Bilingual Instruction Model for a STEAM Course: A Preliminary Study

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Abstract. This study proposes a natural science course for elementary school students in Taiwan that combines the STEAM (science, technology, engineering, art, and math) and CLIL (content and language integrated learning) models. The course's lesson plan explains the teaching content and procedures for teachers who are interested in using English to teach STEAM-based natural science courses. Compared with the lesson plans applied in traditional natural science and English classes, the lesson plan of this STEAM–CLIL natural science course incorporates problem-based integrated learning and may be used to train teachers to teach natural sciences and to develop STEAM and bilingual teaching materials.

Keywords: Teaching model · STEAM · Bilingual instruction in natural science curriculum · Content and language integrated learning

1 Introduction

Science, technology, engineering, art, and math (STEAM) literacy emphasizes students' STEAM reading and writing ability and the integration of students' knowledge to solve practical problems [1]. STEAM education originated from science, technology, engineering, and mathematics (STEM) education. STEM combines diverse subjects into integrated courses and emphasizes the interdisciplinary nature of students' learning process. The STEM education policy was initiated in the 1990s in the United States and subsequently implemented by three presidents of the United States. They promulgated relevant education policies and regulations and passed the STEM Act in the United States Congress to improve STEM literacy in the United States. In recent years, advocates of the STEM-to-STEAM movement have caused a worldwide shift toward STEAM education [2]. STEAM education is a teaching model that emphasizes an interdisciplinary curriculum comprising science, technology, engineering, art, and mathematics. STEAM curriculum design is guided by five components, namely cross-domain topic research, hands-on learning, life applications for stimulating students' curiosity, solving of real-life problems, and application of five senses in learning [3]. STEAM literacy emphasizes the development of literacy skills and cultivation of integrated knowledge among students. Through a STEAM education, students learn to adapt and continue developing their ability to solve practical problems [1]. Such an education also helps students to apply interdisciplinary concepts to solve real-world problems.

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In response to globalization and international trends, Taiwan must improve the English proficiency and competitiveness of its people. To this end, Taiwan has developed a blueprint for becoming a bilingual country by 2030 [4]. Taiwan's Ministry of Education uses content and language integrated learning (CLIL) as its main teaching axis and actively promotes the teaching of English in small and medium learning areas [5]. CLIL is a teaching method that combines subject content with foreign language learning. In CLIL, subjects such as mathematics, natural science, and social science are taught in a foreign language to achieve the dual learning objectives of learning a language and domain knowledge by means of learning integration [6]. The cultivation of students' ability to use foreign languages to acquire new knowledge and communicate is a key aspect of CLIL. Currently, the CLIL pilot program in Taiwan is primarily implemented in elementary schools, particularly in the lower grades. Experimental courses mainly involve the fields of life curriculum, integrative activities, health and physical education, and the arts [5]. The goal is to allow students to familiarize themselves with a bilingual environment [7]. CLIL teaching is not equivalent to English teaching. For each subject, teachers can plan the ratio of Chinese language to English language instruction to suit their attributes and goals [5]. The development of a CLIL model suitable for the teaching environment in Taiwan is a topic that warrants discussion.

In the present study, an ICIL teaching model suitable for application in STEAM natural science courses in Taiwan was developed. The related curriculum uses the "plants in our daily life" theme to integrate natural science, English, integrative activities, mathematics, and art; it also encourages students to apply their imagination and curiosity to understand and describe phenomena in the natural environment. This curriculum design is a dual-objective learning model that incorporates subject content and language and uses the natural science component of STEAM education as its main curriculum design axis.

2 STEAM–CLIL Natural Science Curriculum

The STEAM–CLIL natural science curriculum proposed in the present study uses images of specific plants and plant landscapes (Table 1).

The author of the present study has applied the aforementioned teaching plan in a small community of natural science teachers who engage in practical teaching using

Table 1. STEAM–CLIL natural science curriculum

Teaching unit	Plants
Teaching objectives	Students can identify the parts and growth elements of plants
Teaching object	Third grade
Context analysis	This lesson plan does not emphasize full English instruction; Chinese is the main language of instruction for this teaching mode. Only essential natural vocabulary and key sentence patterns are taught in English
Natural sciences principal axis	Third-grade elementary school students have a complete conceptual understanding of the roots, stems, leaves, flowers, fruits, and seeds of the six major parts of the plant. Students have the basic ability to observe plants • Natural learning goals The student can correctly name plant parts

(*continued*)

Table 1. (*continued*)

Teaching unit	Plants
Target language	• Natural sciences academic vocabulary Root, stem, leaf, flower, fruit, seed, sunshine, air, water • Main key sentence pattern What plant parts do you see? • Social language "Good job," "repeat after me," "please raise your hand" English learning goals Labeling the parts of a plant in English Student can write out plant parts in English
Integrated learning	Students can use English to discuss plant parts in specific situations Student can write down the names of plant parts
Classroom management	The teacher uses English language phrases related to classroom activities Phrases used: "Repeat after me," "please raise your hand," "good job."
Lesson plan design	
Activity	Procedure and Practice
Warm-up	Question: "What is the effect of COVID-19?" Story: Freud and Rilke were walking in the mountains in 1913. Rilke liked the beauty of the mountains very much, but he couldn't feel happy because of this beauty. Freud told Rilke that "flowers that only bloom for one night will not appear less beautiful because of this." We must accept the feeling of loss to appreciate the beauty of flowers. Plants have the power to heal our soul Search: 1. Guide students to explore and identify plants on campus Show students a picture of the campus and state the following: T: Look at the picture T: This is a garden S: I see…(expected answers: Banyan tree, lavender, Rosemary) T: Do you see plants? S: Yes, I do/No, I don't 2. There are many plants around us in school T: What is the word plant in Chinese? T: What are plants? T: Plants are living things that grow from the earth T: Can you name the plants? T: Where are they? 

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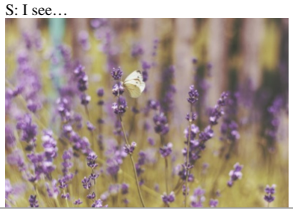
Teaching unit	Plants
Natural principal axis	Observation: • Ask students to observe the plant T: What is this? S: It is a lavender plant T: Is it a plant? S: Yes, it is a plant T: What plant parts do you see? S: I see… 
Target language	The teacher asks a student to name plant parts Student can name plant parts This is the root This is the stem These are the leaves These are the flowers These are the fruits These are the seeds
Integrated learning	• The teacher shows the potted plants to students and points out the plant parts during a group competition • One lavender plant requires 0.16 square meters of planting area. How much planting area is needed to plant 15 lavender plants? The teacher asks each group of students to calculate and share their results and encourages them when they perform well • The moisture meter can measure soil moisture. Please write down the steps for using the Micro:bit program  1. Leave the Duplicate Detection box 2. Turn on the Pin analog signal reading 3. Open the “variables” field 4. Insert the soil moisture detector into the soil 5. Select “basic” to display numbers • The display and placement of plants influence our visual senses and emotional state when we learn to appreciate them “Please observe the following landscape image and talk about the change in your mood.” Students then describe their mood changes after viewing the landscape image 
End activity	The teacher shows the plant and asks students to name plant parts

English. The author used simple and easily understood English sentences during the demonstration process. Teachers can flexibly adjust their lesson plans to suit their English ability and teaching goals.

3 Practical Implications

The present study uses a specific teaching plan to describe a STEAM–CLIL natural science curriculum. The proposal of this teaching model is expected to aid the development of a feasible plan for promoting the STEAM bilingual education policy in the natural science domain. It can be extended to other learning areas and used as a reference for research and development programs in other learning areas.

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