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Integration of explicit vocabulary instruction in teaching Science

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Abstract

Reading comprehension is an essential interdisciplinary skill that serves as a foundation of all other subject areas. In science, as a subject rich in vocabulary words, the learner's ability to read and comprehend to generate a conceptual understanding cannot be set aside. Thus, integrating literacy strategies such as vocabulary instruction strategies in teaching the subject is of great help to the learners. This quasi-experimental research determined the effect of integrating explicit vocabulary instruction strategy in the conceptual understanding of students in science. Forty-four students served as participants in this research. Inquiry-based approach, particularly the Engage, Explore, Explain, Elaborate, and Evaluate Learning Cycle (5 E's) was utilized in teaching the control group. While in the experimental group, the same strategy was employed, but with the integration of vocabulary instruction strategies. T-test was used in determining the significant difference in the performances of the two groups. The findings reveal that the students who were taught with the integration of explicit vocabulary instruction strategy performed better than the students who did not undergo vocabulary instruction. This suggests that the integration of the explicit vocabulary instruction strategy in teaching science enhances the conceptual understanding of the students in the subject. Thus, it is recommended that science teachers who are trained as content specialists should consider integrating explicit vocabulary instruction strategies in teaching to address the literacy needs of the students.

Keywords: 5 E's learning cycle, Frayer model, inquiry-based teaching, reading comprehension, science performance, vocabulary instruction, wordlist

Introduction

Reading comprehension as one component of literacy is an important interdisciplinary skill that serves as the foundation of all other subject areas. In science for instance, as a disciplinary subject that deals with abundant vocabulary words, the learners' ability to read and comprehend to generate a conceptual understanding cannot be set aside (Marchand-Martella, Martella, Modderman, Petersen, & Pan, 2013). Nevertheless, studies conducted revealed that poor reading comprehension among today's learners has been a global concern ("PISA 2018 National Report of the Philippines", 2019; Kissau & Hiller, 2013). In the Philippines, the result of the 2018 Programme for International Student Assessment (PISA) showed that Filipino learners were the poorest in terms of English reading comprehension among the 79 countries that participated. Likewise, the same test also revealed that Filipino learners' performance in science has greatly declined ("PISA 2018 National Report of the Philippines", 2019). Studies revealed that this poor performance in science could be associated with a lot of factors which include learner's poor reading comprehension (Nyarko, Kugbey, Kofi, Cole, & Adentwi, 2018; Akbaşlı, Şahin & Yaykiran, 2016; Imam, Mastura, Jamil, & Isamail, 2014). The great deal of unfamiliar terms, domain-specific and non-technical terminologies that the students encounter in science texts and discussions post a major comprehension barrier that affects their ability to generate conceptual understanding in the subject and as well as their ability to successfully participate in the class discussions (Jones, 2018; Wellington & Osborne, 2001). Thus, science teachers who are trained as content specialists should integrate literacy strategies such as vocabulary instruction strategies in teaching content areas to address the literacy needs of the learners.

The role of vocabulary in conceptual understanding

Employing literacy strategies in teaching content areas like science is greatly linked to students' ability to attain success in the subject (Ayodele, 2017). Vocabulary instruction for instance as a literacy strategy is a great way of helping students generate conceptual understanding of the topic being discussed which leads to a high level of achievement in the subject (Ayodele, 2017; Gillis, 2014; Beck, McKeown & Kucan, 2013). Vocabulary refers to all the words that a student needs to unlock the meaning to express his or her thoughts, communicate effectively, and form new concepts (Sedita, 2005). It plays an important role in reading and reading comprehension (Saygili, 2017) and a key factor in the students' ability to understand a certain concept (Sidek & Rahim, 2015). A student who is unfamiliar with the different words or terminologies found in the text being read most likely unable to comprehend what he or she reads, while a learner who knows the meaning of the words he or she encounters while reading the text is found to have a greater understanding of what he or she reads (Kameli & Baki, 2013).

Knowledge of vocabulary is greatly related to students' academic success because a student who has rich vocabulary words can grasp new concepts more quickly as compared to those who have limited vocabulary words (Ayodele, 2017; Gillis, 2014). The words found on the text represent the contents and concepts a student needs to grasp to develop a conceptual understanding of the text being read; therefore, having limited knowledge of the meaning of these words leads to difficulty in comprehending the text, makes them unable to connect what they are reading to their pre-existing knowledge and limits their ability to make inferences and reasoning ability (Rupley, Nichols, Mraz & Blair, 2012). Although learning science and literacy are long viewed to be entirely different arenas, recent studies have recognized the increasing importance of the role of language for students to communicate their ideas and develop a scientific understanding ("Developing Language in

the Context of Science," 2015). While proficiency in vocabulary is vital for every subject, its effects on enhancing students' learning are more evident in content areas such as science (Cohen, 2012). Hence, employing literacy strategies in teaching such as vocabulary instruction strategies becomes an important aspect of all content areas that are rich in vocabulary words (Fenty & Brydon, 2017).

Explicit vocabulary instruction

Vocabulary instruction refers to the different strategies which primarily involve teaching the meaning of an unfamiliar word directly or indirectly (Sedita, 2005). Direct or explicit vocabulary instruction refers to teaching specific words and their meanings intentionally, usually done before the start of the reading session while indirect vocabulary instruction involves students' learning words and their meanings through hearing conversations and independent reading ("What Components Comprise High-quality Reading Instruction?"n.d.). Explicit vocabulary instruction is usually done incidentally by teachers which happens when a student encountered an unfamiliar word in the text and they are redirected to the glossary or dictionary for the definition of the unfamiliar word, however, this strategy does not lead to much learning of the word (Moore, n.d.).

Cervetti, Hiebert, Pearson, and McClung (2015) mentioned that for vocabulary instruction to be effective, the students must have an encounter with the unfamiliar words in various modalities such as in reading, writing, speaking, and listening. It was also mentioned that the unfamiliar words must be learned by the students in a meaningful context and must be used in performing their investigations such as in writing investigation reports and in communicating the results of their inquiry. Furthermore, vocabulary instructions become effective when learners are provided with different strategies that allow them to create a mental picture that represents the meaning of the words and connect prior knowledge with new knowledge. Therefore, teachers should utilize several explicit vocabulary instruction strategies inside the classroom such as contextual analysis, concept wheels, semantic word maps, webbing, semantic feature analysis, word relationship, and structural features of a word (Rupley et al., 2012), Frayer model map (Sullivan, 2014), concept definition map (Jones, 2018) graffiti wall and picture-word wall (Gallagher & Anderson, 2016).

Selecting the words for vocabulary instruction

Selecting the vocabulary words to teach is an important aspect of effective vocabulary instruction. Beck et al. (2013) introduced a framework known as the Three Tiers Framework which will guide teachers in selecting the words to be included in vocabulary instruction. In this framework, there are three levels of vocabulary words namely Tier 1, Tier 2, and Tier 3. Tier 1 vocabulary words are the highly frequent words that include commonly used words in daily conversations and not specific to a certain discipline. Tier 2 vocabulary words are the general academic words that are rarely used in conversation and commonly found in written texts. On the other hand, Tier 3 words are those words considered domain-specific which include scientific terms and mathematical terms. They further highlighted that teachers should emphasize selecting Tier 2 words for vocabulary instruction.

Flanigan and Greenwod (2007) on the other hand classified vocabulary words into four levels namely: Level 1 or the critical "before" words, Level 2 or the "foot-in-the-door" words, Level 3 or the critical "after" words, and level 4 or the words not to be taught. They explained that words in level 1 are the words that represent new concepts or pre-known concepts that need to be reinforced and words that are vital to understanding the text and constructing meaning from it; therefore, it needs to be understood thoroughly and requires

more instructional time. Level 2 words on the other hand are the words that are also important to be learned before reading, however, they do not require a thorough explanation and therefore require only minimal instructional time. These words can be learned by simply giving its definition and synonyms. It was further explained that level 3 words are the words that the teacher thinks somehow essential for the students to know but not necessary before reading to successfully construct concepts while level 4 words are the words that no longer need to be taught. These are the words that the students probably already know, words that are not necessary for understanding the lesson, and words whose meanings are already found in the text.

Theoretical perspectives of vocabulary instruction

The primary goal of vocabulary instruction is to broaden and enhance students' reading comprehension and conceptual understanding of what they read. The RAND Reading Study Group (2002) as cited by Brevik (2019) described reading comprehension as a process that is influenced by the interaction of three factors namely text, reader, and context. This means that the readers' knowledge of the text and ability to construct meaning from his or her sociocultural context plays a crucial role in successful reading comprehension.

The use of vocabulary instruction strategies to improve comprehension is anchored on Schema Theory and Psycholinguistic Theories. Schema can be defined as the chunks of knowledge or information stored in the human brain which are organized together to represent knowledge about a certain concept. It also refers to the individual's previously acquired knowledge about certain objects, situations, and events (Zhao & Zhu, 2012). Schema can be classified into three: linguistic schema, content schema, and formal schema. Linguistic schema refers to the individual's lexical knowledge or understanding of the words and their uses. It includes knowledge of grammar, phonetics, and vocabulary. Content schema on the other hand refers to the individual's background knowledge that relates to a particular word which is often influenced by different factors such as previous experiences and cultural backgrounds. While formal schema refers to the background knowledge related to the genre and linguistic structure of the written text (Linyang, 2021; Zhao & Zhu, 2012).

According to Anderson (2013) as cited by Moody, Hu, Kuo, Jouhar, Xu, and Lee (2018), activating students' schema results to comprehension by allowing students to extract and combine their pre-existing knowledge and link them with the information found in the text, which helps in constructing meanings. Moreover, Geng (2020) cited that lack of the corresponding schema about the text and failure to use schema to explore meanings of text results in reading failures such as inability to read with comprehension. On the other hand, Psycholinguistic refers to the study of the cognitive or mental processes that are involved in the production, acquisition, and comprehension of language (Linyang, 2021). Similar to Schema Theory, the psycholinguistic point of view believe that comprehension is not just a result of the reader's lexical knowledge of the text but the interaction between the reader's mental representation of the text, conceptual abilities, cognitive processing strategies, and background knowledge.

Both Schema and Psycholinguistic theories explain how learners acquire the meaning of the text when they are being engaged in vocabulary instruction strategies such as using background knowledge to construct word meanings, giving word synonym and antonym, analyzing how words are formed based on their morphology, creating graphic organizers such as concept maps, semantic maps and Frayer model map (Moody et al., 2018).

Explicit vocabulary instruction integration in Science

Several studies have been already conducted which investigated the integration of explicit vocabulary instruction in science teaching. These studies include the study of Jones (2018) on the use of the Concept of Definition Word Map to Teach Science Vocabulary. In this study, the main objective of the researcher was to examine the efficacy of teaching science vocabulary using the concept of definition word map. Specifically, the researcher sought to determine its effect on students' vocabulary knowledge and how students used the concept of definition word map to support their understanding of content area texts and/or concepts. The findings of the study have proven that the students who used the concept of definition map showed greater success in understanding the lesson and exhibited a greater capacity to apply the knowledge they learned as compared to those who did not use the concept of definition map.

Another study was conducted by Stockton (2016) on the effect of explicit science vocabulary instruction on vocabulary acquisition. The main purpose of the researcher was to see if increasing the amount of vocabulary instruction to which the students will be exposed will have a positive impact on the student's ability to acquire new vocabulary words. The researchers utilized explicit vocabulary instruction strategies such as List-Group-Label, Word Maps, Compare and Contrast, Interactive Word Wall, and Frayer Model. The findings of the study revealed that the use of explicit science vocabulary instruction improved the students' performance on summative vocabulary assessment. However, the findings further revealed that the improvement in the performance of the students did not correlate with the increase in instruction.

In the study of Cohen (2012) on strengthening science vocabulary using imagery interventions with college students, the participants were subjected to four different interventions which include Word Only intervention, Picture Presentation Intervention, Image Creation-No Picture Intervention, and Image Creation-Picture Intervention. The overall findings of the study revealed that students who received the imagery creation group registered the highest scores. The researchers also saw a pattern that the deeper the student processed the words to be learned, the more that they acquire and retain the words.

Another study was conducted by Pittman (2018) on the use of engaging vocabulary instruction in the science classroom. The main aim of the study was to determine whether the use of T-charts as an interactive vocabulary instruction strategy would improve the students' test scores in science. The findings of the study revealed that the intervention was effective based on the improved result of the students' final test scores.

Science performance and reading comprehension of Filipino students

Over the past years, several efforts have been made by the Philippine Department of Education (DepEd) to stride the quality of science education in the country. Nonetheless, despite the various efforts to uplift the science achievement of the students, the recently conducted international assessment revealed that the level of performance of Filipinos in science is still below the international standards. This poor performance was shown in the result of PISA 2018 wherein the Philippines placed 2nd to the last in terms of scientific literacy among all the 79 participating countries worldwide ("PISA 2018 National Report of the Philippines", 2019). In addition, the results of the National Achievement Test for the school year 2017-2018 revealed that the national mean percentage score of students in science is still among the lowest. While in Central Luzon, the Philippines, the Division of Mabalacat City ranks 10 and 16 out of 20 schools' division for junior high school and senior high school respectively in terms of mean percentage score in science (City of San

Fernando, Pampanga-City Information Office [CSFP-CIO], 2019). These are clear indicators that a gap between the students' performance and desired quality of science education in the country still exists despite various initiatives of the education sector.

Studies revealed that science performance is linked to learners' reading proficiency (Nyarko, et al., 2018; Akbaşlı et al., 2016). Jones (2018) noted that the great deal of vocabulary words in science text and during science discussions is one of the factors that hinder learners to comprehend what they are reading, thus, become major barriers for generating conceptual understanding which eventually leads to low performance. Although the country's education department promotes "every child is an independent reader" advocacy through intensifying reading programs in every school across the country, still poor reading comprehension appears to be a common problem among Filipino learners across all levels of education. The results of the 2018 PISA revealed that Filipino learners were the poorest in terms of reading comprehension among the 79 participating countries ("PISA 2018 National Report of the Philippines", 2019).

This poor reading comprehension was also revealed in some local studies such as the study of Cabasan (2011) on the reading comprehension of freshman education students which showed that among the 33 participants, only two learners were able to read independently with comprehension and more than half of the participants were categorized as struggling readers. Furthermore, the study conducted by Cabardo (2015), as cited by Bilbao, Donguila, and Vasay (2016) on the reading proficiency level of high school students in one school in the country, indicated that majority of the students belong to frustration level or those who cannot read and comprehend on their own in when it comes to silent reading, and categorized as instructional readers or those students who can read and comprehend with the help of others when it comes to oral reading. In the study conducted by Imam et al. (2014) on the reading comprehension skills and performance in science among high school students in the Philippines, the overall reading comprehension of students was found to be at a low mastery level. The findings further revealed that the reading skills of the learners such as understanding vocabulary are positively correlated with the learners' science performance. It can be ascertained from these research findings that Filipino learners' poor reading comprehension ability needs to be addressed. This inspired the researcher to research integrating vocabulary instruction in teaching science lessons.

Inquiry-based teaching strategy using 5 E's learning cycle

In the Philippines, several efforts have been made by the Department of Education (DepEd) over the recent years to stride the quality of science education in the country. One of these efforts is the implementation of the K to 12 Curriculum in which the science education framework is transformed and designed gearing towards the development of critical thinking skill and science process skills among learners through the use of constructivist, learner-centered, and inquiry-based approach in teaching the subject (Montebon, 2014). Among the many strategies under the inquiry-based approach prescribed by the new curriculum is the Engage, Explore, Explain, Elaborate, and Evaluate (5 E's) learning Cycle because this strategy suits the nature of the 21st-century learners and enables them to generate a conceptual understanding of the subject through inquiry and investigations (Sen & Oskay, 2017; Abdi, 2014). The 5 E's learning cycle consists of five phases namely; engage, explore, explain, elaborate and evaluate is aligned in the constructivist point of view that learners are capable of constructing their learning through their experiences (Chola & Shumba, 2016). Madu and Amaechi (2012) expounded on each phase of the learning cycle. In the engage phase, the learners' attention is captured, and their prior knowledge is evaluated by the teacher while the exploration part allows learners to engage in an investigation to solve a

problem. In the explanation phase, the concepts identified by the learners in the exploration part will be reinforced through a discussion facilitated by the teacher for the learners to have an in-depth understanding of the concept while the elaboration part will allow the learners to apply the scientific concepts they learned to their daily lives. The last phase which is the evaluation part aims to assess learners' conceptual understanding and progress.

The fact is accepted that science is a subject that does not only require learners to perform investigations but also to do a content reading to gain a conceptual understanding of the topic being discussed. Learning science requires learners to deal with various terminologies wherein most of the time, unfamiliar to them. This great deal of unfamiliar words that the students encounter in science subjects could be one of the factors that affect their performance and interest in the subject. Knowledge of vocabulary is not only vital in learning language subjects, but its impact on enhancing students' conceptual understanding is also evident in content areas such as science. Because of the foregoing, this study was conceptualized. Although the integration of explicit vocabulary instruction strategies in teaching science has been examined already, most studies conducted focused on its effect on the science vocabulary acquisition of the learners and not on the possible impact of vocabulary instruction in enhancing the conceptual understanding of the learners in the subject, and no published studies were conducted in the Philippine context.

Research questions

The main objective of this study was to examine the impact of integrating explicit vocabulary instruction strategies in the conceptual understanding of learners in science. Specifically, the study sought answers to the following questions:

1. What is the pretest and posttest scores of the control and experimental group?
2. Is there a significant difference between the pretest and posttest scores within each group?
3. Is there a significant difference between the posttest scores of the control and experimental group?
4. Based on the findings of the study, did the integration of explicit vocabulary instruction strategies enhance the conceptual understanding of the students in science?

Methodology

Research design

This study employed quasi-experimental research with pretest and posttest design to determine the performance of the students in science with the integration of explicit vocabulary instruction strategies. The design was chosen because it allows a researcher to test the effect of manipulating the independent variable on another variable such as teaching strategies on the achievement of the students (Kibirige, Osodo, & Tlala, 2014). The independent variable in this study was the strategy utilized in teaching the two groups while the dependent variable was the conceptual understanding of the students. Inquiry-based approach, particularly the 5 E's learning cycle was utilized in teaching the control group. While in the experimental group, the same strategy was employed, but with the integration of vocabulary instruction strategies to determine its impact on the students' conceptual understanding.

Participants of the study

Forty-four (44) grade ten students from two intact heterogeneous classes of one public junior high school in the Division of Mabalacat City, wherein each class consists of 22 students were selected as the participants of this study. The two intact classes were assigned randomly as the control group and the experimental group. To ensure the validity of the study, some parameters were taken into consideration by the researcher in selecting the participants. First, the researcher ensured that both classes were a heterogeneous group. Second, the mean pretest score of the two groups was treated to assure that the two groups are statistically comparable before the intervention. Lastly, the two sections were exposed in the same classroom conditions taught by the same teacher. The only difference was that the experimental group have undergone vocabulary instruction before the actual teaching sessions. The study utilized non-probability sampling in selecting the participants. Particularly convenience intact group sampling was employed because it is cost and time-effective, considering the availability of the students during the conduct of the study.

Instrumentation

The main instrument utilized in this study was a 15-item multiple-choice test. It was used to determine the students' conceptual understanding of the subject matter before and after employing the intervention. For the posttest, the same set of questions was utilized but with a rearranged sequence of item numbers. In formulating the research instrument, the researcher adhered to the principles of assessment in test construction to ensure its validity. The procedures that were undertaken were as follows: firstly, the researcher mapped the learning competencies to be included in the test paper to ensure that all the competencies were anchored on the prescribed curriculum for Science Grade 10 for the fourth quarter under the K to 12 Enhanced Basic Education Curriculum or (EBEC). Secondly, the instrument was subjected to a face and content validation by three experts on the subject matter in the Division of Mabalacat City, and the comments and feedbacks of the validators were considered and incorporated in the revised version of the instrument. Upon the approval of the revised instrument, it was subjected to pilot testing by administering it to another class taking the same subject to further establish its reliability and validity. After the validity and reliability of the instrument have been established, the final copy of the test paper was drafted and was utilized in the actual conduct of the study. For the easy interpretation of the results, the mean raw scores of the students were interpreted as Outstanding (13-15); Very Satisfactory (10-12); Satisfactory (7-9); Fairly Satisfactory (4-6), and Poor (0-3).

Data gathering procedure

Upon the approval of the request to conduct the study by the proper authorities, an orientation was conducted among the participants and to their parents particularly on the objectives of the study and the ethical considerations to be undertaken in conducting the study. Informed consent and assent were also signed by the parents and students respectively. After the orientation, the standardized 15-item multiple-choice test was administered to measure students' conceptual understanding of the topic before the intervention. After administering the pretest, the control group was taught using the inquiry-based approach employing the 5E's learning cycle while the experimental group have undergone vocabulary instruction before the actual teaching sessions and was taught using the same inquiry-based strategy.

The 5'E's learning cycle is an inquiry-based strategy that consists of five steps namely: engage, explore, explain, elaborate, and evaluate. In the engage phase, the learners' attention is captured, and their prior knowledge is evaluated by the teacher while the exploration part allows learners to engage in an investigation to solve a problem. In the explanation phase, the concepts identified by the learners in the exploration part will be reinforced through a discussion facilitated by the teacher for the learners to have an in-depth understanding of the concept while the elaboration part will allow the learners to apply the scientific concepts they learned to their daily lives. The last phase which is the evaluation part aims to assess learners' conceptual understanding and progress (Madu & Amaechi, 2012).

The researcher utilized wordlist and Frayer model as explicit vocabulary instruction strategies as part of the unlocking of difficulties before the start of the lesson. A survey of vocabulary words was conducted before the actual teaching sessions to determine which words to be included in the vocabulary instruction. After the vocabulary words have been identified, the students were acquainted with the words by presenting them to the class, asking them to read each word aloud, and teaching them the correct spelling and pronunciation of each word. Next, the learners were tasked to create a wordlist and Frayer model for each word and they were asked to study them. In creating the wordlist, the students were first asked to list the unfamiliar words in a paper, then they were required to identify the meaning of each word, paste a picture or illustration beside every word that represents its meaning, write its synonyms, antonyms, and use it in a sentence. While in the Frayer model, the students were tasked to define the word, give its important characteristics, examples, and non-examples. After that, the students were given enough time to study the wordlists and Frayer model individually and within a group with the facilitation of the teacher. Finally, the students were given a test to determine how far their vocabulary acquisition has improved after the vocabulary instruction.

After the completion of the teaching sessions, a posttest was administered to the students. The scores of the participants in the pretest and posttest were recorded, tabulated, and analyzed using appropriate statistical tests.

Data analysis

All the data that were gathered were analyzed using the Statistical Package for Social Sciences (SPSS). Both descriptive and inferential statistics were applied in analyzing the results. Mean and standard deviation were used to quantify the scores of the students in the pretest and posttest while t-test was used in comparing the mean scores of the participants at a 0.05 level of significance. Specifically, the dependent sample t-test was used in determining the significant difference between the mean pretest and posttest scores within each group while the independent sample t-test was employed in determining the significant difference between the mean posttest scores of the experimental and control group.

Findings and discussion

Table 1 presents the pretest and posttest scores of the participants. In the pretest, the control group obtained a mean score of 6.00 which is interpreted as fairly satisfactory while the experimental group obtained a mean score of 6.29 which is also interpreted as fairly satisfactory. In the posttest, the table shows that the control group obtained a mean score of 11.00 which is interpreted as very satisfactory while the experimental group obtained a mean score of 12.05 which is also interpreted as very satisfactory. The results reveal that both groups got higher scores in the posttest.

Table 1. Mean and standard deviation of pretest and posttest scores of the two groups.

Group	Measure	Mean	SD	Interpretation
Control Group	Pretest	6.00	1.92	FS
	Posttest	11.00	1.87	VS
Experimental Group	Pretest	6.29	1.79	FS
	Posttest	12.05	1.07	VS

Legends:	*Numerical Rating*	*Descriptive Rating*
	13-15	*Outstanding (O)*
	10-12	*Very Satisfactory (VS)*
	7-9	*Satisfactory (S)*
	4-6	*Fairly Satisfactory (FS)*
	0-3	*Poor (P)*

From the pretest results, it was evident that both groups have almost the same mean pretest scores and have incurred a notable increase in their posttest scores. This suggests that before the intervention, the students in both groups have the same level of conceptual understanding about the topic at hand, and their level of knowledge improved after being taught using the inquiry-based 5 E's learning cycle as manifested in their performance in the posttests. This increase in the achievement scores proves that the use of inquiry-based strategy particularly the 5 E's learning cycle that allows learners to acquire conceptual understanding on their own through a hands-on learning experience, meaningful investigation, and discovery positively affected their performance in science. This finding is consistent with the finding of Abdi (2014) that the posttest scores of the participants improved after being taught using the 5 E's learning cycle. It was also evident from the results that the mean posttest score of the experimental group is quite higher as compared to the control group. This implies that the students who were subjected to vocabulary instruction acquired a better conceptual understanding of the topic. This finding supports the findings of Cohen (2012) that the participants' scores in science increased significantly with the integration of vocabulary instruction.

Table 2 shows the difference between the pretest and posttest scores within each group. The control group obtained a p-value of 0.000 at a 0.05 level of significance while the experimental group also obtained a p-value of 0.000 at 0.05 level of significance. As the results reveal, both groups obtained a p-value of less than 0.05 which means that there is a significant difference between the mean pretest and posttest scores of the control group and experimental group. This also means that the null hypothesis that there is no significant difference between the pretest and posttest scores of the control group and the experimental group is rejected.

Table 2. Difference between the mean pretest and posttest scores within each group.

Group	Measure	Mean	SD	Mean Difference	p-value	Remarks
Control Group	Pretest	6.00	1.92	5.00	0.000	Significant at 5 %
	Posttest	11.00	1.87			
Experimental Group	Pretest	6.29	1.79	5.76	0.000	Significant at 5 %
	Posttest	12.05	1.07			

The comparison between the mean pretest and posttest scores of the control group and experimental group revealed that there is a significant difference between the performance of the students within each group before and after the intervention. This finding

implies that the strategies employed in teaching the participants in both groups were effective in enhancing the conceptual understanding of the students in science as manifested in the statistical difference between their mean pretest and posttest scores. This improved performance can be associated with the fact that the students in both groups were taught using inquiry-based strategy, particularly the 5 E's learning strategy which engaged them in hands-on activities such as doing investigations, thus, allowing a thorough exploration of their pre-existing ideas about the topic and enabling them to reconstruct their knowledge and generate a better conceptual understanding of the topic (Sen & Oskay, 2017; Bybee, 2014). The findings further revealed that the experimental group obtained a higher mean posttest score. This performance can also be linked with the integration of vocabulary instruction which enabled learners to construct meanings of the unfamiliar words and improved their ability to comprehend, thus, helped them in grasping the concepts easily. This finding affirms the findings of the study of Kimberlin and Yezierski (2016) that inquiry-based approach is an effective strategy to improve students' conceptual understanding in chemistry and the findings of Pittman (2018) that integrating vocabulary instruction in science teaching enhances the performance of the learners.

Table 3 reveals the difference between the posttest scores of the experimental and control groups. It can be gleaned from the table that there is a difference of 1.05 in the posttest scores of the two groups with a p-value of 0.033 at a 0.05 level of significance. Since the p-value is less than 0.05, a significant difference between the mean posttest scores of the two groups can be concluded. This also means that the null hypothesis that there is no significant difference between the posttest scores of the control and experimental group is rejected.

Table 3. Difference between the mean posttest scores of the experimental and control group.

Variables	Mean	SD	Mean Difference	p-value	Remarks
Control vs. Experimental	11.00	1.87	1.05	0.033	Significant at 5%
	12.05	1.07			

In comparing the performance of the control and experimental group, it was revealed that the students in the experimental group obtained a higher mean posttest score than the students in the control group. It was further revealed that there is a statistical difference in their mean posttest scores. These findings denote that the students who were taught using the 5 E's learning cycle with the integration of explicit vocabulary instruction performed better than the students who were taught with the same strategy but did not undergo vocabulary instruction. This also means that the students who were subjected to vocabulary instruction before the actual teaching of the science concepts were able to construct a better conceptual understanding of the topic than that of those students who did not undergo vocabulary instruction.

It can be asserted from the findings that the integration of wordlist and Frayer model as explicit vocabulary instruction strategies were effective in improving the vocabulary acquisition of the learners. The result affirms the findings of Alashry, Qoura, and Gohar (2018) that the use of the Frayer model helps learners grasp new concepts easily and provides them with a deeper and complex understanding of the vocabulary word they encounter in the text by giving the meaning of the unfamiliar word as well as its important characteristics, examples, and non-examples. Moreover, the result coincides with the findings of Coşgun (2016) on the impact of using wordlists on students' vocabulary acquisition, that the use of wordlist integrated with other activities such as identifying which part of speech the word belongs, giving synonyms and antonyms of the word, and using

them in sentences enhances the vocabulary acquisition of the learners and develops among learners the habit of identifying which words should be unlocked before the course discussion, thus, allows them to give more focus and in-depth processing on learning the vocabulary words.

Furthermore, it can be deduced from the results that the students' improved knowledge of vocabulary words enhanced their comprehension skills which helped them to successfully grasp the ideas or concepts in the text, thus, positively impacting their conceptual understanding of the subject. This finding is in line with the finding of Rupley et al. (2012) that every word that the learner encounter in the text represents the concepts that they need to grasp to comprehend what they are reading, therefore, understanding the meaning of these words through vocabulary instructions activates their background knowledge and enhances their ability to make connections, meanings, and inferences which eventually help them construct a better conceptual understanding. It also supports Schema Theory which suggests that activating students' schema results in comprehension since it enables learners to extract and combine their pre-existing knowledge and connect them with the information found in the text to construct meanings (Moody et al., 2018), and the psycholinguistic point of view that comprehension is not just a result of the reader's understanding of the words and their uses but also a result of the interaction between the reader's mental representation of the text, conceptual abilities, cognitive processing strategies and background knowledge (Linyang, 2021).

Lastly, it can be ascertained that the integration of vocabulary instruction strategy in teaching science enhanced the learners' conceptual understanding of the topic. This finding supports the finding of Jones (2018) that the integration of vocabulary instruction strategy in teaching science is effective in enhancing the students' conceptual understanding of the subject since it lessens the comprehension barriers they experience brought by the unfamiliar terms they encounter in the text. Furthermore, the findings also support the findings of Ayodele (2017) and Gillis (2014) that knowledge of vocabulary is greatly related to students' academic success because a student who has rich vocabulary words can grasp new concepts more quickly as compared to those who have limited vocabulary words and the findings of Sidek and Rahim (2015) that vocabulary is a key factor in the students' ability to understand a certain concept.

Conclusions and recommendations

Based on the findings of the study, the following conclusions were drawn: First, both groups obtained a low mean score in the pretest. This suggested that the students in both groups have limited knowledge and the same level of conceptual understanding before the intervention. Second, there was a significant difference between the pretest and posttest scores of the control group and the experimental group. This revealed that the inquiry-based approach, particularly the 5 E's learning cycle and the integration of vocabulary instruction were effective in enhancing the performance of the students in science. Finally, there was a significant difference in the mean posttest scores of the two groups and the students who were taught using the inquiry-based approach 5 E's learning cycle with the integration of wordlist and Frayer model as explicit vocabulary instruction strategies performed better than the students who did not undergo vocabulary instruction. This indicates that the integration of explicit vocabulary instruction in teaching science was effective in enhancing the conceptual understanding of the students.

It is a wrong notion that vocabulary instruction is only applicable in teaching language subjects such as English. Although learning science and literacy are long viewed to be entirely different arenas, the findings of this study recognize the increasing significance

of the role of language for students to communicate their ideas and develop a scientific understanding. Unlocking comprehension difficulty through vocabulary instruction before the start of the discussion is an essential activity that every teacher should not neglect especially in teaching content areas that are rich in vocabulary words such as science subject. Given the findings drawn from this research, science teachers who are trained as content specialists should consider integrating explicit vocabulary instruction strategies in their science teaching to address the literacy needs of their students and to help improve their performance in the subject. They may also explore the use of other explicit vocabulary instruction strategies in teaching science concepts to test which vocabulary instruction strategy suits their students. Vocabulary instruction can also be included by science teachers in conducting remedial classes for their students.

Since the present study only utilized the Frayer model and wordlist as vocabulary instruction strategies, a similar study should also be conducted with a focus on integrating other explicit vocabulary instruction strategies. Moreover, the present study is purely quantitative, thus, it does not incorporate the thoughts, opinions, and perceptions of the participants. Therefore, science teachers who wish to conduct the same study may also employ a mixed-method sequential explanatory research design to give an in-depth explanation regarding the effectiveness of explicit vocabulary instruction strategy in enhancing the conceptual understanding of the students in science.

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