The Use Of Content And English Language Integrated Learning (CELIL) Methodologies In Teaching Selected Concepts In Physics

Ian Phil Canlas

Abstract: This study is part of an integrated teaching program in physics and English that attempted to develop and implement a teaching sequence on selected physics concepts using content and English language integrated learning (CELIL) methodologies. Specifically, this paper discussed its advantages and challenges as implemented in a school following a trilingual curriculum design. About 8 teachers were involved in the development and validation of the teaching sequence and 55 students from 5 classes were involved in the implementation process. Effectiveness was measured through students' achievement using criteria-based assessment and simple Collaizi method was used to process the external observers' and teacher-researchers' reflections. Preliminary results revealed that CELIL methodologies maybe helpful in developing and increasing students' conceptual understanding of selected physics concepts as well as improving their English language skills.

Keywords: content and English language integrated learning (CELIL), integrated teaching, teaching sequence, physics

1 INTRODUCTION

THE end of the 20th century was also characterized by an increased utilization of content and language integrated learning (CLIL) approach along teaching and learning especially to non-English speaking countries such as countries in Europe, Asia, and South America. As defined by Coyle, Hood and Marsh [1], CLIL is an approach whereby a second language is used in teaching and learning both the non-language subject content and the second language. Ideally, it is assumed that in this approach, the learning objectives of subject content and second language are interwoven throughout the teaching and learning process. Through the years, a number of studies have identified and enumerated compelling reasons for an increased and more advanced utilization of CLIL [2, 3]. These include the ability of CLIL approach to create conditions for natural learning of the second language. Moreover, it provides a defined purpose for the use of second language in the classroom, which may result to a positive effect on language learning through putting emphasis on the meaning instead of the form. Lastly, it increases the level and length of exposure to the second language. Along this line, Naves [4] and de Graaf, Koopman, and Westhoff [5] identified several crucial indicators and characteristics of a successful CLIL program implementation. These include the active teaching behavior of the teacher and the selection of appropriate strategies in presenting new information. In addition, immediate feed backing and creation of opportunities to respond in various ways were also found to significantly affect as well as the consistent integration of content and language in the teaching and learning process.

- *IAN PHIL CANLAS holds a degree on Master of Arts in Science Education – Physics from University of San Carlos in the Philippines. Currently he is a science faculty at University of Central Asia-Naryn Campus in Naryn City, Kyrgyz Republic. E-mail: ian.canlas@ucentralasia.org or lordphil2003@gmail.com*

Moreover, utilizing local contexts, using hands-on, and minds-on activities, and the use of collaborative, autonomous, and self-directed learning were also among the important factors that may define the success of CLIL implementation. In the last decade, a number of frameworks were developed to position CLIL in the teaching and learning process. Zydatiß [6] developed a curricular framework for CLIL showing the interaction of communication, content, culture and cognition (4Cs) as shown in Figure 1.

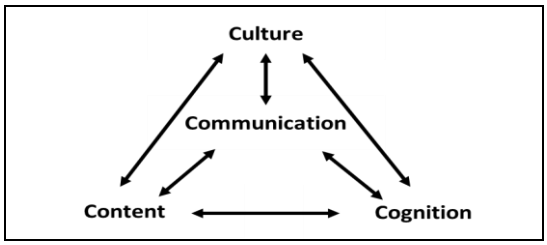

Figure 1. *Curricular framework for CLIL [6]*

This framework, illustrates the central role of communication in developing cognition, content and culture as well as how these factors shape communication. Moreover, Coyle, Hood, and Marsh [1] developed another framework. Aside from the 4Cs discussed and illustrated by Zydatiß [6] they recognize the role of context when implementing CLIL as shown in Figure 2.

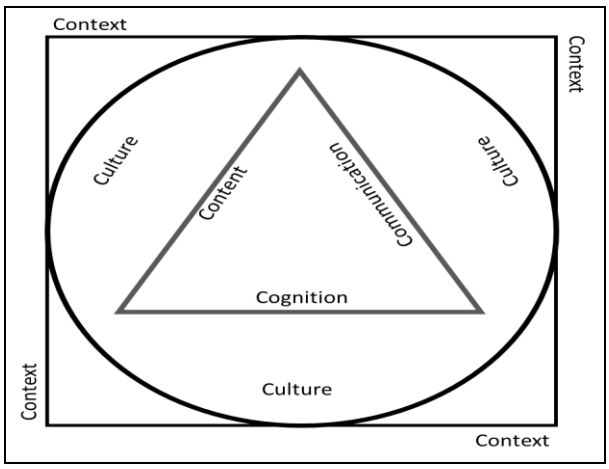

Figure 2. *Framework for CLIL [1]*

In that, a number of manuals and guidebooks on CLIL implementation have been developed, tested, and published. These include the ones developed by the European Commission [7, 8] and the ones developed by University of Cambridge [9, 10]. There are also available guidebooks put together for local contexts such as the ones developed by Pinkley, [11], Gimeno, O Donaill, and Zygmantaite [12] and Ionnou-Georgiou and Pavlou [13]. Few studies have reviewed the implementation of CLIL in Europe [14] and the rest of the world [15]. These include some country-specific studies such as the work of Bonces [16] in Columbia, Suwannoppharat and Chinokul [17] in Thailand, Wolff [18] in Germany, Leone [19] in Italy, Smala [20] in Queensland, Australia and Cross and Gearon [21] in Victoria, Australia. A number of studies have investigated the effectiveness of some specific strategies within the framework of CLIL. These include the use of collaborative approach [22], task-based approach [23, 24], blended learning strategy [25], the use of information and communication technology [26] and the use of videos [27] among others. Some studies investigated the implementation of CLIL in specific disciplines such as geography [28], chemistry [29] and physics [30, 31] These studies have proven the effectiveness of CLIL approach in teaching and learning. However, despite the progressive implementation of CLIL in the different parts of the world, a number of limitations and gaps still exist [32]. In the work of Dalton-Puffer [2], a question was raised as to what language learning goals and objectives are pursued during the implementation of CLIL in a non-language subject. This came up from the observations that teachers teaching non-language subjects were more focused in achieving content-related objectives. Moreover, in the study of Harrop [33], she pointed out that using CLIL in a non-language subject increases the level of difficulty in learning new themes which may result to leaving the weakest learners vulnerable for being left out. This may imply the need for a sufficient reinforcement for language development that is subject-specific. In addition, she was skeptical on the issue of cultural awareness. She argued that although CLIL frameworks included culture, the role of cultural awareness during CLIL implementation is less well established and not defined in CLIL models. Despite these differences in perspectives, the above-mentioned studies have recognized the important role of the teacher in defining the success of CLIL implementation. Pavron-Vasquez and Ellison [34] enumerated key competencies necessary for CLIL implementation in the classroom which include mastery of the subject matter as well as mastery of the second language among others. For reason of advancing the English language proficiency among learners in a Kazakh and Russian dominated school context, this study was conceptualized. Specifically, this study was aimed at developing and implementing a teaching sequence that uses CELIL methodologies in teaching selected physics concepts to Year 9 students. Moreover, it attempted to find out its effectiveness, advantages and challenges as implemented in a school that implements a trilingual science curriculum.

2 METHODOLOGY

This study followed the descriptive-developmental design. This design allowed the researchers to gather observations from the process of developing and implementing the teaching sequence using CELIL methodologies. It was implemented in a school following a trilingual (Russian, English, Kazakh) curriculum framework and accepts students with outstanding academic achievement. For all levels, the number of students in each class vary from nine (9) to ten (10). Due to the unique characteristics of the teaching force, such that local physics teachers have very minimal command of the English language, it was necessary to perform a distinctive integration method in the process. During the developmental phase of the study, eight (8) teachers were involved in the development and validation of the integrated lessons. These include four (4) local physics teachers, three (3) local English teachers, and one (1) international physics teacher. The group identified themes in physics and English that can be interwoven. The guiding principle in the integration process is that, the physics group should use teaching and learning strategies that develop English language skills while the English group should use the physics themes in teaching English language skills. This principle was conceived to give more opportunity for the learners to use English language in physics classes while newly learned concepts in physics are repeated and reinforced in English classes. The implementation phase involved 55 students from five (5) classes. It was agreed that the physics group commences first before the English group. This allowed the learners to get acquainted with the concepts as well as the procedure and activities. At least two (2) observers were asked to write observations and reflections regarding the implementation of every lesson which took for a month. Moreover, the teacher-researchers implementing the lessons were also asked to write down reflections during and after every lesson. These collective observations and reflections were used in the revision of the teaching sequence during the revision phase of the study. Meanwhile, in an attempt to establish the effectiveness of the teaching sequence, the criteria-based assessment employed by the school was used. In that, every learner is rated achieved or learning towards in every specific lesson objective. Results of which were presented in frequency counts and percentages. Meanwhile, observations and reflections were analyzed using Collaizi method of which themes and patterns were sought, presented and discussed in this paper.

3 RESULTS AND DISCUSSION

Preliminary results of the study revealed that the use of CELIL methodologies in teaching selected physics concepts maybe effective in developing and increasing conceptual understanding, as well as developing English language skills among year 9 students.

3.1 Development of the teaching sequence

In the developmental phase, seven (7) themes in physics and English were identified that is possible for interweaving. These themes were summarized in Table 1.

Table 1
Integrated themes in physics and English

Themes in Physics	Themes in English
Properties of light	Traditions: reading about superstitions
History of light	Language: the history
Simple harmonic motion	Language: post reading activity
Sound and human ear	Language: listening activity
Properties and characteristics of sound	Music: listening with task
Amplitude and frequency	Musical instruments: writing report
Forms of energy and energy transformation	Information gap analysis: video

Meanwhile, Table 2 summarized of the lesson objectives in physics that were derived from the identified themes. These appeared in the criteria-based assessment from which students' achievement were based upon.

Table 2
Lesson objectives derived from the physics themes

Properties of light
Describe reflection
Illustrate images formed by flat mirrors using ray diagram
Illustrate images formed by convex mirror using ray diagram
Illustrate images formed by concave mirror using ray diagram
Describe refraction
Illustrate images formed by concave lens using ray diagram
Illustrate images formed by convex lens using ray diagram
Describe interference
Differentiate between destructive and constructive interference
Describe diffraction
History of Light
Trace the chronological development on the study of light
Name some important scientist that made important contributions on the study of light
Simple Harmonic Motion
Describe simple harmonic motion
Use simple harmonic equation in solving practical problem sets
Identify events/phenomena manifesting simple harmonic motion
Perform an experiment related to simple harmonic motion
Sound and Human Ear
Identify the parts of the human ear and their specific functions in sound transmission
Trace the transmission of sound in the human ear
Properties and Characteristics of Sound
Describe the properties of sound
Differentiate between a sound wave and a light wave
Describe the production of sound
Trace the transmission of sound in different media
Amplitude and Frequency
Identify the different parts of a wave
Describe amplitude
Describe frequency
Solve problem sets related to amplitude
Solve problem sets related to frequency
Perform an experiment related to amplitude and frequency
Forms of Energy and Energy Transformation
Describe the different forms of energy
Differentiate between renewable and non-renewable energy
Describe the law of conservation of energy
Trace energy transformation

In addition, the CELIL-related strategies and activities were also identified and agreed upon. Tables 3 and 4 summarized the CELIL methodologies used in the delivery of physics and English lessons.

Table 3
Physics themes and strategies/activities used

Themes in Physics	Strategies/activities related to CLIL	Duration
Properties of light	10-minute reading about optical illusions and their scientific explanations	80 minutes
History of Light	10-minute reading and summarizing events in chronological order	80 minutes
Simple Harmonic Motion	10-minute reading, summarizing and synthesizing	80 minutes
Sound and Human Ear	10-minute listening activity about how human ear hears sound, summarizing and synthesizing	
Properties and Characteristics of Sound	Listening to music played with different musical instruments; writing observations and inference	80 minutes
Amplitude and Frequency	Playing musical instruments and writing a synthesis report on how these selected musical instruments produce sound and music	80 minutes
Forms of Energy and Energy Transformation	Film showing and video analysis	80 minutes

Table 4
English themes and strategies/activities used

Themes in English	Strategies/activities related to CLIL	Duration
Traditions: Reading about Superstitions	Reading about optical illusions	40 minutes
Language: The history	Reading about the history of light	40 minutes
Language: Post Reading Activity	Reading about simple harmonic motion	40 minutes
Language: Listening Activity	Listening a narration about how human ears hear sound	40 minutes
Music: Listening with Task	Listening a narration about how music and melodies are produced	40 minutes
Musical Instruments: Writing Report	Investigating how musical instruments produce sound and music	40 minutes
Information Gap Analysis: Video	Watching a video on energy forms and transformation	40 minutes

3.2 Implementation of the teaching sequence

The criteria-based assessment revealed that a greater majority of the learners were able to achieve the identified lesson objectives after the implementation of the teaching sequence. About 84% of the learners were rated achieved from the different lesson objectives. Table 5 summarized the specific frequencies and percentages of learners who were marked achieved from these lesson objectives.

Table 5
Distribution of learners and their achievement of lesson objectives using criteria-based assessment

Lesson Objectives	Frequency	Percentage
Simple Harmonic Motion		
Describe simple harmonic motion	42	76%
Use simple harmonic equation in solving practical problem sets	40	73%
Identify events/phenomena manifesting simple harmonic motion	44	80%
Perform an experiment related to simple harmonic motion	44	80%
Mean		***77%***
Properties of light		
Describe reflection	50	91%
Illustrate images formed by flat mirrors using ray diagram	48	87%
Illustrate images formed by convex mirror using ray diagram	44	80%
Illustrate images formed by concave mirror using ray diagram	43	78%
Describe refraction	49	89%
Illustrate images formed by concave	41	75%

lens using ray diagram		
Illustrate images formed by convex lens using ray diagram	42	76%
Describe interference	48	87%
Differentiate between destructive and constructive interference	45	82%
Describe diffraction	44	80%
Mean		***83%***
History of Light		
Trace the chronological development on the study of light	44	80%
Name some important scientist that made important contributions on the study of light	48	87%
Mean		***84%***
Sound and Human Ear		
Identify the parts of the human ear and their specific functions in sound transmission	49	89%
Trace the transmission of sound in the human ear	47	85%
Mean		***87%***

Continuation of ***Table 5***

Lesson Objectives	**Frequency**	**Percentage**
Properties and Characteristics of Sound		
Describe the properties of sound	45	82%
Differentiate between a sound wave and a light wave	43	78%
Describe the production of sound	46	84%
Trace the transmission of sound in different media	46	84%
Mean		***82%***
Amplitude and Frequency		
Identify the different parts of a wave	47	85%
Describe amplitude	48	87%
Describe frequency	49	89%
Solve problem sets related to amplitude	43	78%
Solve problem sets related to frequency	44	80%
Perform an experiment related to amplitude and frequency	42	76%
Mean		***83%***
Forms of Energy and Energy Transformation		
Describe the different forms of energy	48	87%
Differentiate between renewable and non-renewable energy	51	93%
Describe the law of conservation of energy	49	89%
Trace energy transformation	44	80%
Mean		***87%***

Nine (9) learners were marked learning towards after the implementation of the teaching sequence. Six (6) of these learners were marked achieved after giving one (1) reinforcement activity. The remaining three were marked achieved after giving two (2) reinforcement activities. Interviews revealed that these learners have difficulty coping up and understanding the concepts using English language.

3.3 Advantages and challenges of using CELIL

The advantages and disadvantages of using CELIL methodologies were derived and synthesized from the reflections of external observers and teacher-researchers. Reflections of both groups confirmed that the use of CELIL methodologies in teaching physics gave the learners an opportunity to practice the use of English language both for speaking and writing. Moreover, it initiated cognitive stimulation among the learners during the process. Below are transcripts of some written observations of external observers that maybe proofs of cognitive stimulation.

> *"Learners working in groups started asking questions and finding meaning of the words in English that were associated with the instructions and other activities that uses English language."*

> *"The students opened dictionaries to check the meaning of words."*

> *"Some students started using Google Translate to understand the instructions given in English."*

In addition, teacher-researchers were in agreement that using CELIL methodologies gave them a new variation of teaching approach. Moreover, it also gave them English language learning opportunity through increasing their physics-specific vocabularies and a number of speaking opportunities. Below were some transcripts of their reflections during the implementation phase.

> *"I also need to memorize and understand the English equivalent term of many words."*

> *"Many times, I am pressed to answer in English since my students started asking questions in English."*

In addition, the external observers agreed that the strategy was helpful in learning physics-specific vocabularies. The following are some transcripts of their observations.

> *"The students started using the English physics vocabulary words."*

> *"Some students asked the teacher for meanings of new vocabulary words."*

On the other hand, a number of challenges were identified. Teacher-researchers and external observers noted that longer time is necessary to accomplish CELIL-related activities and tasks. This is evident when external observers noted that some activities were cut short by the teacher due to lack of time, hence, no emphasis or discussions were given. Teacher-researchers also noted that there were some CELIL-related activities and tasks they skipped due to lack of time. In addition, teacher-researchers were uncertain whether or not they have given enough information or build enough knowledge among the learners. Below were transcripts of their reflections and discussions.

> *"It feels like my students did not understand enough about the topic because of the use of English language."*

> *"I have a feeling of uncertainty whether or not the idea or information recited by students during the question and answer portion is the same as what I understood. Though in my explanation I used the Russian language."*

"I also have the feeling that many times I think I missed understanding correctly what my students were saying especially when they do it in English language."

4 IMPLICATIONS

The preliminary result of this study revealed that using CELIL methodologies in teaching selected concepts in physics maybe effective in developing and increasing conceptual understanding among students. Moreover, it maybe an effective strategy in creating an opportunity for the increase use of English language, hence may result to learning English language skills. In addition, observation revealed that the use of English language in selected activities may lead to cognitive stimulation that could result to the development of critical thinking skills. On the other hand, the use of CELIL also posed a number of challenges. This include the increased difficulty in understanding the selected physics concepts brought by the use of English language in a number of activities. Moreover, there is a threat of misinterpretation and misunderstanding both for teachers and students especially during discussions, hence, the need for the teacher to have a good command of the English language.

5 RECOMMENDATIONS

5.1 On the result

1. As using CELIL maybe an effective strategy for developing and increasing students'conceptual understanding and learning English language skills, it is recommended to use the same methodology in other physics topics across different levels.
2. CELIL may also be used in various contexts as well as in other non-language related subjects such as biology, chemistry, history, geography among others.

5.2 On the methodology

1. For comparison, the same study may be replicated in another context.
2. Aside from the ones used in this study, other CELIL-related activities and strategies may also be used and its effectiveness be explored.
3. The use of other assessment tools to measure achievement and effectiveness may also be utilized.
4. A correlation study may also be done between students' achievement in physics and English.
5. A comparison between the physics and English achievement between the Russian and the Kazakh group may also be explored.
6. The change in index of difficulty of the non-language subject taught in English or other second language may also be measured and sought.
7. Perspectives of teachers, students, parents and stakeholders on the use of English in teaching a non-language subject may also be explored.

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