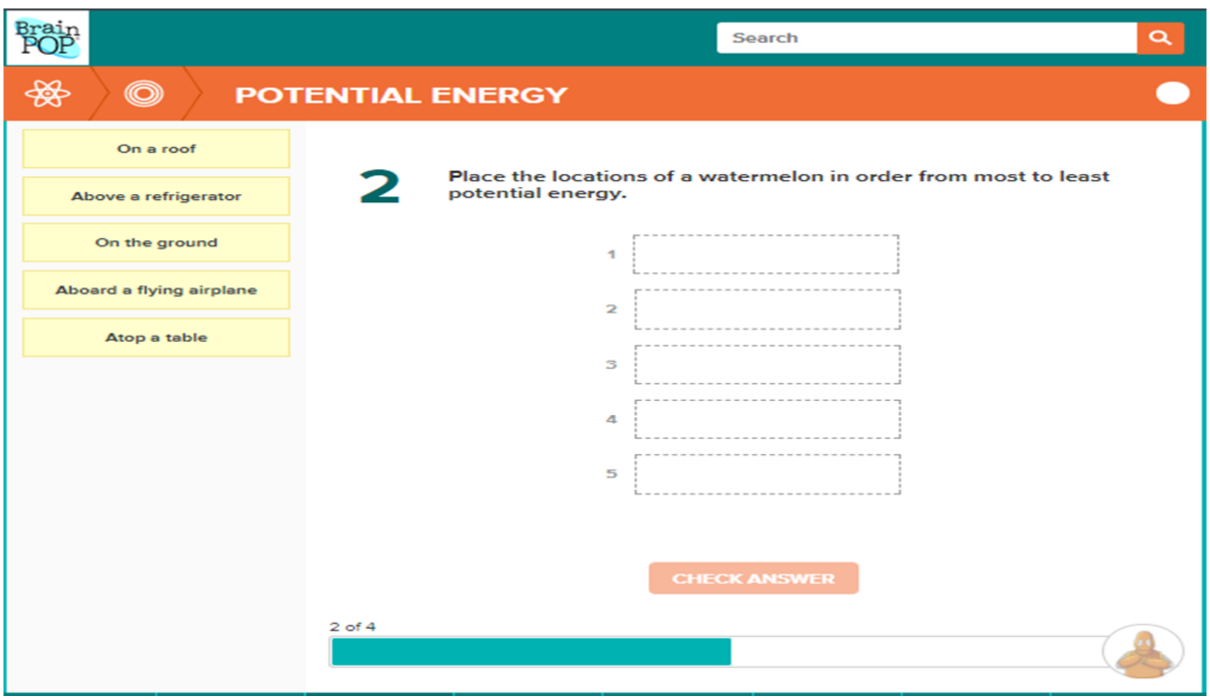
https://www.brainpop.com/science/energy/formsofenergy/

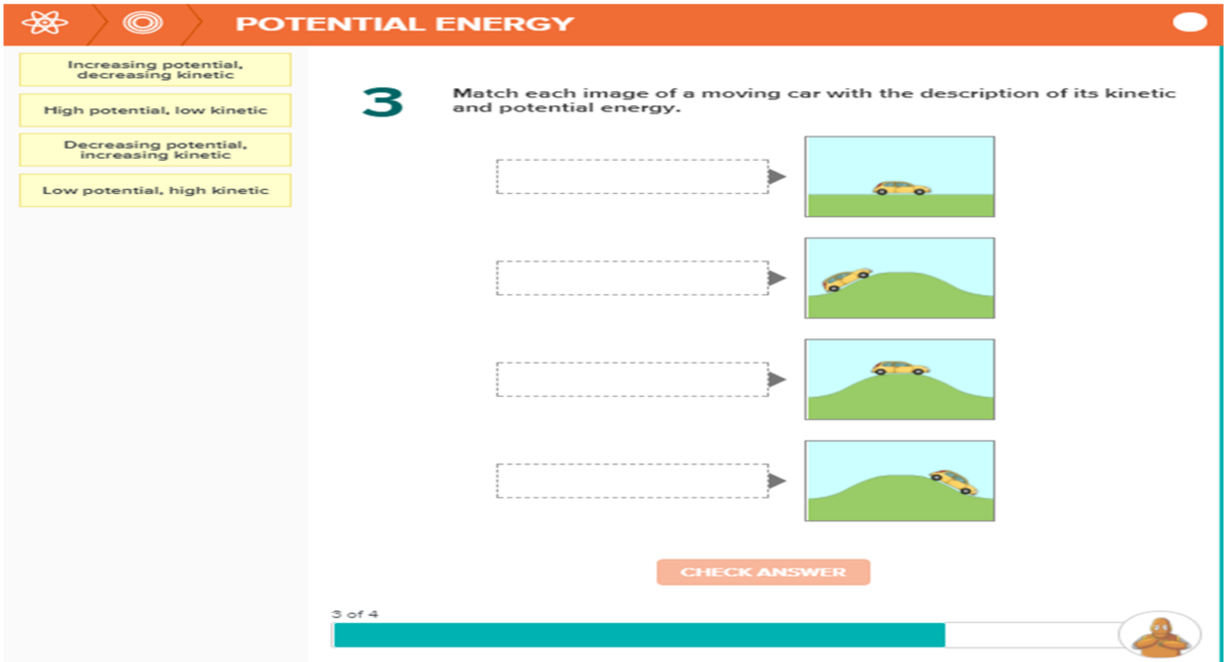
Whole Class Instruction:

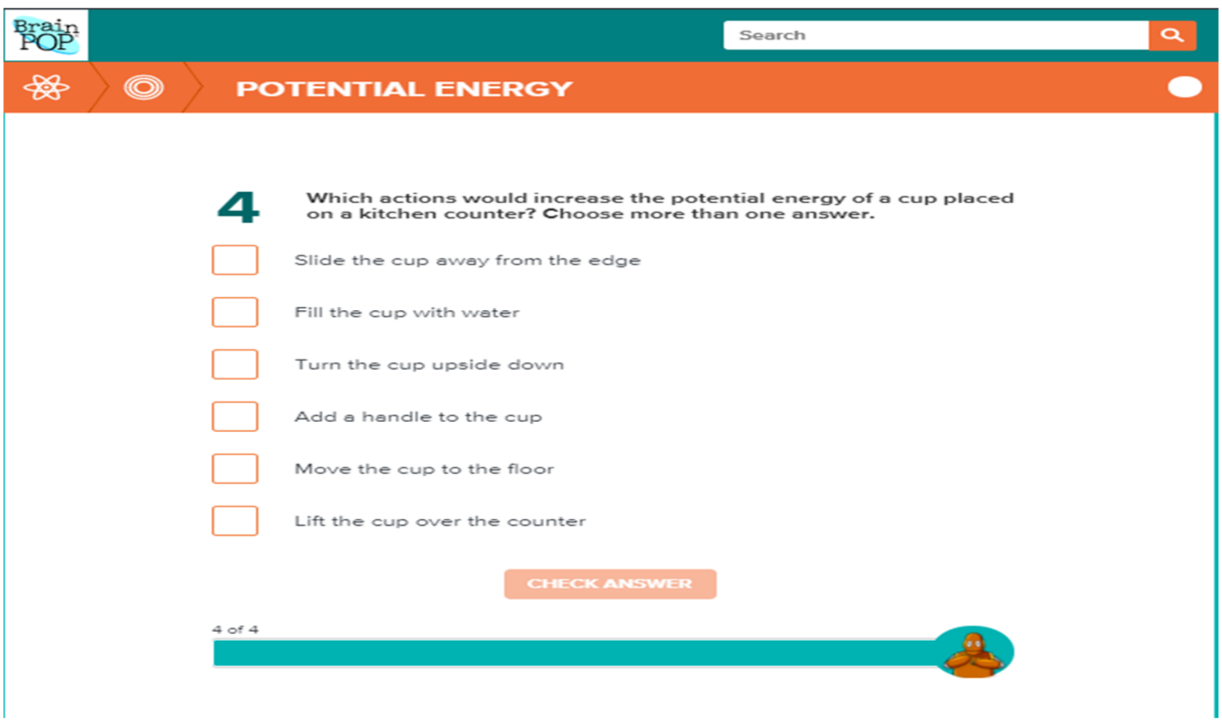
- Students first will be grouped as pairs to complete the challenge on Brainpop to check if they can identify and differentiate between potential and kinetic energy (below is a picture of the challenge)
- In pairs, students will then watch a video about the different forms of energy on Brainpop in which they will identify the following types: potential, kinetic, electrical, chemical, light, and thermal energy (heat).
- Then, they will complete the following worksheet (adapted from Science Fusion page 444).

Pictures of the Online Challenge on Brainpop






POTENTIAL ENERGY
Increasing potential, decreasing kinetic
High potential, low kinetic
Decreasing potential, increasing kinetic
Low potential, high kinetic
3
Match each image of a moving car with the description of its kinetic and potential energy.
CHECK ANSWER
3 of 4


Brain POP
Search
POTENTIAL ENERGY
4
Which actions would increase the potential energy of a cup placed on a kitchen counter? Choose more than one answer.
Slide the cup away from the edge
Fill the cup with water
Turn the cup upside down
Add a handle to the cup
Move the cup to the floor
Lift the cup over the counter
CHECK ANSWER
4 of 4

Name: ________________________ Date: __________________________

6 Many forms of energy are around us and within us. Write three paragraphs in the form of an e-mail to a friend or family member describing some ways you use energy in a typical day. Tell your reader where the energy comes from and how it transforms into other forms of energy.

APPENDIX VII: Grade 4, Unit 9, Lesson 4

EXPERIMENT 2: HOW IS HEAT PRODUCED?
TEACHER'S VERSION

Inquiry Flipchart p. 50
Student Edition pp. 459–460
Guided Inquiry
50 minutes
Pairs

Objectives
- Students will be able to identify that different kinds of bulbs can emits different amounts of heat and cause different temperature changes.
- Students will be able to examine how electrical light bulb generates heat.
- Students will be able to conclude that electricity is one type of energy that can be transformed to another form of energy which is heat.

Inquiry Skills
- Hypothesize
- Formulate or Use Models
- Observe
- Plan and Conduct a Simple Investigation

Materials (per pair)
- lightweight paper
- pencil
- scissors
- sewing needle
- incandescent light bulb and base
- compact fluorescent light bulb and base
- dowel
- safety goggles
- piece of thread, 50 cm long

Alternative Materials
- String can be used in place of a needle.
- A sturdy plastic drinking straw can be used in place of a dowel.
- Have a tape measure or ruler handy to measure distance.

Procedure

- Students should draw a spiral on a sheet of paper. Cut the spiral out.
- Students must thread the sewing needle. Tie a knot on the far end of the thread. Then put the thread through the center of the spiral.
- They should push the needle into the dowel so that the spiral is hanging from the dowel.
- Put one of the light bulbs in the base and turn it on. They should hold their hand about 30 cm above the bulb. They should not touch the bulb, just observe and record. Then, hold the spiral 30 cm above the bulb and again observe and record.

- Test the other light bulb in the same way.
- Student must record their observations.

Prep Tip

- Students should use the photographs on the Flipchart page as a guide for how to draw and cut the spiral. Tell students that they may be able to draw a more uniform spiral if they begin by placing the pencil point in the center of the paper instead of on the outside of the sheet of paper.
- If you have concerns about students using needles, the same result can be achieved by taping a piece of string to the inner most part of the spiral.

Troubleshooting

- If only one base per pair is available, have students test the compact fluorescent light bulb first, as these bulbs do not get hot. After the test, students can wait for a minute or two and then carefully change the bulbs.
- Use 8.5 in. × 11 in. paper.
- Have students hold up the swirl without putting it over a bulb, and then make and record an observation.
- If string is used instead of a needle the other end of the string could be taped to the dowel or a drinking straw.
- You will find a ruler or tape measure helpful.

Caution! Warn students to be careful when using the scissors and the sewing needle. When they poke the needle through the paper, their other hand should not be anywhere near the place where the needle will poke through. If they have difficulty pushing the needle into the dowel, suggest that they push it in with a pencil eraser or the side of a pencil. Warn students not to touch the lit bulbs, as incandescent bulbs can become very hot.

Expected Results

The incandescent bulb will produce enough heat to turn the spiral, but the compact fluorescent bulb will not. Students should follow the prompts and record their responses.

EXPERIMENT 2: HOW IS HEAT PRODUCED?

STUDENT'S VERSION

Group Name: ___________________ Date: _________________

Objectives

- Observe that an object's temperature increases when it is exposed to a heat source.

How Is Heat Produced?

You know that heat moves by conduction, convection, and radiation. You can feel it move. In this investigation, your job is to make a model that will allow you to "see" heat move.

Materials

lightweight paper
pencil
scissors
sewing needle
incandescent light bulb and base
compact fluorescent light bulb and base
dowel
safety goggles
piece of thread, 50 cm long

1 CAUTION: Be careful using scissors. Draw a spiral on a sheet of paper. Cut the spiral out.

2 CAUTION: Wear goggles. Be careful not to poke yourself with the needle! Thread the sewing needle. Tie a knot on the far end of the thread. Then put the thread through the center of the spiral.

3 Push the needle into the dowel so that the spiral is hanging from the dowel.

4 Put one of the light bulbs in the base and turn it on. Hold your hand about 30 cm above the bulb. Do NOT touch the bulb. Observe and record. Then hold the spiral 30 cm above the bulb. Observe and record.

5 Test the other light bulb in the same way. Record your observations.

50

Materials

- lightweight paper
- pencil
- scissors
- sewing needle

- incandescent light bulb and base
- compact fluorescent light bulb and base
- dowel
- safety goggles
- piece of thread, 50 cm long

Procedure

- Draw a spiral on a sheet of paper. Cut the spiral out. Be careful using scissors.
- Wear goggles. Be careful not to poke yourself. Thread the sewing needle. Tie a knot on the far end of the thread. Then put the thread through the center of the spiral.
- Push the needle into the dowel so that the spiral is hanging from the dowel.
- Put one of the light bulbs in the base and turn it on. Hold your hand about 30 cm above the bulb. Do NOT touch the bulb. Observe and record. Then hold the spiral 30 cm above the bulb. Observe and record.
- Test the other light bulb in the same way.
- Record your observations on the lines below.

EXPERIMENT 2: HOW IS HEAT PRODUCED?

Group Name: ____________________ Date: __________________

1- **In the space below, make a table in which you record your observation.**

2- **What did you learn from this procedure about the difference between compact fluorescent bulbs and ordinary light bulb?**

____

____

____

____

____

____

APPENDIX VIII

PRE-TEST: WHERE DOES ENERGY COME FROM?

Name: ___________________________ Date: _________________________

Based on what you have learned answer the following prompt:

Would an arrow travel a longer distance if the bow is fully or partially stretched? Support your answer.

POST-TEST: WHAT IS HEAT?

Name: ___________________________ Date: _________________________

Based on what you have learned answer the following prompt:

Walid's mom was baking a cake. Walid was playing and made a spiral using a sheet of paper. He held the spiral next to the oven. Would the oven cause the paper spiral to turn? Support your answer.

APPENDIX IX

CONCEPTUAL KNOWLEDGE ASSESSMENT: ANSWER KEY

Name Answer Key

Unit 9

Energy

Vocabulary

Fill in the circle of the best choice. (2 points each)

1. Lana buys a battery for her flashlight. Which type of energy does the battery have?
   - Ⓐ light energy
   - Ⓑ kinetic energy
   - Ⓒ potential energy
   - Ⓓ electrical energy

2. Objects may have potential energy and/or kinetic energy. How do potential energy and kinetic energy compare to each other?
   - Ⓐ Both describe objects at rest.
   - Ⓑ Both describe objects in motion.
   - Ⓒ Both are forms of mechanical energy.
   - Ⓓ An increase in one leads to an increase in the other.

3. Gasoline is a common source of energy. Which sentence is **false** about gasoline?
   - Ⓐ It is most of the vehicles source of energy.
   - Ⓑ It has chemical energy that changes to kinetic energy.
   - Ⓒ It has sound energy.
   - Ⓓ It burns to release energy.

4. Sara knows that conduction is a form of heat energy transfer. Which transfer of heat energy is made through conduction?
   - Ⓐ hand heats a snowball
   - Ⓑ radiator warms a home
   - Ⓒ boiling water heats pasta
   - Ⓓ sun warms a greenhouse

5. Objects can have potential energy because of their position. Which object has potential energy?
   - Ⓐ a parked car idling
   - Ⓑ a rocket on its way to space
   - Ⓒ a spinning top on the floor
   - Ⓓ a mango hanging from a branch

6 Jad plugs a radio into an electrical outlet and turns it on. What change in energy takes place when he does this?

- (A) Light energy changes into sound energy.
- (B) Electrical energy changes into sound energy.
- (C) Sound energy changes into electrical energy.
- (D) Chemical energy changes into sound energy.

7 What type of energy change takes place as an airplane burns fuel to take off?

- (A) electrical energy to light energy
- (B) kinetic energy to potential energy
- (C) chemical energy to kinetic energy
- (D) mechanical energy to kinetic energy

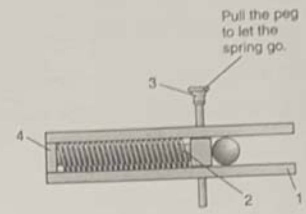
8 Which form of energy results from vibrations that travel through air?

- (A) sound energy
- (B) potential energy
- (C) electrical energy
- (D) chemical energy

9 Ali and his family sit around a campfire. What provides energy to keep the fire going?

- (A) flames
- (B) heat
- (C) matchstick
- (D) wood

10 Look at the picture below.

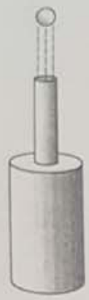


If the spring is squeezed to half its length in the picture, what effect will that have on the ball?

- (A) The ball will create more energy.
- (B) The ball's kinetic energy will decrease.
- (C) The ball's potential energy will increase.
- (D) The ball's potential energy will decrease.

Name ______________________ Date ______________________ **Unit 9**

11 During an experiment, Aya uses a piece of equipment to send a ball into the air. The picture below shows Aya's equipment. It shows how the ball travels.



What type of energy will the ball have just before it comes down?

(A) electrical
(B) kinetic
(C) magnetic
(D) potential

12 Youssef has a pogo stick. When he jumps on it, the spring squeezes toward the ground and then moves back to its starting position. What type of energy does the pogo stick have as Youssef plays on it?

(A) chemical energy
(B) electrical energy
(C) magnetic energy
(D) mechanical energy

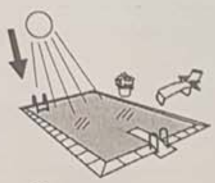
13 On a warm sunny day, a lizard sits on a rock. Which word explains why the lizard feels heat from the sun?

(A) convection
(B) friction
(C) gravity
(D) radiation

14 Jad recorded the average temperatures in Beirut, for four months from February through May. Which is **most likely** the temperature for February, knowing that February is the coldest?

(A) 19° C
(B) 25° C
(C) 21° C
(D) 16° C

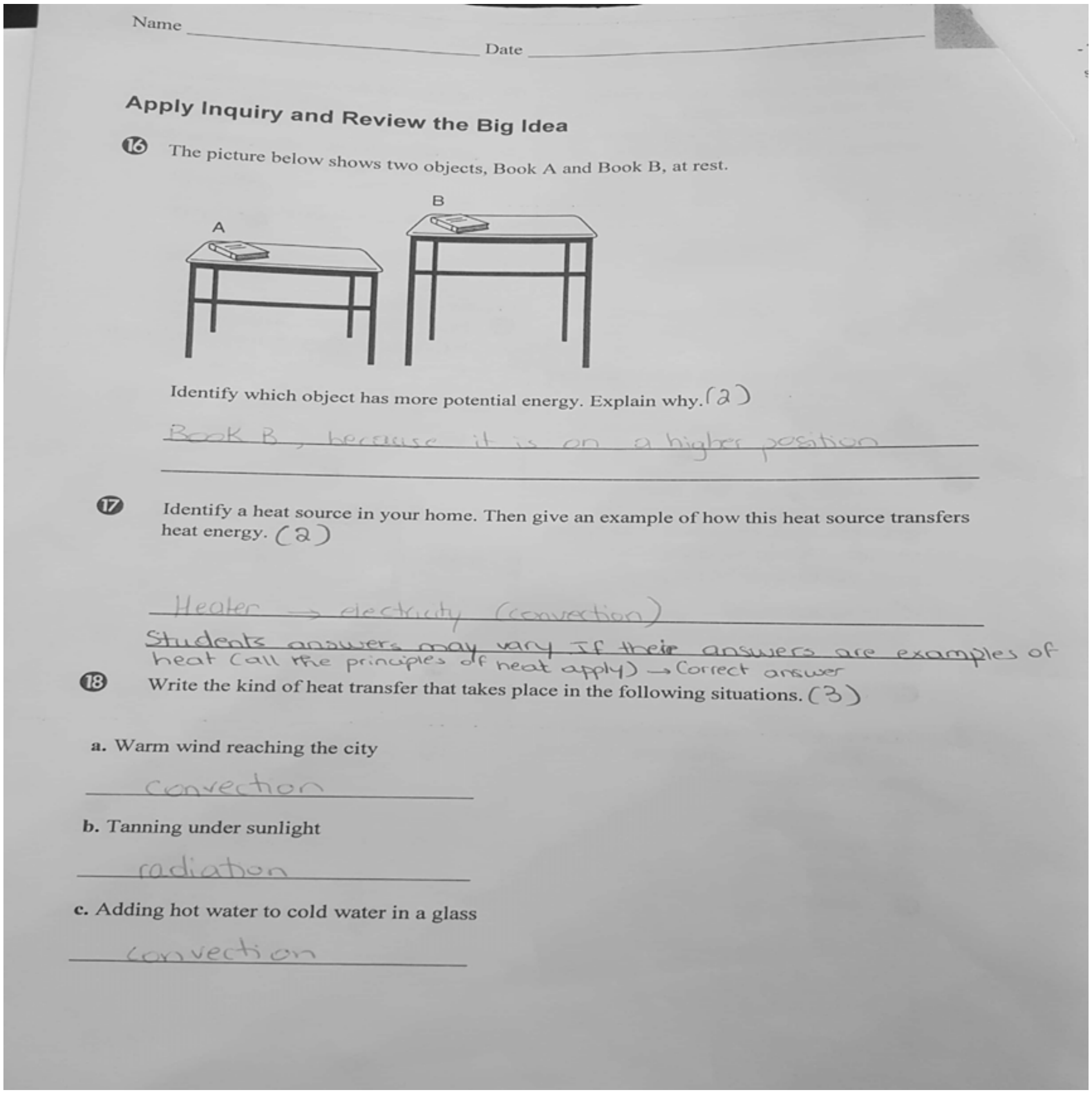
15 Each picture shows a source of heat. Which picture shows heat transfer through convection?

(A)


(B)


(C)


(D)

Name ______________________ Date ______________________

Apply Inquiry and Review the Big Idea

16 The picture below shows two objects, Book A and Book B, at rest.

Identify which object has more potential energy. Explain why. (2)

Book B, because it is on a higher position

17 Identify a heat source in your home. Then give an example of how this heat source transfers heat energy. (2)

Heater → electricity (convection)

Students answers may vary. If their answers are examples of heat (all the principles of heat apply) → Correct answer

18 Write the kind of heat transfer that takes place in the following situations. (3)

a. Warm wind reaching the city

convection

b. Tanning under sunlight

radiation

c. Adding hot water to cold water in a glass

convection

Name ______ Date ______

Unit 9

⑲ Describe an example of an object where its potential energy changes to kinetic energy. (3)

Students' answers may varry.

Example: Ball sitting at the edge of the desk. When we throw it down, potential energy will change into Kinetic energy.

APPENDIX X

CODES FOR WRITING CHALLENGES

Code	Description	Example
Generating	Challenges in generating ideas	"Miss I don't have anything more to say"
Evaluating	Challenges in evaluating the quality of the writing	-
Revising	Challenges in the revision process	-
Structuring	Challenges in structuring the writing	-
Translating thoughts to written text	Challenges in rendering one's ideas in the conventions of written English	"If the bow was fully … because the more pressure … I don't know how to write pressure it is with an 'e' and two's'"
Hesitating	Challenges in lacking confidence and hesitating in articulating their thoughts	"So if I euh euh… if I pulled the arrow the arrow more harder the arrows will go wider will go wider because it is stori storing more potential energy"
Translating from native language to Arabic	Challenges in translating from their native language of Arabic to the language of instruction, English.	"I think eno (I mean) I think eno (I mean) the arrow will travel longer distance when it is fully because bikoon fi more potential in it. Bs tetreka lal arrow the arrow will go when you throw it bikoon fi more kinetic and when it is falling."

Source Modified from: Beck, S. W., Llosa, L., & Fredrick, T. (2013). The challenges of writing exposition: lessons from a study of ELL and Non-ELL high school students. *Reading & Writing Quarterly*, *29*(4)

APPENDIX XI

DETAILED RESULT OF THE ASSUMPTIONS

For each aspect of the expository writing, an ANCOVA was run and the following assumptions were checked and were found to be met: there was a continuous dependent variable and covariate variable, the independent variable was categorical with two independent groups

Claims

-The normality of conceptual knowledge post-test was not met across the control and experimental groups as revealed by the Shapiro-Wilk test; W (19) = 0.75, $p< .001$, *ns,* W (16) = 0.40, $p< .001$, *ns* respectively.

- The homogeneity of variance assumption was not met as indicated by the Levene's Test; F (1, 33) = 14.35, p = .001, *ns*.

However, since ANCOVA F-test is robust to the violation of normality and homogeneity of variances, the analysis could be carried out.

- There were no outliers in the data, as no cases with standardized residuals greater than ±3 standard deviations were found.

- The independence of covariate and treatment effect assumption was met; F (1, 33) = 0.05, p = .82, *ns*

- The homogeneity of regression slopes assumption was met; F (1, 31) = 0.07, p = .79, *ns.*

Support

- The normality of conceptual knowledge post-test was not met across the control and experimental groups as revealed by the Shapiro-Wilk test; W (19) = 0.52, $p< .001$, *ns,* W (16) = 0.27, $p< .001$, *ns* respectively.

- The homogeneity of variance assumption was not met as indicated by the Levene's Test; F (1, 33) = 5.22, p = .029, *ns*.

However, since ANCOVA F-test is robust to the violation of normality and homogeneity of variances, the analysis could be carried out.

- There were no outliers in the data, as no cases with standardized residuals greater than ±3 standard deviations were found.

- The independence of covariate and treatment effect assumption was met; *F* (1, 33) = 3.52, *p* = .07, *ns*

- The homogeneity of regression slopes assumption was not met; *F* (1, 31) = 9.68, *p* = .004, *ns*.

Reason

- The normality of conceptual knowledge post-test was not met across the control and experimental groups as revealed by the Shapiro-Wilk test; *W* (19) = 0.79, *p*= .001, *ns, W* (16) = 0.86, *p*= .018, *ns* respectively.

However, since ANCOVA F-test is robust to the violation of normality, the analysis could be carried out.

- The homogeneity of variance assumption was met as indicated by the Levene's Test; *F* (1, 33) = 2.34, *p* = .14, *ns*.

- There were no outliers in the data, as no cases with standardized residuals greater than ±3 standard deviations were found.

- The independence of covariate and treatment effect assumption was met; *F* (1, 33) = 1.14, *p* = .29, *ns*

- The homogeneity of regression slopes assumption was met; *F* (1, 31) = 0.10, *p* = .75, *ns*.

Academic Vocabulary

- The normality of conceptual knowledge post-test was not met across the control and experimental groups as revealed by the Shapiro-Wilk test; *W* (19) = 0.81, *p*=.002, *ns, W* (16) = 0.55, *p*< .001, *ns* respectively.

- The homogeneity of variance assumption was not met as indicated by the Levene's Test; *F* (1, 33) = 5.36, *p* = .027, *ns*.

However, since ANCOVA F-test is robust to the violation of normality and homogeneity of variances, the analysis could be carried out.

- There were no outliers in the data, as no cases with standardized residuals greater than ±3 standard deviations were found.

- The independence of covariate and treatment effect assumption was met; *F* (1, 33) = 2.35, *p* = .14, *ns*

- The homogeneity of regression slopes assumption was met; *F* (1, 31) = 0.33, *p* = .57, *ns.*

<u>Conventions/ Organization</u>

- The normality of conceptual knowledge post-test was not met across the control and experimental groups as revealed by the Shapiro-Wilk test; *W* (19) = 0.74, *p*< .001*, ns, W* (16) = 0.81, *p*= .004, *ns* respectively.

However, since ANCOVA F-test is robust to the violation of normality, the analysis could be carried out.

- The homogeneity of variance assumption was met as indicated by the Levene's Test; *F* (1, 33) = 0.22, *p* = .64, *ns*.

- There were no outliers in the data, as no cases with standardized residuals greater than ±3 standard deviations were found.

- The independence of covariate and treatment effect assumption was met; *F* (1, 33) = 0.26, *p* = .61, *ns*

- The homogeneity of regression slopes assumption was met; *F* (1, 31) = 2.41, *p* = .13, *ns.*

<u>Linguistic Features</u>

- The normality of conceptual knowledge post-test was not met across the control and experimental groups as revealed by the Shapiro-Wilk test; *W* (19) = 0.36, *p*< .001*, ns, W* (16) = 0.77, *p*= .001, *ns* respectively.

- The homogeneity of variance assumption was not met as indicated by the Levene's Test; *F* (1, 33) = 69.13, *p*< .001, *ns*.

However, since ANCOVA F-test is robust to the violation of normality and homogeneity of variances, the analysis could be carried out.

- There were no outliers in the data, as no cases with standardized residuals greater than ±3 standard deviations were found.

- The independence of covariate and treatment effect assumption was met; *F* (1, 33) = 0.28, *p* = .60, *ns*

- The homogeneity of regression slopes assumption was met; *F* (1, 31) = 0.03, *p* = .87, *ns.*

<u>Concluding Statement</u>

- The normality of conceptual knowledge post-test was not met across the control and experimental groups as revealed by the Shapiro-Wilk test; W (19) = 0.47, p< .001, *ns*, W (16) = 0.78, p= .002, *ns* respectively.

- The homogeneity of variance assumption was not met as indicated by the Levene's Test; F (1, 33) = 5.79, p= .022, *ns*.

However, since ANCOVA F-test is robust to the violation of normality and homogeneity of variances, the analysis could be carried out.

- There were no outliers in the data, as no cases with standardized residuals greater than ±3 standard deviations were found.

- The independence of covariate and treatment effect assumption was met; F (1, 33) = 0.63, p = .43, *ns*

- The homogeneity of regression slopes assumption was met; F (1, 31) = 0.50, p = .48, *ns.*

Overall Writing

- The normality of conceptual knowledge post-test was met across the control and experimental groups as revealed by the Shapiro-Wilk test; W (19) = 0.55, p= .44, *ns*, W (16) = 0.90, p= .08, *ns* respectively.

- The homogeneity of variance assumption was met as indicated by the Levene's Test; F (1, 33) = 2.90, p= .10, *ns*.

- There were no outliers in the data, as no cases with standardized residuals greater than ±3 standard deviations were found.

- The independence of covariate and treatment effect assumption was met; F (1, 33) = 1.29, p = .26, *ns*

- The homogeneity of regression slopes assumption was met; F (1, 31) = 1.00, p = .32, *ns*

APPENDIX XII

GRAPHIC ORGANIZER

Claim (take a position)
Evidence (relevant observations)
Reasoning (connect evidence to claim)
Conclusion (reinforcement of the claim)

Unit 9: Energy

Science Fusion

Here's Why The best waves have a lot of energy. Surfers use the energy from these waves to get a nice, long ride to shore.

In this unit, you will explore the Big Idea, the Essential Questions, and the Investigations on the Inquiry Flipchart.

Levels of Inquiry Key ■ DIRECTED ■ GUIDED ■ INDEPENDENT

Track Your Progress

Big Idea Heat is a form of energy that can be transferred between objects.

Essential Questions

Science Notebook

Before you begin each lesson, be sure to write your thoughts about the Essential Question.

428 Unit 9

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