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Can Science Process Skills be a Teaching Method for Students Who are Not Native English Speakers?

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Abstract

English, spoken by many people around the world, has also become a language of communication with international validity. Therefore, millions of non-native English speakers (ELLs) are currently learning science in English. Teaching and learning science includes not only content of science, but also effective reading, writing, listening and note-taking strategies, as well as academic language functions necessary to participate in science learning. Therefore, ELLs are unlikely to be successful in science education. In this study, the difficulties faced by ELLs in learning scientific knowledge will be revealed and it will be discussed whether teaching with Science Process Skills (SPSs) is an alternative teaching model for ELLs. As a result, it is suggested that ELLs who do not understand scientific concepts and terms, therefore cannot participate in scientific discussions, and are hesitant to ask questions to the teacher.

Keywords: Science Process Skills, ELLs, Science Teaching

Introduction

The main purpose of science education is to explain the science concepts that students encounter in everyday life and to make the scientific knowledge understandable to all students including traditionally lagged behind majority culture students such as immigrants (American Association for the Advancement of Science [AAAS], 1989, 1993; National Research Council [NRC], 1996).

However, science teaching in English is unlikely to be unsuccessful and is likely to have a negative impact on English Language Learners (ELLs). ELLs are "students whose first primary and native language is not English and who are learning all subjects in English at school" (Diaz-Rico, 2012). ELLs students who learn all subjects in English can be divided into two groups:

1. Students who immigrated to another country and have to learn the language of that country. An example of this group is those who emigrated to English speaking countries such as Canada, America. For example, students from different

backgrounds have now reached a noticeable population within the school-age population in the United States (Au & Raphael, 2000). Current classrooms in USA schools have the number of school-age children (ages 5–17) who spoke English as a second language rose from 4.7 to 11.2 million between 1989 and 2009 (National Center for Education Statistics, 2011).

2. Since English is the language of science, some states provide education in the English language in their schools, although English is not their native language. An example of this group is Malaysians. The Malaysian Ministry of Education has implemented the use of English as a medium of education at the primary school level since 2003 (Sulaiman, Hassan, & Baki, 2009).

There still are not enough studies exploring what works with ELLs (August & Shanahan, 2010). For this reason, there is a need for studies on how to meet language learning and science literacy needs in the same class consisting of students with different cultures, skills and capacities.

The Learning Environment of ELS Students

Since there are many specific terms and concepts in science or other courses, it is likely that ELLs will encounter some difficulties when learning. Therefore, many ELLs do not have access to rigorous and in-depth training (Sulaiman, Hassan, & Baki, 2009). Wellington and Osborne (2001) indicated that language has a role in mediating the content of science. It is alarming that students are beginning to lose interest and confidence in learning science due to lack of comprehending what teachers say. Often, instead of teaching high-quality subject content to ELLs students, remedial teaching programs are reduced to the acquisition of students' basic literacy skills and the improvement of students' English proficiency levels (Stoddart et al., 2011).

English proficiency will negatively affect ELLs' ability to communicate through the process of teaching and learning, as well as their understanding of the subject and concepts. Students moving into secondary school are faced with complex language patterns to explain science content. This problem is more difficult for ELLs who have to deal with increasing abstract content while doing this in a second language (Buxton et al., 2013). For example, the 2005 National Assessment of Educational Progress (NAEP) showed that there was an average difference of 48 points in science scores between ELLs and native English speakers: only 28% of fourth-grade ELLs scored at or above the basic level of science, while more than twice that number (71%) of native English speakers have reached this level of achievement (NAEP, 2005). In the process of teaching and learning, it is also necessary to take into account the level of English proficiency and language acquisition of students.

An interesting aspect of the topic is that since teachers witness that ELLs speak

fluent English with other students, they may not realize that they sometimes don't understand specific terms and science concepts. Although the development of conversational English takes 1-3 years, it is not clear that these students need help developing science literacy skills.

McNeil (2010) stated that ELLs showed apprehension about answering questions in settings where native-speakers were present. In summary, there is a reciprocal relationship between language and literacy learning, and this relationship is synergistic (Stoddart et al., 2002). It is certain that ELLs will face great difficulties in reading, writing or speaking certain terms of course (Carrier, 2005).

Science Education Objectives and Science Process Skills

The purpose of science education is that each individual should be able to (a) demonstrate the basic skills of common total literacy, (b) "find, ask, or determine answers to questions derived from curiosity about everyday experiences"; (c) "explain, identify, and predict natural phenomena"; and (d) "read articles about science with understanding", (g) evaluate arguments based on scientific evidence (Vieira & Tenreiro-Vieira, 2016).

Science education also develops students' scientific literacy, which is a critical stance (Hackling, Goodrum, & Rennie 2001). NRC (1996) defined scientific literacy as "knowledge and understanding of scientific concepts and processes necessary for personal decision-making, participation in scientific and cultural affairs, and economic efficiency" (p. 22). Therefore, the aim of science education is not only to inform students about scientific facts and concepts, but also to raise awareness about the benefits of using scientific thinking in the personal and public sphere (Kumar & Singh, 2018).

As can be seen from the goals of scientific literacy, science courses not only include the vocabulary of science, but also the academic language functions necessary to participate in science learning (Carrier, 2005). Through the use of language functions such as description, explanation and discussion in inquiry science, students develop their conceptual understanding (Stoddart et al., 2002). The fact that students use language functions while developing their conceptual understanding is an issue that needs to be focused on for science educators. Therefore, students need environments that enable both the use of concepts and the development of language skills.

Science texts are an especially powerful context for learning languages and literacy because learning science includes language activities that are clearly linked to processes, objects, visual representations, hands-on experimentation, and naturally occurring events in the environment (Stoddart et al., 2002).

The Importance of Teachers in Effective Science Learning

ELLs are required to be proficient in English before starting science teaching.

However, this is problematic, because it may take up to seven years for a foreign student to achieve a level of language proficiency comparable to that of a native English speaker (Stoddart et al., 2010). In order for teachers to effectively meet the science learning requirements of ELLs, they must support the language development of students and gain the necessary knowledge and practice for this purpose.

Teachers need to consider how the learning challenges of students who are English language learners differ from native English speakers in our science classrooms. In 2007, a survey of graduate teachers from California State University, which trained 60% of California teachers, revealed that more than 70% of teachers do not want to teach English Learners (CSU Office of the Chancellor, 2008). Gandara, Maxwell-Jolly and Driscoll (2005) stated that one of the main concerns of teachers was the lack of knowledge and skills in teaching subjects to non-native speakers of English.

The ESL teacher can help ELLs to improve not only English language proficiency, but also science literacy skills. Therefore, ELLs teacher needs to know not only the basic science vocabulary but also the language structures needed (Carrier, 2005; Garza & Cavazos, 2020). Teachers in the language classroom can provide their students with opportunities for scientific thinking and reasoning by using science process skills as tools for learning and applying ESL strategies that facilitate the use of academic language for science inquiry and literacy.

The current science education reform highlights three main areas of knowledge and practice necessary for teachers to conduct effective science teaching (NRC, 2007): (a) Teachers' mastery of the content of scientific topics. (b) Developing students' scientific understanding through various applications. (c) Encouraging students' scientific research through various applications. Teachers are allowed to customize learning experiences linked to language development and to connect with course topics. For this purpose, teachers encourage students to scientific research and facilitate applications to construct their own knowledge through inquiry (August & Shanahan, 2010).

Developing ELLs' Language Functions through Science Process Skills.

Akcay and Yager (2016) noted that many scientists work using some special process skills. How scientists think and work are important methods that should be applied to students in the learning process. This method used by scientists is called scientific process skills (SPSs).

SPSs is defined as identifying and trying to solve problems around individuals by equipping the information they have with the necessary skills. These skills are to observe qualities, measure quantities, sort and classify, inference, predict, experiment, and communicate (Vitti & Torres, 2006; Hirca, 2015).

Table 1: Science process skills

Science Process Skills	Description
Observing qualities	Using words to describe something or its details using the five senses.
Measuring quantities	To identify an object using numbers by measuring different parts with a ruler, weighing them with a scale scale, and comparing objects using quantities.
Sorting and classifying	Categories are created and they are grouped into subgroups. (Eg. It's like putting red pencils in the first box and blue pencils in the second box.
Inference	Assumptions are generated. (What have you seen before that reminds you of this? Why do you think this is going to happen? I'm assuming it's an insect because it has six legs. When I saw the bugs before, they had six legs.)
Predicting	If I do this, this will happen.…How do we know what's going to happen? What are we going to do to find out what's going to happen?
Experimenting	I wonder what will happen if we do this? I'm guessing this would happen. But what should I do to find out if I am right or wrong? What materials will I need? What steps will I take (procedure)? What does it have to be for my prediction to be correct? How do I know if I'm wrong? How do I measure it? Isn't that my guess? If so, why? If not, why not?
Communicating	Sharing ideas through conversation and listening, drawing and tagging images, drawing and tagging graphics, and taking actions.

Source: Vitti and Torres (2006)

These goals are based on the specific content of science courses. They include not only vocabulary of science, but also effective reading, writing, listening and note-taking strategies, as well as academic language functions necessary to participate in science learning (Carrier, 2005). These practices require a rich vocabulary and knowledge of the language when it supports scientific knowledge (Lee, Quinn & Valdés, 2013). Therefore, to clarify meaning, ELLs must pay attention to vocabulary, check comprehension, and present ideas clearly both orally and in writing. They should also paraphrase their words and try to expand their explanation (August & Shanahan, 2010).

In recent years, there have been decisively increasing initiatives to improve the interactions between literacy and science education. This relationship gives researchers a new perspective on the meaning of scientific literacy, and divides the concept into the derived sense (to be knowledgeable, learned and educated in science) and the basic sense (to be able to read, write and reason with science content) (Phillips & Norris, 2009).

Amaral, Garrison and Klentschy (2002) developed a teaching module in a project. The aim of the module is to provide students with rich opportunities to be directly interested in both science content and SPSs development. In this module, a smaller number of scientific content is covered in more depth compared to the multitude of topics covered in a traditional textbook approach. In this unit-based model, each topic becomes a tool for the construction of important scientific concepts that are designed to be both developmentally appropriate and engage the natural curiosity of students. The results showed that the success of ELLs increased according to the number of years they participated in the project. In conclusion, they stated that the longer the students stayed in the program, the higher their scores were determined in science, writing, reading and mathematics.

Sulaiman, Hassan & Baki (2009) also conducted a study and the purposes of the study were: a) compare the students of Class 1 science that uses the English terminology of urban and rural areas in terms of their qualifications, and (b) to see whether 1 grade students' science, English, reading levels is the determination of science process skills in learning. The research findings show that there is a significant difference in communication skills, classification skills and observation skills between 1st grade students living in rural and urban areas.

For example, in Wilder and Shuttleworth's (2004) study on cell research, students were asked to hypothesize about the composition of a “blob” of material given to them. A possible literacy goal for this course is "I can use the correct vocabulary and sentence structures to make and justify my predictions." For this literacy goal, teachers can derive examples of sentence frames that students can use to achieve this goal, for example, "I think the blob consists of _____ because_____.” They can hang this sentence frame where students can see it in the classroom in their written and oral discussions and present it as they can apply. Teachers can model the use of the sentence framework both verbally and in writing, and ask students to do the same using a sample “blob"." Teachers can also read scientific language examples from texts, draw students' attention to these examples, write on the blackboard for students, and also model English pronunciations for ELLs.

Discussion and Conclusion

The number of students who are not native English speakers studying science in English is gradually increasing in the world. One group of them is students who immigrated to English-speaking countries such as Canada, America. The other group is countries which

teach science in English in their schools such as Malaysia. Although language has a role in delivering the content of science to students, these groups have difficulty understanding it. Therefore, these students begin to lose interest and confidence in learning science due to the fact that they cannot understand what the teachers are saying.

Language is a tool for transferring basic science concepts to other students. However, ELLs have difficulty in understanding the science concepts described by teachers. Moreover, although some ELLs can speak English with each other, they can't understand English scientific conversations. Therefore, since teachers have witnessed ELLs speaking fluent English with other students, they may sometimes not be aware that they do not understand certain terms and concepts of science.

Science courses include not only the vocabulary of science, but also the academic language skills such as effective reading, writing, listening and note-taking strategies, as well as academic language functions necessary to participate in science learning. For this reason, there is a need for methods and learning environments that will contribute to the development of language skills as well as students' learning science. Developing students' conceptual understanding by using language functions is an issue that needs to be emphasized for science educators. According to literature findings, SPSs encourage students to ask questions, observe, explore, explain, and engage in discussion with each other on specific issues. Students who are hesitant to ask questions to the teacher can reach a conclusion by communicating among themselves decisively. Students develop their conceptual understanding in inquiry science by using language functions such as estimation, explanation, and discussion.

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