

An Initial Study of Integrating Bilingual and Science Instructional Modules for Elementary Science Teacher Preparation

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Abstract

The study aimed to develop integrated English and Mandarin instructional modules for elementary science teacher preparation. The instructor played a researcher's role in implementing action research during science teaching and learning. Fifty university elementary pre-service students taking the three-semester hour course during the two semesters participated in the study. The researcher developed the multi-models of multimodalities, consulted with five science education experts, and modified them to apply in the science teaching and learning course. They were integrating English and science concepts to guide the pre-service students to learn by doing inquiry-based science activities, such as identifying plant characteristics, insect taxonomy, and a variety of science experiments. Data were collected from classroom observation, questionnaires, student assignments, and feedback; most pre-service students put their hearts into operating science activities and expressed their thoughts in bilingual ways through the integrated instructional modules. Some pre-service students wrote interesting poems and science stories and developed lesson plans across several disciplines, including science, Mandarin, English, art, and mathematics. On the other hand, some pre-service students needed help with science concepts and theories in English. Multimodality was effective in engaging their understanding of learning science. Two-thirds of pre-service students were interested in designing science activities in English. However, they needed to be more self-confident in expressing themselves in bilingual ways. Learning confidence needed to be enhanced to engage the elementary pre-service students using English as the medium of instruction, content, and language-integrated learning skills.

Keywords: Bilingual, Multimodality, Pre-service Students

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Introduction

The new national education curriculum for the 12th year emphasizes that the English curriculum in national primary and secondary schools aims to develop students' abilities and habits in independent learning and lifelong learning of English. English learning should also follow the era of globalization and go beyond the framework of classrooms and textbooks so that English learning can be continuous. English is no longer just a language in school but can be learned from everything in life. English learning can also continue understanding the broader world by expanding life experience. Meanwhile, culture and nation enhance the ability of international participation and cultivate a global outlook for the learners.

In conjunction with the "2030 Bilingual National Policy Development Blueprint" announced by the National Development Council today, the Taiwanese Ministry of Education will aim to "comprehensively launch the bilingual activation of the education system and cultivate Taiwan's bilingual talents for the world" by accelerating teaching and learning activation. There are five significant strategies include adapting to daily life, expanding English human resources, making good use of technology to popularize individualized learning, promoting the internationalization of the education system, and relaxing regulations and establishing flexible mechanisms to strengthen students' ability to apply English in life and their future competitiveness in the workplace, and through joint efforts with various ministries.

To meet the goal of the "Blueprint for Developing Taiwan into a Bilingual Nation by 2030", it is essential to nurture pre-service students' capabilities in bilingual science activity design and to enhance their self-efficacies in bilingual science teaching. Therefore, examining the pre-service students' capabilities and self-efficacy is crucial to developing integrated English and Mandarin instructional modules for elementary science teacher preparation. Two research questions raised to guide this study were listed as the following.

1. How did the pre-service students perform their self-efficacies in bilingual science teaching?
2. How did the pre-service students exhibit their capabilities in bilingual science activity design?

Literature Review

Content and language integrated learning (CLIL) is not only language courses but also includes courses that focus on one subject and combine language learning. According to the 4C Principles proposed by Coyle (1999), successful curriculum implementation must consider four main aspects: content, communication, cognition, and culture, and design curriculum and teaching content per national conditions and cultural characteristics. CLIL practices are initially from Europe and are widely applied in European schools (Eurydice, 2017). Nowadays, CLIL practices are applied globally. To achieve the bilingual national education policy, a content, and language integrating learning approach is also used in bilingual classroom teaching in Taiwan. Content and language integrating learning (CLIL) encompasses subject knowledge and concepts, cognitive skills, and academic language needed to understand and illustrate subject knowledge (Lo & Lin, 2019). Students can learn both subject knowledge and language knowledge in the classroom at the same time through the CLIL approach.

Rabidge (2019) indicated five translanguaging strategies enhance teacher-student interaction and English learning outcomes, including instructional, vocabulary-discovery, concept-checking, associative, and affective translanguaging strategies. Translanguaging is like cross-linguistic practice and is derived from both multiliteracy and multimodality. It comes from the concept that emphasizes the variability in language practice. When we use language, we usually combine languages and multiple media, such as gestures, text, images, and symbols, to construct meaning. The strategies of translanguaging can help students overcome language learning barriers and gain a deeper understanding of subject knowledge. The concept of multimodality is that meaning-making does not occur through language but rather through the multiplicity of modes (Kress, 2010). Content knowledge combined with multimodal teaching design makes content learning more enjoyable.

Meanwhile, students can understand subject concepts and principles directly while overcoming language barriers through multimodality. Graphic resources like charts, diagrams, and graphs are used in science. Science teaching and learning usually occur through multiple modes (Liu & Lin, 2021).

Methods

In two semesters, the instructor played the researcher's role in implementing action research during science teaching and learning. Fifty university elementary pre-service students took the three-semester hour course during the two semesters. Twenty-four pre-service and twenty-six pre-service students participated in the study during the first and second semesters. The researcher developed the instructional modules with multimodal approaches, consulted with five science education experts, and modified them to apply in science teaching and learning within two semesters. When pre-students have difficulty understanding concepts and principles, the approaches of translanguaging and multimodality were applied to engage students' learning understanding and effectiveness, such as pictures, videos, and teaching aids.

Both quantitative and qualitative methods were applied in this study. Triangulation was achieved by collecting data from questionnaires, classroom observation, pre-service students' assignments, and feedback. Five science researchers designed and validated the self-efficacy questionnaire of pre-service students concerning bilingual science teaching and learning. The meaning-making of science concepts and theories for the pre-service students was taught in the class. Bilingual instructional models emphasizing scientific inquiry were used in science teaching and learning. Science activities as the approach of instructional translanguaging. For instance, identify plant characteristics, insect taxonomy, and a variety of science experiments. The instructor integrated English and science concepts to guide the pre-service students to learn by doing inquiry-based science activities. The multimodalities, translanguaging, content, and language-integrated learning approaches were applied in science instruction. The pre-service students' capabilities were encouraged to present in bilingual science activity design.

Findings

By introducing basic English and books or media, almost all students can understand the content taught in this course. During the first semester, picture and word cards were used for bilingual science teaching and learning. Twenty-six pre-service students participated in the second semester; many multimodalities were applied in the course, such as science reading

and writing of picture books, picture cards, word cards, and board games. The above methods were used in the class. Multimodalities were effective in engaging their understanding of science learning. Most of the pre-service students feel interested in bilingual learning ways. However, some pre-service students needed help learning science concepts and theories in English. Data on the self-efficacy of pre-service students during the first semester and the second semester were collected from the questionnaires. For instance, they are interested in the application of listening, speaking, reading, and writing in English (52.8%; 43.9%). Like the course delivered in an English-speaking way (59.5%; 58.5%). They are interested in elementary science teaching using English as a bilingual method (66%; 63%). They are confident in incorporating English into elementary science teaching (39.6; 29.2%).

According to the data from the questionnaires on the self-efficacy of pre-service students in the 2nd semester, there were similar results in the first semester. The findings showed that the performance of pre-service students still has a long way to go. For instance, 48.8% of pre-service students understand and use translanguaging strategies in bilingual science teaching. The 43.9% know and use multimodalities to implement bilingual science teaching. The 48.8% of them understand and use CLIL strategies for bilingual sciences teaching. 53.6% of them understand and use question guidance strategies to teach sciences through English question-led discussions. Approximately sixty percent of pre-service students agreed with the course instruction and liked the course taught in English. Roughly fifty percent of pre-service students understand the approaches of translanguaging, multimodalities, and CLIL. Two-thirds of pre-service students were interested in designing science activities in English; however, they needed to be more self-confident in teaching in bilingual ways. Therefore, English proficiency for all the pre-service students must be enhanced step by step.

The English training in listening, speaking, reading, and writing was emphasized throughout the study. Forty percent of pre-students taking the course can answer various questions correctly in English, and other learners are studying hard. Nearly forty percent of the students taking the course can respond to course questions in English. They looked very hard, thought and discussed in English, and tried to respond to the teacher's questions in English. More than 90% of students can read and understand the English books and articles related to this course. More than 90% of students can read and understand professional vocabulary in science and teaching in English. Eighty-five percent of students can correctly answer worksheets and test questions and report writing assignments in English. Forty percent of students can write about the design and evaluation of scientific activities in English. Data were collected from classroom observation, pre-service students' assignments, and feedback. Most pre-service students put their hearts into operating science activities and express their thoughts in bilingual ways through integrated instructional modules. Some of the pre-service students wrote interesting poems and science stories. They developed science lesson plans across several disciplines, including science, Mandarin, English, art, and mathematics, such as bilingual STEAM instructional modules. Exciting stories were written by the pre-service students as follows.

Example 1:

Time Passing--

The banyan tree is so big and full of leaves; who knows how many years it has accumulated. His thick hands keep me cool whenever I walk under the banyan tree in the hot summer.

Example 2:

A traveling Frog in a Rainy Day--

I am a frog who likes to travel, and I like rainy days, too. It's raining today, so a lot of creatures came out. Butterflies, bees, and ants are my friends. They gave me many gifts.

This study was conducted during the preliminary implementation of bilingual teaching in Taiwan. All pre-service students worked hard to present imaginative works. Although they adapted to bilingual teaching and learning, the acceptance rate in all aspects is about 60%. However, pre-service students' acceptance of incorporating English into learning science has already exceeded 60% and is increasing day by day. The process and model of exploring cross-language and cross-semiotic practices as a scaffolding for classroom teaching in bilingual classrooms are helpful for students' English learning. This study focused on science teaching and learning for Taiwanese pre-service students and also obtained similar results as Liu did (Liu, 2020). Taking the English comprehensive humanities class of a junior high school in Hong Kong as an example, Liu (2020) collected and analyzed videos of teacher-student interactions in the classroom and students' after-class exercises to study teachers and students' cross-lingual and cross-symbol practice of expressing expressions, and proposed that these real-time spontaneous phenomena are called cross-lingualism. Inter- and trans-semiotic practices can support planned and systematic scaffolding (Liu, 2020).

Some pre-service students said they needed to improve at explaining scientific terms and specific subject knowledge in English. Therefore, more training in specific-subject knowledge is needed for the pre-service students. Kim and Graham (2022) stated that CIIL teachers responded that they must take more training in developing specific-subject knowledge from the analysis of related research. Meanwhile, time-constraint is also a big challenge to deliver content in bilingual teaching. The problems that pre-service students encountered are the same as Massler (2012) found many teachers reported time constraints as a problem and found it influenced instruction owing to their heavy workload.

Conclusion

Pre-service students performed well in science activity design, emphasizing scientific inquiry. The motivation and interest of the pre-service students concerning bilingual science teaching and learning were successfully nurtured in the two semesters. Pre-service students' self-efficacy and confidence need to be gradually enhanced in bilingual science teaching, especially in interpreting science concepts and expressing skills in English. Scaffolding is essential for the learners to cross their learning zones of proximal development in bilingual science teaching and learning. Even though pre-service students are facing the challenge of implementing bilingual teaching and learning in Taiwan, most of them are optimistic and willing to make efforts to go for it. To engage the elementary pre-service students using English as the medium of instruction, content and language-integrated learning skills and learning confidence must be enhanced. Implementing bilingual instructional design is a good approach for nurturing the pre-service students' capabilities in science activity design and English proficiency. It is helpful to create a supportive learning environment for pre-service students to engage them in bilingual science teaching and learning.

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