

CLIL IN GENETICS: CLASS ACTIVITY AND ENGLISH LANGUAGE USAGE IN CLASSROOM

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Abstract: Utilization of the English language to access scientific knowledge is essential to learning. Therefore, many schools have developed the Integrated English Program (IEP), to enable students to develop both academic content and language skill. Teaching genetics by using English as a medium, is challenging for non-native English speaking teachers as there are many specialized terms in the content to be delivered. Students' confidence in using the language in authentic situations seem low and learner engagement is often lacking in such traditional educational settings. The purpose of this study is to investigate how content and language integrated learning (CLIL) impact on student's attitudes, learning achievement and use English of students' when applying CLIL in teaching Genetics. The class activities were designed as six steps in delivering the program. The result indicates that both learner engagement and students' confidence in using the language are characteristic. It can also be noted that content integration, with extensive focus on authentic materials and cooperation, promote language development. As well as learning achievement with a higher score after using such integration. Nevertheless, the main challenge outlined by the participants is the language barrier. Hence, planning of the teaching units, as to provide the right support and challenges for the different learners, and to design the tasks so that natural collaboration becomes a key factor for introducing a content integrated collaborative language classroom.

Keywords: CLIL in Genetics, Genetics teaching, Teaching Biology, Learning achievement, Attitude test

Introduction

Content and Language Integrated Learning approach (CLIL) is an approach in integration of content and language learning. This approach involves many

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activities of learning different subjects such as science, biology, genetic, history, geography, etc., through an additional language or second language (Coyle et al. 2010). It gives important for both content learning and language at the same time through lesson activities (Coyle, 2007). The lesson activities emphasize the student – center approach to enable student to construct their knowledge from their self-study and under the directives of instructor which is consistent with the teaching model according to the theory of self-knowledge creation (constructivism) (Kamane, 2011).

Genetics is a science of biology that focuses on the study of the process of transferring genetic characteristics from living things to ancestors. Classical genetics was first studied in 1905, most of which were based on Gregor Johann Mendel's inheritance (Oxford English Dictionary, 2012) and advances in molecular genetics based on the knowledge of molecular biology by Watson and Crick (1953) that can explain the structure of DNA (Deoxyribonucleic acid: DNA). It is responsible for the preservation and transmission of genetic information of most organisms. Resulting in continuous development of biotechnology.

Genetics studies in Thailand at present, involve many challenges due to most learning being related to invisible and intangible matter. The students therefore have attitude that Genetics is too complex, difficult to understand and not easy when recalling content and students may have misunderstandings about genetics which will affect student learning. (Auckara-aree, 2015) as there are many specialized terms that resulting in confusion in understanding, such as “locus” that is the location on the genome of a gene (Elston, R., Satagopan J. and Sun S., 2012) mean a position on a gene or a position on the DNA sequence that is on the chromosome. Including from the report of Bunting et al (2003) that found the misconceptions about the functions of DNA from first year students studying biology at the university level. As a result of these reasons, teaching genetics that use English is a challenge, which requires a way to make students understand both the content and the use of English.

As English is now developing to be the leading international scientific language (Manten, 1968) and used almost exclusively as the language of science (Drubin and Kellogg, 2012). Many schools have developed the Integrated English Program (IEP) necessary for students to raise international standards (Booncherdchoo, S. L., Saphuksri, S., Songsombat, T. and Wongpoodpraw, N., 2019) enables students to develop both academic content and language skill. Teaching genetics at higher secondary school by using English as medium becomes challenging to non-native English-speaking

teachers as there are many specialized terms in the content to be delivered. On the other hand, there are quite a lot of content and there are a lot of specific vocabulary in English that students are not interested in studying (Larsing, 2015). For this reason, traditional educational environments do not seem to be suitable for preparing learners to function or be productive (Bingimlas, 2009). Therefore, the instructors should find ways to make the students interested in the content that is difficult and very much in English in learning activities.

Researchers are therefore interested in applying the Content and Language Integrated Learning approach because there are studies that confirm the success of such integration, both from reporting of Yamano (2013) that taught in the arts, crafts, science and social, in which the researcher analyzes data from class observations. And the use of questionnaires, the studies shows that students with the teaching CLIL with content in subject, Effective in attracting students' attention and contributing to experiential learning. Also, Pérez and Basse (2015) study of frequently of used incorrect grammatical in upper secondary school students, divided into groups that use the CLIL and normal language teaching method to test the English proficiency level through Cambridge Key English Test (KET), found that grammar is the most difficult for students. The test results indicate that Students who have received regular teaching have used grammatically incorrect English more than students who have been taught with CLIL. In this regard, the researcher confirmed the method of teaching in the integrated language teaching method, which is necessary for students with bilingual teaching. It consists of 6 steps; greetings, review, direction, give task, assessment, and delivery (Kewara and Prabjandee, 2018). In order to assess the impact of CLIL on learning achievement and students' attitudes towards CLIL teaching in genetics research must be conducted by using English language which is the second language of students in the classroom. The outcomes from this research would be advantageous to developing lesson plans and learning activities for students to gain better knowledge in both content and leverage their English communication.

Research objectives

1. To compare learning achievement after using teaching CLIL in Genetics between before and after the learning.
2. To compare learning achievement after using teaching CLIL in Genetics after the learning with the set 70 percent criteria.
3. To study the attitudes of students after learned with CLIL in Genetics
4. To study the leverage of English communication in the classroom of students studying the CLIL in Genetics

Research questions

1. How does students use English in a classroom with CLIL teaching in genetics?
2. How does the student have an attitude towards teaching CLIL in genetics?

Research hypotheses

Ho1 There is no difference between Pre-test and Post-test on learning achievement after using CLIL in Genetics.

Ha1 There is difference between Pre-test and Post-test on learning achievement after using CLIL in Genetics.

Ho2 There is no difference between Learning achievement and the set 70 percent criteria after using CLIL in Genetics.

Ha2 There is difference between Learning achievement and the set 70 percent criteria after using CLIL in Genetics.

Conceptual framework

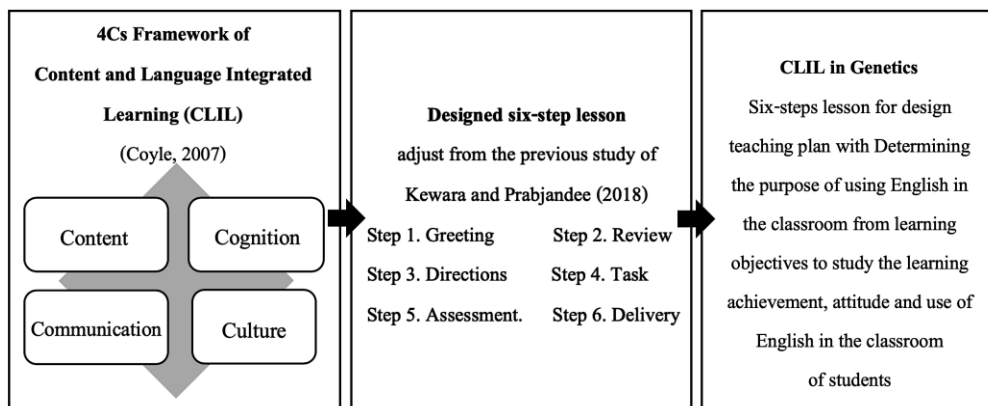


Figure 1: Uses the 4Cs framework of CLIL together with Six-step lesson

Literature review

Content and Language Integrated Learning (CLIL)

CLIL stands for Content and Language Integrated Learning. It refers to delivering subjects or content such as science, genetic and biology to students through a foreign language. Teaching and learning will not focus on either teaching between language and course content but focuses on the learners to acquire both content or and language in parallel (Dalton-Puffer, 2007). Integration of languages and content is not a new language learning style, but a combination of both innovations (Coyle et al., 2011). Teachers should understand the core of the subjects that are integrated together focus on the

student participation with the main education unit in various educational levels. Language and content integration is similar to bilingual learning program (Brinton, Snow and Wesche, 1989). Teachers must therefore prepare appropriate activities (Mcgroarty, 1998). However, the teaching of the integrated language can be divided into 2 part, which are, the language and the content. The main objective is for the learners to improve both language skill and expand knowledge of subjects.

The use of 4C in CLIL

The framework of the 4Cs is the relationship model of each aspect to be used as a guideline for teaching and learning (Coyle, March and Hood, 2010). **Content** is the subject matter which the teacher will use as a tool for students to access the knowledge by themselves. **Communication** is a language used as a medium to achieve interaction in the classroom activity. **Culture** is learning to live together through various cultures. **Cognition** is learning practice of thinking processes.

The learning process based on the 4 concepts and the integration of content and language occurs in the development of learners' skills in communication and thinking process skills about various subjects through a second language or new language (Bentley, 2010). Learners and instructors use language to pass on content stimulate thought processes language learning and communication skill of learners (Kewara, 2017). It enables students to use English in questioning concepts including classroom management as a classroom (Bently, 2007) and increase the level of interest and interests of the learners' cognitive processes (Calviño, 2012).

Six steps of CLIL

CLIL, with a sequence of 6 steps adapted from Kewara and Prabjandee (2018) is the same as the Constructivism theory. The students actually perform searching for knowledge by themselves until discovering knowledge and are able to create knowledge by themselves with the following steps.

The first step, Greeting, the first step for students is to relax and ready to encounter good interaction between teachers and students. Teachers may say hello or inquire about general matters using the English for classroom language which will create a supportive atmosphere for using English in the classroom

The second step, Review, teacher uses questions to encourage learners to link their previous knowledge with new knowledge. It is a review of previous

knowledge before presenting new knowledge to students to help them get ready to connect new knowledge with their former knowledge.

The third step, Directions, the teacher gives the assignment and explains in detail about the requirements and sets of criteria, including planning activities with students. At this stage, students will think of solutions to problems or find answers.

The fourth step, Task, the teacher allowed the student to perform group work with classmate to complete their assigned task. Teacher facilitated activities that enable students to use various skills in both English communications along with the use of knowledge in genetics.

The fifth step, Assessment, the teacher facilitates activities to let students use English to present their work. Teachers evaluate the problem-solving process of students. The teacher may assign each group of students to present problem solving solutions or answers as well as explaining the thought processes of each group.

The sixth step, Delivery, Teacher leads the students to summarize results from their activities in the form of knowledge in which they understand the content both from the learning objectives and the purpose of using English in the classroom.

These are a research that uses CLIL in science-related subjects, which is based on the study of Thanathana (2007) that studies the effect of integrating English language learning and Science of primary school students when testing knowledge in Science content found that students have knowledge through criteria at a good level, testing English proficiency and reading English, found that students were able to pass the criteria at a very good level And moderate levels, respectively, as well as from the study of Mawanthana (2010) that developed the teaching and learning model on health behavior at the lower secondary level, Using English as a medium according to learning theory that emphasizes experience and have integrated language teaching, Which the researcher called this specific teaching model that HEC model (H: health, E: experiential learning theory, C: content and language integrated learning approach) found that both experimental results to enhance health behaviors and experimental results to supplement Build the ability to communicate in English Students have cognitive behavior after studying higher from before More than 60 percent in terms of practice . The attitude of students had higher post-test scores than before using the overall at the statistical significance level of 0.05

Methodology

This study used a mixed method to collect data and find out the situation and opportunity to improve learning achievement and student's attitude toward applying CLIL in genetics teaching. Applying mixed methods together with integrated procedures is an exceptional practice to conduct high quality research. This study utilizes both qualitative and quantitative study to achieve the objectives of the study. Quantitative research in this research refers to counts and measures of the learning achievement to benchmark and assess the progress of the student. Qualitative research refers to document study of the meanings, concepts, definitions, characteristics of the related factors, situation of the CLIL learning activities, and field note log of teaching lesson plan.

1. Population and sample

Population

The participant of this study is grade ten students from Science-Mathematics course, from a private school in Chonburi Province, second semester of academic year 2018. The number of students is 350 students from 9 assorted classrooms.

Sample

Clustering Sampling technique was applied to get one classroom of 40 grade ten students from Science-Mathematics course

2. Research Instrument

The instruments used in the research were;

Four lesson plans which researcher determines the purpose of learning (Content) and the purpose of using English in the classroom to enable easier measurement and better evaluation.

Quantitative data collection instrument

- 2.1 Test paper with 30 Questions (multiple choice) of a learning achievement of students who learned with CLIL in genetics to assess learning achievement that researcher created based on learning objectives to assess cognitive behaviors in all six domains according to the concept of the Bloom's Revised Taxonomy (Anderson, Lorin W., Krathwohl, & David R., 2001)

Learning achievement test instrument has the difficulty value (P) between 0.23-0.82 and the differentiate power (B) from 0.05-0.42 and

reliability value at 0.91 when determining the criteria-based by using the method of Lovett's method.

2.2 Attitude test of students who learned with CLIL in Genetics of Likert (Likert, 1932) consists of five Topic, 1) General opinions 2) Interest in the teaching of integrated language courses in genetics 3) Expression or participation in activities 4) Significance of importance and benefits and 5) Esteem in teaching. The instrument has the differentiate power (B) from 0.26-0.63 and reliability value at 0.85 when determining the criteria-based by using the method of Cronbach's alpha coefficient.

Qualitative data collection instrument

Post-teaching record form four lesson plans of chromosome and genetic material

1. Data collection

Quantitative data collection process

1. Pre-test with pre-test for chromosome and Genetic material.
2. The researcher conducted the teaching six steps of CLIL model integrating chromosome and genetic material in the amount of 4 lesson plans
3. Post-test with a chromosomal test and genetic material
4. Test the attitude of students who are taught in the integrated language curriculum in the subjects Genetics by using attitude test
5. Check the test and use the results to analyze by using statistical methods.

Qualitative data collection process

1. Collect information on the use of English in the classroom of students who have been taught genetics in the form of integrated language after each lesson.
2. As the triangulation is a powerful solution to the problem of relying too much on any single data source or method, qualitative data was triangulated with quantitative data to strengthen evaluation and make findings more useful by providing different information and perspectives about the learning achievement of the student. In this study examination of data with the triangulation method consists of observing how student use English and content understanding to respond to each other to topic discussion in class, interview each student to observe the development of English communication

skill, and the examination of the test at the end of the lesson (Ladachart, 2015). Therefore, this research made use of a variety of methods to ensure the correctness and trustworthiness of the research findings and lessen the risk to unreliability.

3. Reflection on the researcher's interpretation of data in order to examine the interpretation of the researcher which is used in the research report and discussion of results (Ladachart, 2015).
4. **Data Analysis**
 - 4.1 Descriptive statistic such as Percentage, Mean, Standard deviation
 - 4.2 Statistic to test hypothesis is One sample t-test
 - 4.3 Analyze the data obtained from the post-learning field note. The researcher organized the data observed according to the teaching procedure in all 6 steps (Data grouping) then, analyzed the data using content analysis.

Quantitative findings

Table 1: *PRE-TEST and POST- TEST comparison on learning achievement after using CLIL in genetics teaching (total score = 30).*

Sample	N	\bar{X}	SD	Std. Error Mean	t	Sig. (1-tailed)
Pre-test	40	14.98	5.106	0.807	13.362*	0.000
Post-test	40	22.15	3.549	0.561		

* $p < .05$

Table 1 indicated that students who have been taught using CLIL in genetics teaching. The mean score of learning achievement before and after school was 14.98 and 22.15, respectively. The learning achievement after using CLIL in genetics teaching was significantly higher than before using CLIL at the level of .05. The null hypothesis H_0 is rejected and H_a is accepted. Therefore, the researcher would conclude that there is difference between Pre-Test and Post-Test on learning achievement after using CLIL in genetics teaching

Table 2: *Learning achievement and the set 70 percent criteria comparison on learning achievement after using CLIL in genetics teaching.*

Sample	N	criterion	\bar{X}	SD	t	P (1-tail)
Post-test	40	21	22.15	3.549	2.05*	0.023

* $p < .05$

Table 2 indicates that after using CLIL in genetics teaching the student from grade ten have achievement after learning that was significantly higher than the set 70 percent criteria (score = 21 from 30) at the level of .01. The null hypothesis Ho2 is rejected and Ha2 is accepted. Therefore, the researcher would conclude that there is difference between Learning achievement and the set 70 percent criteria after using CLIL in genetics teaching.

Table 3: *The attitudes of students after learned with CLIL in genetics.*

Topic	\bar{X}	S.D.	Level
Aspect 1. general opinion	3.88	0.38	Agree
Aspect 2. The interest in the teaching of integrated language	3.46	0.60	Medium
Aspect 3. The expression or participation in the activity	3.68	0.66	Agree
Aspect 4. The importance and benefits	3.80	0.61	Agree
Aspect 5. Popularity in teaching integrated language	3.81	0.59	Agree
Total	3.73	0.41	Agree

Table 3 indicates that the students had an overall attitude at a high level with an average of 3.73, standard deviation equal to 0.41, with a high level of attitudes, ie, 1. General opinion with the mean of 3.88, the standard deviation is 0.38, the aspect 3. The expression or participation in the activity has an average of 3.68, the standard deviation is 0.66, the side 4. The importance and benefits with an average of 3.80, standard deviation equal to 0.61 and side 5. Popularity in teaching integrated language with an average of 3.81, standard deviation equal to 0.59 and having a moderate attitude level, which is 2. The interest in the teaching of integrated language with an average of 3.46, the standard deviation is 0.60

Qualitative findings

In this research, the researcher introduced of the research by explaining to the participants about the integrated language teaching model one week before the beginning. There is an agreement that the teaching and learning in the classroom will use English as the main language of communication between

teachers and between students in the classroom. However, if some students are unable to use English in conversation or activity, they can modestly use Thai language to help communicate effectively and efficiently. If students have questions or do not understand the lesson, students can ask or ask the teacher to explain that topic again, using the time apart from the normal study time. The data of the use of English in the classroom with integrated language teaching genetics was collected from the post-teaching relatively according to the purpose lesson plan and the teaching process in all 6 stages of the integrated language teaching.

The researcher found from the observation that in **the first step, greetings (Greeting)**, students have evolved significantly and gradually increased their enthusiasm. Some of the students found it difficult to use English in conversations with teachers and with classmates. At the beginning, students still had ideas that were attached to using grammar, afraid of using incorrect English, afraid of speaking wrong, and lack of confidence in speaking. Therefore, the teacher encouraged them to keep practicing and involve their close friends to help each other.

In **the second step, Review**, teacher used questions to encourage learners to link their previous knowledge with new knowledge. The student tried their best to use English for answering questions that the teacher had asked and continue the discussion in English. The Researcher was able to evaluate each of the student's basic skill to communicate in English and ability to plan for next lesson activities.

In **the third step, Directions**, the teacher gave the assignment and explained in detail about the requirements and sets of criteria, including planning activities with students. The students participated the discussion actively. They use English to ask question and negotiate about load of work and time frame. They showed a little development in their fluency in English expression. Although at this stage, some students choose to use both Thai language and English in communication.

In **the fourth step, Task**, the teacher allowed the students to perform group work with classmates to complete their assigned task. Teacher facilitated activities that enable students to use various skills in both English communications along with the use of knowledge in genetics. Students can use both Thai and English to communicate between friends in the group

In **the fifth step, Assessment**, the teacher facilitated on activity to let students use English to present their work. They students actively use English mixing

with Thai to try their best in delivering the content to share with their friends while presenting their work. Students tried to use English to communicate with friends in the group first. If not understood, then they changed to use Thai language later. They showed better performance in the process of thinking.

In **the sixth step, Delivery**, the students were able to summarize results from their activities in the form of knowledge which they understood from the learning objectives and the purpose of using English in the classroom. Students could explain the process of protein synthesis by using English. Students chose to use a short role play to explain the story of DNA replication instead of the classroom report. They also explained the structure of DNA from modelling in English and discussed with friends in the classroom with mix of English and little Thai. Students created BINGO games to deliver knowledge from specialized terminology in genetics. They could conduct all activities using English to communicate with friends in the room

Result and discussions

Based on CLIL teaching in genetics with 6 steps, the researcher concludes that CLIL teaching can help students improve achievement levels. The learning achievement after using CLIL in genetics teaching was significantly higher than before using CLIL at the level of .05. The hypothesis Ha1 is accepted. After using CLIL in genetics teaching the student from grade ten, learning achievement after learning was significantly higher than the set 70 percent criteria (score = 21 from 30) at the level of .05. The hypothesis Ha2 is accepted. This is due to the emphasis on both the content used in teaching and the language used in communication between teaching and learning. The student-centered teaching is essential to gives students the opportunity to find the means to acquire knowledge by themselves. Teachers should be mindful to facilitate activities with decreasing roles of the lecturer in the classroom and increasing supportive environment for the students to perform learning by themselves among their classmate.

The students had an overall attitude at a high level. It is because the teaching of integrated language teaching focuses on the importance of the learner. It enables students to use English in real communication, daily life animates them to simply use ideas to link knowledge in genetics content from activities that the researcher held. It boots up popularity in teaching to high level.

The use of English in the classroom of students from the six steps of teaching and the purpose of using English in the classroom in each lesson plan shown developed in the record data using post-teaching log and field notes record. The researcher found that the use of English in students' greetings at

Assessment step and the conclusion has evidently developed. Students have the courage to express in English and confidently to communicate in English with the researcher and classmates.

The result of the lesson plan, design activities for learners, and the use of the 6 steps of the teaching process is considered a success that the researcher received. Choosing to use CLIL makes the most benefit to learners and teachers. It provides an empirical scene that confirms that the use of CLIL in the genetics course allows the learner to gain better knowledge of the content and develop skill to use the language to communicate.

Recommendation to the future researcher

Assessing the language readiness of the learner is an important factor that will make using CLIL in genetics teaching as efficiently as possible. The researcher proposes to extend time frame to arrange lesson plan and facilitate activities. Allowing more time at the assessment steps will enable the student to perform better in presentations in English which is better than taking a test. Students with different language backgrounds will cause learning and teaching activities to be delayed. Researcher recommend further study on the impact of collaborative learning among students from different levels of English communication skill.

REFERENCES

- Auckara-aree, N. (2015). khwāmkhaočhai khlātkhlūran kīeokap phanthu sāt [Misunderstandings about genetics]. Retrieved April 1, 2019, from <http://biology.ipst.ac.th/?p=2402>
- Anderson, L. W., & Krathwohl, D. R. (2001). A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives. New York: Addison Wesley Longman.
- Benitez-Castro, Miguel-Angel & Adan-Nieto, Miguel. (2007). Teaching science in CLIL: A sample lesson plan for the non-linguistic areas. GRETA, A Journal for Teachers of English (ISSN: 1989-7146).
- Bently, K. (2007). Teaching science through English - a CLIL Approach. Cambridge: CUP
- Bentley, K. (2010). The TKT teaching knowledge test cause. Cambridge: CUP
- Bingimlas, K. A. (2009). Barriers to the Successful Integration of ICT in Teaching and Learning Environments: A Review of the Literature. Eurasia Journal of Mathematics, Science and Technology Education, 5(3), 235-245. <https://doi.org/10.12973/ejmste/75275>
- Booncherdchoo, S. L., Saphuksri, S., Songsombat, T., Wongpoodpraw, N. (2018). kānphatthanā laksūt phāsā 'Angkrit (English Program)

- rōngriān sāthit Mahāwitthayālai Sinlapākōn (pathommawai læ prathom suksā) radap pathommawai [The English Program Curriculum Development at the Demonstration School of Silpakorn University (Early Childhood and Elementary) Early Childhood Level]. *Silpakorn Educational Research Journal*, Volume (10), 35-42
- Brinton, D., Snow, M. A., & Wesche, M. B. (1989). *Content-based second language instruction*. Boston: Heinle & Heinle Publishers.
- Bunting, Catherine M.; Campbell, Alison; Coll, Richard K. & Jones, Alister. (2003). But I Didn't Do Biology at High School. Paper presented at the annual meeting of the Australasian Science Education Association, 10-12 July 2003. Melbourne
- Calviño, M. A. M. (2012). Content and language integrated learning. *Tlatemoani-Revista Academica de Investigacion*, April (9), 1-11.
- Colye, D. (2007) Content and Language Integrated Learning: Towards a Connected Research Agenda for CLIL Pedagogies, *International Journal of Bilingual Education and Bilingualism*, 10:5, 543-562, DOI: 10.2167/beb459.0
- Coyle, D., Hood, P., & Marsh, D. (2010). *Content and Language Integrated Learning*. Cambridge, United Kingdom: Cambridge University Press.
- Coyle, D., Philip, H., & David, M. (2011). *CLIL content and language integrated learning (3rd ed.)*. New York: Cambridge University Press.
- Dalton-Puffer, C. (2007). *Discourse in content and language integrated learning (CLIL) classrooms*. Amsterdam: John Benjamins Pub.
- Drubin, D. G., & Kellogg, D. R. (2012). English as the universal language of science: opportunities and challenges. *Molecular biology of the cell*, 23(8), 1399. doi:10.1091/mbc.E12-02-0108
- Elston, R. C., Satagopan, J. M., & Sun, S. (2012). Genetic terminology. *Methods in molecular biology (Clifton, N.J.)*, 850, 1–9. doi:10.1007/978-1-61779-555-8_1
- Kamane, T. (2011). *sāt kānsōn [teaching pedagogy]*. Bangkok: Chulalongkorn University Printing House
- Kewara, P. & Prabjandee, D. (2018). CLIL Teacher Professional Development for Content Teachers in Thailand. *Iranian Journal of Language Teaching Research*. 6. 93-108.
- Larsing S. (2016). kānsuksā phon samrit thāngkān rīan læ chētakhati tō witthayāsāt dōi chai kānsōn bāp sūpsō hā khwāmṛū (hā E) dūai sū prasom rūang rabop prasāt læ ‘awaiyawa rap khwāmṛū suk samrap nakriān chan matthayommasuksā pī thī hā [The study of learning achievement and attitude towards science by using inquiry method with multimedia on the nervous system and sense organs for 11th grade students.]. *Silpakorn Educational Research Journal*, Volume (8), 1243-1248

- Likert, R. A. (1932). *Technique for the Measurement of Attitude*. Archives Psychological, 3(1), pp. 42-48.
- Luecha Ladachart. (2015). Qualitative research for science teacher. Bangkok: Chulalongkorn University Printing House
- Manten, A. A. (1968). English as a scientific language. Review of Palaeobotany and Palynology, 7(3), 145–148. doi:10.1016/0034-6667(68)90021-3
- McGroarty, M., & Acton, W. (1998). Constructive and constructivist challenges for applied linguistics. Author's reply. *Language learning*, 48(4), 591-629.
- Nanthaya Auckara-aree. (2015). Misunderstandings about genetics. The institute for the promotion of teaching science and technology. Retrieved April 29, 2019, from <http://biology.ipst.ac.th/?p=2402>
- Paperback Oxford English Dictionary. (2012). Printed in Great Britain on acid-free paper by Clays Ltd, St.Ives plc. Watson, J.D., & Crick, F.H.C. (1953) Molecular structure of nucleic acid. Retrieved October from 10, 2018, Nature Publishing Group Website: <http://www.sns.ias.edu/~tlusty/courses/landmark/WatsonCrick1953.pdf>
- Punwalai Kewara. (2017). *Integrated English learning: concepts for Thai teachers*. *Journal of Education*, 27(1), 28-40