CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

The major decision made by the Malaysian government in introducing English as the medium of instruction to teach Science and Mathematics shows that English language has snatched the limelight where Science and Technology is concerned. The Director of Curriculum Development in the Education Ministry, Dr. Sharifah Maimunah Syed Zin states:

> This measure will enable students to keep abreast of developments in science and technology in contemporary society by enhancing their capability and know-how to tap the diverse sources of information on science written in the English Language .At the same time, this move would also provide opportunities for students to use the English language and hence, increase their proficiency in the language.
>
> (National Secondary School Science Curriculum, 2002, p. xi)

However, this shift in the medium of instruction of teaching Science using English has given great impact to teachers who have learned and taught Science in Bahasa Malaysia and now have to teach it in English. Teachers seem to 'struggle' in teaching the Science content in the English language as they lack proficiency in it. Teachers find the switch from Bahasa Malaysia to English as a 'new agenda' that requires much preparation in using the language rather than the content.

Students on the other hand, learning English as a second language and as a subject in school, basically use English for communicative purposes only. The communicative English learned in the language classroom is different from the academic English learned in the Science classroom. Hart and Lee (as cited in Ramiah et al., 2006, p. 193) explained that scientific words convey meaning based on specific scientific context, for example words such as “matter , energy and force”. Therefore,

students being in the process of learning English would need a better comprehension of such “non-technical words” and in what circumstances such words are being used (Ramiah et al., 2006, p. 193).

For the literature review pertaining to this study on 'Problems Faced in the Teaching and Learning of Science in English' the researcher will look into the following studies:

(i) Krashen's Comprehensible Input Theory on Second Language, 1985.
(ii) Wilkins Environmental Factors in Learning, 1974.
(iii) Bruner's Theory of Instruction for Teaching and Learning, 1966.
(iv) Collier's Conceptual Model-Acquiring a Second Language for School Language Science, 1999.
(v) Content-Based Second Language Instruction, 2003.
(vi) CALLA Teaching and Learning Strategies, 1994.
(vii) Linking Second Language Strategies with Content Instruction, 1999 and
(ix) Global Perspectives on Change in Language Policy ,

As part of the literature review, studies concerning the teaching and learning of Science in English language in schools in Malaysia will also be reviewed.

2.1 Krashen's Comprehensible Input Theory

In the context of learning Science in English, Comprehensible Input is an important concept in second language development. Krashen (1985) proposed Comprehensible Input Theory which means “students should be able to understand the essence of what is being said or presented to them” (p. 3). Students should be able to comprehend the content of the lesson or what is taught throughout the lesson. Once students gain an understanding of what is taught, this would encourage them to understand the bigger scope of the learning process. Through this, students could proceed with a clear understanding of the whole learning task (p. 3). Krashen (1985) adds that in order for students to be actively engaged in the learning process, teachers should play a vital role in consistently using the 'language of instruction' and encourage

more participation of students in the teaching and learning process (p. 3). This will motivate students to express their ideas and opinions using the English language. Krashen (1985) says that creating opportunities and using visual aids for students to use the target language will result in better language learning as it encourages students to ask questions and enhance their understanding of the language and the Science lesson (p. 3). In the Malaysian school context, the frequent use of the English language will provide an opportunity for students to slowly master the technical words and functions of the language. This will eventually help students to understand the Science concepts in the English language. It may be a difficult task at the beginning stage especially with moderate and weak students but the consistent usage in class will provide the way for students to gradually understand the language and Science concepts.

Chaudron (1988) points out that when content-based instruction is applied in the teaching of Science in English, understanding the content of the instruction as information and social interaction is paramount, even though comprehending structures and meaning is equally important (p. 8). As such this approach can be applied in the Malaysian context of teaching and learning Science in English. Students need to understand the Science content taught in the classroom and the language used to convey the subject matter. This is where the language used to explain the content should be in a simple structure; emphasizing a communicative type of teaching. A practical and interactive way of using the English language to teach the Science content will help in the understanding of the Science context and they will learn how the English language is used to transmit the meanings of Science.

2.2 Environmental Factors in Learning

Wilkins (1974) lists the environmental factors that contribute towards learning to occur in a classroom context. According to Wilkins (1974) there are four factors that give an impact to the learning process namely, The Educational Context, The Social Context, The Teacher and The Pupil. Figure 2.1 below shows the environmental factors that are involved in a learning process.

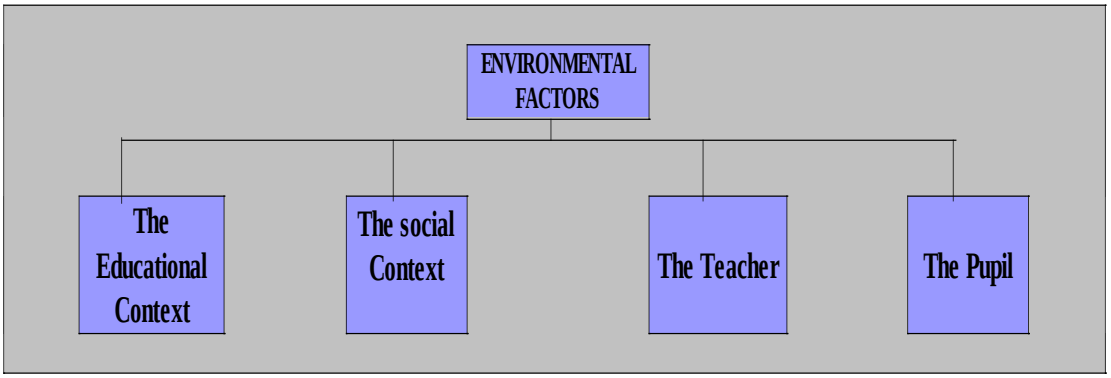

Figure 2.1

Environmental Factors in Learning

(Source : Adapted from Wilkins, Second Language Learning and Teaching, 1974, p. 43-55)

Based on Figure 2.1, "The Educational Context" refers to the time period spent in the teaching and learning process. The more hours spent on exposure of the second language and explaining the content in the target language will encourage a better level of attainment in the Science lesson. On the other hand, the less hours spent will result in a loss of motivation and lack of interest in learning (Wilkins, 1974, p. 44). "The Social Context" refers to an individual's attitude, characteristics and to which social group he

or she belongs to. Wilkins (1974) says that, if a pupil belongs to a society that has a negative attitude towards the use of a language, then language learning will be difficult for the pupil (p. 47). Wilkins (1974) compares that the highest achievement is attained when attitudes and teaching link, whereas, lowest achievement is seen when attitude is negative and at the same time teaching is weak (p. 48). The roles of “pupil and teacher” are crucial elements too. Wilkins (1974) claims that a student's past learning experience has an impact to his present language learning situation (p. 51). This statement cannot be denied as they (the pupils) are the onset of language learning. As for the role of the teacher, Wilkins (1974) feels that a teacher's skill in the learning context depends on two essential factors, which is the teacher's language proficiency and credibility in language teaching techniques (p. 53). Wilkins (1974) justifies that a teacher who fails in using the target language to transmit content will not see success in students using the target language well (p. 53). In fact, teachers with a great confidence of their ability in using the target language use different methods and linguistic inputs to make the teaching successful. As today's modern teaching emphasizes mastery on communicative skills, teachers with a limited ability of language competency will end up in an unsatisfactory teaching of a lesson (Wilkins, 1974, p. 54).

2.3 Bruner's Theory of Instruction-Teaching and Learning

According to Lawton (1981) “teaching and learning” works well when the teacher is competent and the students are fairly motivated (p. 45). This implies a teacher's clear understanding of the lesson to be taught and matches the level of ability of students in understanding the lesson. American psychologist and educationist, Jerome Bruner, has made a remarkable contribution by introducing the Theory of Instruction in the teaching and learning task. Bruner (as cited in Lawton, 1981)

highlights that the Theory of Instruction has four major features . This is shown in Figure 2.2.

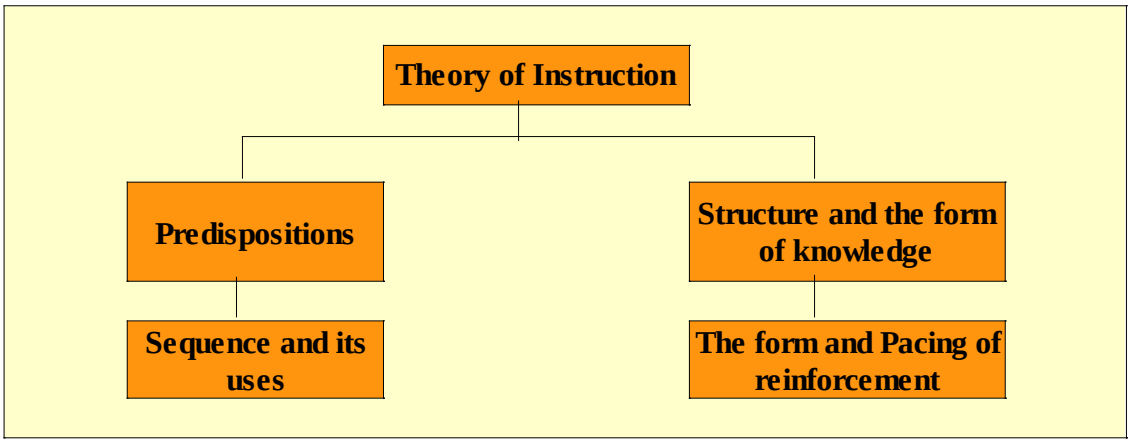

Figure 2.2

Components in the Theory of Instruction

(Source : Adapted from Lawton, An Introduction to Teaching and Learning,1981, p. 45-50)

Based on Figure 2.2, Bruner (as cited in Lawton, 1981) explains that "predispositions" touches on early exposure or experience that make a child eager and able to learn in school. (as cited in Lawton, 1981). He, in addition emphasizes that a teacher must have early understanding of a student's sociocultural background, characteristics of the student and what motivates him/her to engage in the learning process before a teaching and learning task takes place in a classroom. Knowing or understanding the "predispositions" will help teachers to prepare what is to be taught in the lesson using the target language and this will be of a great assistance to pupils. The second component which is "Structure and form of knowledge" highlights the techniques of acquiring knowledge in order for students to comprehend immediately. This is what Bruner (as cited in Lawton, 1981, p. 48) defines as "the relationship

between the knowledge which the teacher thinks should be acquired by the pupil and the nature of the learner as a particular individual". Bruner (as cited in Lawton, 1981, p. 49) adds that a teacher should explain concepts in a simplified manner so that students can easily understand the content and language. Bruner (as cited in Lawton, 1981, p. 49) also postulates that clear learning instructions given by the teacher will increase the learners' ability to comprehend what he or she is learning following a conventional sequence. This is followed by using the "kind of sequence" which proceeds from a "concrete to an abstract or symbolic"(p. 49). Finally, "structures and sequence" are also important in Mathematics and Science studies to enable students to understand the subject-matter. The last component which is "The Form and Pacing of Reinforcement" concerns teacher's praises and criticisms on students when necessary and at an appropriate time during the teaching and learning process.

In short, Bruner's Theory of Instruction (as cited in Lawton, 1981, p. 50) concerns three important factors which are "the nature of the knowledge to be learned, the nature of the learning process and the need to be aware of individual children's specific needs". These three factors are set as the benchmark in giving instructions to students in a teaching and learning process in a classroom.

2.4 Conceptual Model-Acquiring a Second Language for School

Collier (1999) has initiated a Conceptual Model as can be seen in Figure 2.3 on the next page.

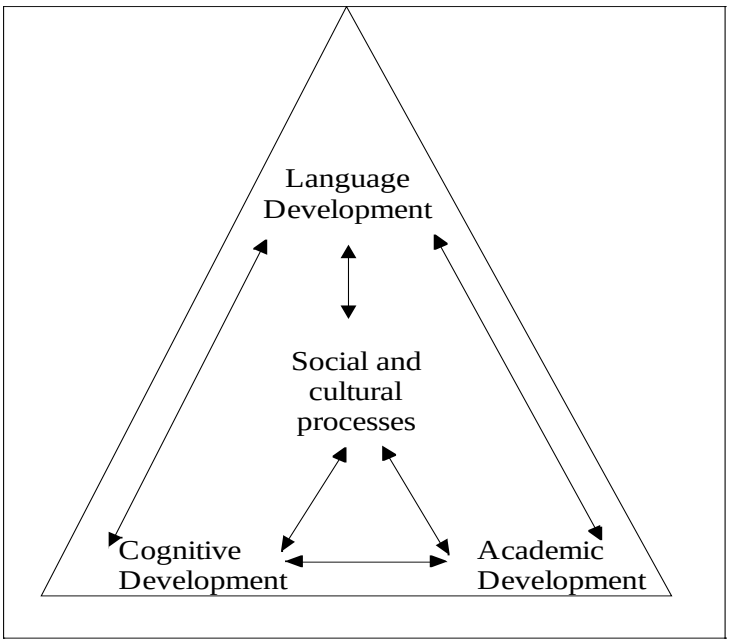

Figure 2.3

Language Acquisition for School

(Source: Taken from Collier, V. P, 1999, p. 17)

The model in Figure 2.3 describes the process that students go through in learning a second language in their school years. It also highlights the strong links between each of the factors in the diagram which a student will experience in the process of acquiring a second language. This is particularly when the second language is used for "instructional purposes across the curriculum" (Collier, 1999, p. 16). Collier (1999) writes that this Conceptual Model has been practiced in the United States among "language minority students" who do not belong to the "dominant language group and learn through a second language in school"(p. 16). Collier adds that the Model can also be used among "language minority students" who communicate in the dominant language but are learning in a bilingual classroom which uses the second language (p. 16).

The Conceptual model illustrates the acquisition of a second language that takes place in a school context. The model comprises four major elements: sociocultural, language development, academic development and cognitive development. The sociocultural processes describe how a student goes through the process of learning a second language in school. The model on a whole, explains that a student's language development is influenced by surrounding factors which are sociocultural, cognitive and academic development. Collier (1999) says that the sociocultural processes that happen in different environments such as “school, home, community and society give an effect to a student's self-esteem, anxiety and other factors” (p. 16). This can be seen in school where the classroom environment may cause “social and psychological distance between groups”(Collier, 1999, p. 17). Furthermore, a community’s way of life can influence a student's achievement who belongs to that community. This gives an impact to a student's perception in learning a new language which is not the native language. If the environment is encouraging, then positive learning will take place efficiently (p.17). Littlewood (1998) claims that the main purpose of learning language is in order to initiate interaction. Therefore, he adds that a student will be interested to learn a second language when he or she finds a clear communicative purpose to use the language (p. 53).

The Language development element emphasizes understanding of linguistic inputs subconsciously in a classroom learning context and a formal teaching setting. In addition, it also emphasizes the grammatical or linguistic aspects of language (Collier, 1999, p.17).

The third element which is academic development incorporates all core and elective subjects' students learn in a classroom. Collier (1999) says by learning varied vocabulary usage in the academic context, students will enrich their language ability and subsequently increase their cognitive thinking skill (p. 17).

The cognitive development is where the academic content is made easier and is penetrated into the language lesson in order for students to easily follow the cognitive activity (Collier, 1999, p.17).

Collier (1999) justifies that all these four elements are interrelated to one another and should be evaluated equally in the process of producing remarkable academic achievement in the second language.

2.5 Content-Based Second Language Instruction

Brinton, Snow and Weschc (2003) have researched on Content-Based Second Language Instruction in classroom situations. It is defined as "the integration of a particular content with language-teaching aims" (2003, p. 2). In other words, it means the teaching of content and second language skills. Content-based instruction is introduced for the purpose of learning a second language and gain an understanding of content knowledge. This is where students obtain content knowledge by the use of a second language, and therefore further improve their academic language skills (p. 21). Brinton et al., (2003) claim that a content based approach stresses that "the activities of the language class are specific to the subject matter being taught and are geared to stimulate students to think and learn through the use of the target language"(p. 2). In this way by using the target language, students can learn content because of the functional use of language to understand the content.

Short and Spanos (1989) stress on why Language-Sensitive Content Instruction is needed. For example, in a Science classroom, if a student lacks proficiency in the language of instruction, this will show an implication for the student to understand the scientific words. They suggest that for students who lack proficiency in using the target language, new activities and teaching strategies should be developed so that they can have a better understanding in the subject (1989, p. 2).

Lyster and Ranta (as cited in Briton et al., 2003, p. 244) suggest that learners can gain a precise use of a second language by exposing them to the "formal features in the language context" in order to create successful communication or interaction.

However, a negative implication in learning content and second language should also be given a thought. Suderman and Cisar (as cited in Brinton et al., 2003, p. 244) claim that a reading text which contains a high use of scientific words and complex sentence structures will create problems in understanding language as well as content. A study by Shaw (as cited in Brinton et al., 2003, p. 244) agrees that, if a clash occurs among course structure, the language ability of a student and knowledge of content subject, then this will result in "frustration" and "loss of motivation" even though the learner is actively engaged in the learning process.

Godman, (1975) has cited his view on the language of Science . He categorizes scientific English into three broad categories, which is words that are set specifically as "scientific language", words that can be applied in both "general language and scientific language", but for scientific purposes, its meaning has a restriction and lastly words used in a "general language" (p. 72). Godman (1975) adds that two basic problems that students will face in learning the language of Science is comprehending the Science vocabulary and the syntax structure in sentence patterns (p. 73).

Mohan (1986) points out that Science classes are content classes; therefore, the second language instruction given by the teacher in such classes should be comprehend able to students learning the second language (p. 10). Students, on the other hand, should “develop competence in academic discourse” so that they can understand the subject matter and be able to convey their point of view well (p. 92).

Wellington (2001) agrees that the language of Science is a 'barrier' to students (p. 23). Therefore, he suggests that students should be taught the scientific terminologies and meanings first, as well as the language patterns in Science to express ideas and concepts. This can be done through explaining the sentence constructions, explaining hypothesis, explaining comparison and ways to prompt questions in the Science classroom (p. 5).

Sutman (1993) recommends that vocabulary in a Science lesson should be first introduced to help students understand and improve their English language. This is because Sutman (1993) claims that English language can only be learned in Science teaching when English is made the main objective in the teaching process (p. 2).

Studies by Wilardjo (1975) on Indonesian students at the Science faculty in Gajahmada University on learning Science in English showed that students had difficulty in using tense and understanding the different tenses that occur in the English language. This is because in the Indonesian language, the only tense that occurs is similar to the simple present tense. This therefore, resulted in students having difficulty in understanding complex tenses structures that are largely used in Science references (p. 139).

Cummins (as cited in Fueyo, 1999, p. 95) has illustrated a framework shown in Figure 2.4 to explain why “language-minority children” face problems in “learning content in the English classroom”. He says that children basically are able to converse

well in both their first and second language. He further explains that their “literacy skills” in the two languages “were significantly below age appropriate levels” (p. 95). However, their ability of language proficiency is differentiated by “communicative skills” and “cognitive academic language proficiency”. This means their use of language to converse in everyday interaction is different compared to the language skills needed for academic purposes (p. 95). Cummins (as cited in Fueyo, 1999, p. 95) concludes that a child who is exposed to an early stage of reading and writing skills which show links to previous experiences, has a tendency to become successful. This concept is also applied to instruction that uses a second language.

Figure 2.4 on the next page can be explained in a context of a child learning a second language. Cummins (1984) explains that a child who has grasped the ability to gain information in his or her first language has therefore obtained the linguistic input and is able to make justification in the language. To replace them in the English language, which is the second language will only require learning of a new choice of words to explain in detail. However, if a child's understanding of language is only at a “conversational level”, then the ability to explain academic concepts will be difficult (p. 95).

Therefore, Cummins (1984) encourages language development in a classroom as it involves mostly written language and meanings. He says that students engage in cognitive tasks which involve thinking skills and second language use. Subsequently this allows academic language usage in learning content subject. Therefore, Cummins (1984) recommends applying effective strategies to fulfill students different levels of ability in a “content-based instructional learning environment” (as cited in Fueyo, 1999, p. 96).

BASIC INTERPERSONAL COMMUNICATION SKILLS

COGNITIVE PROCESS	LANGUAGE PROCESS
◆ Knowledge : Recognizing and Recalling Information ◆ Comprehension : Understanding the meaning of information ◆ Application : Using information	◆ Pronunciation : Reproducing sounds ◆ Vocabulary : Using labels and words in context ◆ Grammar : Using rule-governed language structures

COGNITIVE / ACADEMIC LANGUAGE PROFICIENCY

COGNITIVE PROCESS	LANGUAGE PROCESS
● Analysis : Dissecting information into its Component parts to see their relationship ● Synthesis : Putting components together to form new ideas ● Evaluation: Judging the worth of an idea, notion, theory, thesis, proposition, information or opinion	● Semantic Meaning: Relying on the context of the language for meaning ● Functional Meaning: Understanding language in a meaningful way across setting, topics and breakdowns in communication.

Figure 2.4

Levels of Language and Thinking Skills

(Source: Taken from Fueyo, V., 1996, p. 96)

Studies by Noraini (2006) claim that “an inadequate grasp of the language of instruction” is the main factor why students perform low achievement in school (p. 115). Besides that, age is also a factor why learning a language is important. The younger the students acquire the language of instruction in learning, the more they are able to communicate well the content of the subject using the language (p. 115).

Noraini (2006) also claims the “rate at which students learn a second language” is another important factor (p. 116). Some students are able to grasp the language skills in a short period of time compared to others who may take a longer time. The longer

time taken will result in frustration in learning the second language and will give an impact in using it to understand the content subject (p. 116).

2.6 CALLA-The Cognitive Academic Language Learning Approach

In the realm of teaching and learning Science effectively, research by Chamot and O' Malley (1994) has been the essence for practice in classroom learning conditions. Chamot and O'Malley (1994) have formulated the CALLA Approach - The Cognitive Academic Language Learning Approach (CALLA) which is an "instructional model to meet the academic needs of students learning English as a second language" (p. 4). Chamot and O'Malley (1994) have designed the CALLA Approach which was used for Language Minority Students as well as in the United States of America because these students face problems in learning the English Language and academic subjects. In the Malaysian context, the CALLA approach can be applied in the teaching and learning of Science in English as students may find difficulties in understanding content in a second language.

Chamot and O'Malley (1994) discovered that teaching and learning strategies help learners to achieve a dual purpose of learning content and language at the same time (p. 7). This means that by employing learning techniques or strategies, students can learn the content of a subject as well as the language of the academic subject. This will also encourage students to be "independent learners" (p. 6).

The CALLA Approach was designed at the initial stage with the aim to accomplish academic requirement in three categories of ESL learners:

1. “Students who have developed social communicative skills through beginning level ESL classes or through exposure to an English-speaking environment, but have not yet developed academic language skills appropriate to their grade level”
2. “Students who have acquired academic language skills in their native language and initial proficiency in English but who need assistance in transferring concepts and skills learned in the first language to English”

3. “Bilingual English-dominant students who have not yet developed academic language skills in either language.”

(Source: Taken from Chamot & O' Malley, The CALLA Handbook, 1994, p. 9-10)

The theoretical framework for CALLA Approach is how academic content and language are learned at the same time while using learning strategies in order to gain better understanding of content and language (Chamot & O'Malley, 1994, p. 12). The CALLA Approach gives priority to the content aspect which is the main focus and academic language skills are developed as it arises from the need to understand the content (p. 26). In fact, Reiss (2005) explains that the discourse of academic language comprises complex structures, is highly cognitive, and focuses on situational conditions (p.16). Reiss (2005) adds that the CALLA Approach helps students in obtaining insights on how to use learning approaches or strategies in order to better understand content and second language according to an individual's ability (p. 26-27).

Figure 2.5 illustrates the three major components of the CALLA model:Content Topics , Academic Language Skills and Learning Strategies Instruction.

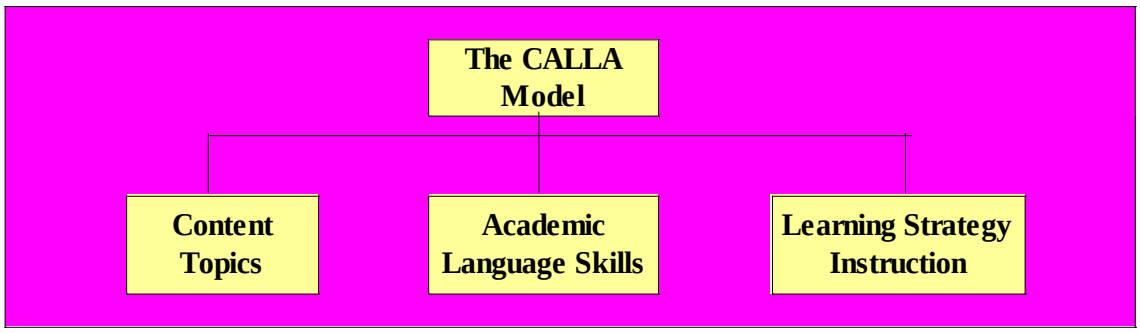

Figure 2.5

The Components of the CALLA Model

(Source: Adapted from Chamot & O'Malley, The CALLA Handbook, 1994, p. 10-11)

Based on Figure 2.5 Content Topics highlight the introduction of Science content to students. Chamot and O'Malley (1994) suggest that introduction to Science discoveries and hands-on approach will encourage students to learn academic language in order to understand the Science content (p.10). As such, teachers should know and be able to introduce the Science topics in a simplified way that touch on the specific scientific words that are frequently used to explain and discuss in the Science lessons.

The second component which is Academic Language Skills focuses on learning language skills, which includes vocabulary and grammar. Besides that, students also learn language functions, for example to analyze, to evaluate, in order to convey the Science content in effective academic language. (Chamot & O'Malley, 1994, p. 11).

The third component which is Learning Strategy Instruction focuses on the "integration of learning strategies with instruction in academic language and content" (Chamot & O'Malley, 1994, p. 58). By applying learning strategies, this will enable students to understand academic language and content. Furthermore, students will be able to see the difference in their own learning besides differentiating strategies that suit them to work on, and improve on their learning to become better learners (p. 58).

Chamot and O'Malley (1994) encourage that teachers can help teach students

the various strategies and emphasize on the importance of using the strategies (p. 58). In this way, students will be able to choose the best learning strategy according to their ability to ensure understanding of content and language is optimum (p. 58). This is supported by Reiss (2005) who claims “Learning Strategies are techniques that facilitate the process of understanding, retaining, and applying knowledge”(p. 31). As a result, problems faced by the Science teacher will be much reduced if learning strategies are exposed to learners.

Based on the research and studies by Chamot and O'Malley (1994), three major types of learning strategies have been identified which are the Metacognitive, Cognitive and Social or Affective Strategies. Table 2.1 on the next page illustrates the three major types of learning strategies in the classroom and the detailed description of each strategy. Metacognitive strategies are advance preparation of a content subject before the lesson is taught in the classroom. It involves a student's self-comprehension of the Science topic or revisions carried out ahead before the teacher explains the topic in class. Cognitive strategies are on-going learning processes which involve concentration and activities while the lesson is being taught in classroom. Students can do a summary of the Science topic that is being learned in the classroom, practice note-taking and memorizing techniques. It is more to a cognitive based task as it relates to student's thinking skills. The Social or Affective strategies involve the participation of a teacher and a student in a context of one-to-one in order to understand a lesson taught in class. It also involves peer or group work to better understand a lesson.

Table 2.1

Learning Strategies in the Classroom

Metacognitive Strategies

Strategy Name (Planning)	**Strategy Description**	**Strategy Definition**
Advance Organization	■ Preview ■ Skim ■ Gist	Previewing the main ideas and concepts of a text ; identifying the organizing principles.
Organizational planning	■ Plan what to do	Planning how to accomplish the learning tasks ; planning the parts and sequencing of ideas to express.
Selective Attention	■ Listen or read selectively ■ Scan ■ Find specific information	Attending to key words, phrases, ideas, linguistic markers, types of information.
Self-management	■ Plan when, where, and how to study	Seeking or arranging the conditions that help one learn
(Monitoring)		
Monitoring Comprehension	■ Thinking while listening ■ Thinking while reading	Checking one's comprehension during listening or reading
Monitoring Production	■ Thinking while speaking ■ Thinking while writing	Checking one's oral or written production while it is taking place
(Evaluation)		
Self-assessment	■ Check back ■ Keep a learning log ■ Reflect on what you learned	Judging how well one has accomplished a learning task.

Table 2.1 (continued)

Cognitive Strategies

Strategy Name	Strategy Description	Strategy Definition
Resourcing	■ Use reference materials	Using reference materials such as dictionaries, encyclopedias or textbooks
Grouping	■ Classify ■ Conduct graphic organizers	Classifying words, terminology, quantities or concepts according to their attributes
Note-taking	■ Take notes on idea maps, T-lists, etc	Writing down key words and concepts in abbreviated verbal, graphic or numerical form
Elaboration of Prior Knowledge	■ Use what you know ■ Use background knowledge ■ Make analogies	Relating new to known information and making personal associations
Summarizing	■ Say or write the main idea	Making a mental ,oral or written summary of information gained from listening or reading
Deduction / Induction	■ Use a rule/Make a rule	Applying or figuring out rules to understand a concept or complete a learning task
Imagery	■ Visualize ■ Make a picture	Using mental or real pictures to learn new information or solve a problem
Auditory Representation	■ Use your mental tape recorder ■ Hear it again	Replaying mentally a word, phrase , or piece of information
Making Inferences	■ Use context clues ■ Guess from context ■ Predict	Using information in the text to guess meanings of new items or predict upcoming information

Table 2.1 (continued)

Social / Affective Strategies

Strategy Name	Strategy Description	Strategy Definition
Questioning for Clarification	■ Ask questions	Getting additional explanation or verification from a teacher or other expert
Cooperation	■ Cooperate ■ Work with classmates ■ Coach each other	Working with peers to complete a task, pool information , solve a problem and get feedback
Self-Talk	■ Think positively	Reducing anxiety by improving one's sense of competence

(Source: Taken from Chamot & O'Malley, The CALLA Handbook, 1994, p. 62)

In the context for Science Teaching and Learning , Chamot and O'Malley (1994) have suggested for CALLA, learning strategies for Science where a list of learning strategies for Science have been recommended as in Table 2.2 on the next page. This strategies can be used by Science teachers in the Science classroom to help students with different levels of ability to learn the Science content and second language based on their own ability. The Metacognitive strategies used in the Science classroom will help students to pre-plan and assess their understanding of a Science topic in order to better understand a Science experiment that is being carried out or a Science lesson that is learned in class. The Cognitive strategies help students to create a mind-map of the lesson learned and follow-up activities to better understand the lesson. The Social or Affective strategies used in the Science classroom help students to understand the learning process through interaction, sharing and exchanging ideas among friends or involve in further discussion and clarification with the teacher to better comprehend the subject or topic learned.

Table 2.2

Learning Strategies for Science

Metacognitive Strategies :	**Students plan,monitor and evaluate their learning of science concepts and skills**
Advance Organization	➢ What's my purpose for solving this problem or doing this experiment? What is the question? What will I use the information for?
Selective Attention	➢ What is the most important information to pay attention to?
Organizational Planning	➢ What are the steps in the scientific method I will need to follow?
Self-monitoring	➢ Does the plan seem to be working? Am I getting the answer?
Self-assessment	➢ Did I solve the problem/answer the question? How did I solve it? Is it a good solution? If not, what could I do differently?

Cognitive Strategies	**Students interact with the information to be learned , changing or organizing it either mentally or physically**
Elaborating Prior Knowledge	➢ What do I already know about this topic or type of problem? What experiences have I had that are related to this? How does this information relate to other information?
Resourcing	➢ Where can I find additional information about this topic? Encyclopedia? Science book? Library?
Taking Notes	➢ What’s the best way to write down a plan to record or to summarize the data? Table? List?
Grouping	➢ How can I classify this information? What is the same and what is different?
Making Inferences	➢ Are there words I don’t know that I

	must understand to solve the problem?
Using Images	➢ What can I draw to help me understand and solve the problem? Can I make a mental picture or visualize this problem?

Social / Affective Strategies	➢ **Students interact with others to assist learning, or use attitudes and feelings to help their learning.**
Questioning for Clarification	➢ What help do I need? Who can I ask? How should I ask?
Cooperating	➢ How can I work with others to answer the question or solve the problem?
Self-talk	➢ Yes, I can do this task – what strategies do I need?

(Source taken from Chamot & O' Malley, 1994, p. 204)

2.7 Second Language Strategies and Content Instruction

Jarett (1999) recommends ideas in connecting "second language strategies" with "content instruction" by pointing out some teaching strategies as effective measures in presenting Mathematics and Science Education (p.15). One instructional strategy that is highly recommended is Thematic Instruction. This is through "organizing key concepts or big ideas into theme-based units" (Jarett, 1999, p. 15). Through Thematic Instruction, it gives sufficient time for students to be familiar with language usage and do in-depth study on the wider scope of the concept learnt (p. 15).

Another effective strategy suggested by Jarret (1999) is Cooperative Learning. This is where students use language that is related to the activity which takes place during a Science discussion in groups with friends (p. 15). Kang and Pham (as cited in Jarett, 1999, p. 16) agree that when students communicate in the target language in

classroom learning conditions, this will enable them to be familiar to difficult language structures. This therefore could help in improving their interaction skills. The students, too, would be able to comprehend meaning well and improve their skills in language as well as skills in reasoning.

Another strategy in connecting second language with content instruction will be the Inquiry and Problem-Solving strategy. Kessler (as cited in Jarett, 1999, p. 16) claims that the Inquiry and Problem-Solving strategy enables students to voice out their opinions on approvals or disapprovals during a Science discussion or experiment that is being carried out.

Littlewood (1998) justifies that most successful learners adopt a vast range of learning strategies which reflect active involvement in learning (p. 67). He cites examples where active learners will make use of the opportunity to interact and share interest with other students on the lesson learned. They also will exchange ideas or information on a topic of interest. Therefore, this will promote better communication skills and give exposure of language and understanding of content in a learning context (p. 67).

Studies by Mohan (1986) pertaining to "language demands of content learning" shows that in the aspect of Science content classroom in which a communicative situation is involved, the language learning of content subjects caters more opportunities to learn the second language within a particular context. This is where students learn the essential words that relate to a particular topic and develop language mastery that can be extended in further discussion or communication (p. 18).

Kessler, Quinn and Fathman (1992) claim that students learning English as a second language may find difficulty in reasoning out Science outcomes if they do not possess the "linguistic structures" or "specialized vocabulary" of Science language.

This would result in the learning process becoming unsuccessful as students lack the specific vocabulary of Science (p. 73).

2.8 Global Perspectives on Change in Language Policy

Lu (2003) states that in Hong Kong after 1997, when English was made the medium of instruction in secondary schools, students tend to still receive instruction in their mother tongue as well as in English in order to understand the content of the subject taught. Lu (2003) explains that secondary students' competency in the English language and Chinese is declining (p. 372); therefore, teachers tend to use both languages in order to teach content subjects. Llewellyn et al.,(as cited in Lu, 2003, p. 372) claims that this code-mixing method resulted in students incapability to develop their English language proficiency. However, Lu (2003) states that the Hong Kong Government justifies that it was “Language In Education” policy that drove to the shift in the medium of instruction (p. 379). The government feels that “students overall English competency factor” was the triggering factor that caused a policy change in education in Hong Kong (p. 379).

Studies by Amy, T., Mark, S., Chi, K.W., Shek, K.T & Wing, W.K (2003) compared correlation between language proficiency and academic achievement. The study involved 7,500 junior secondary students in Anglo Chinese schools. The studies resulted in students who have a high proficiency level in English being able to follow English-medium education. Students with a low proficiency level had difficulty in following English instruction. In fact, teachers tend to use Cantonese and English to explain difficult Science concepts and classroom interaction too was more bilingual.
(p. 3).

Another study by Din, Wing and Sin (2003) who investigated the performance level of English medium students and Chinese medium students in learning Science showed that students learning Science in a second language have done poorly compared to the Chinese medium students (p. 295). This was due to their weakness in understanding difficult concepts, and lack ability to differentiate scientific terminologies in English language (p. 295).

A study by Mooko (2004) highlighted the change in Language Policy in Botswana, Africa and how it affected the teaching and learning of Mathematics. English has been the official language of Botswana since 1976 while Sestwana is the national language of Botswana. In primary education, Sestwana was used as the medium of instruction for two years followed by English for the next four years of primary education. In the Primary School Leavers' Examination, pupils were not able to answer in English due to a lack of proficiency in English as they were taught Sestwana in the early years of education. (Mooko, 2004, p.181). This made the Government of Sestwana switch to English as the medium of instruction in 2001. Bell (as cited in Mooko, 2004, p. 183) suggests that the earlier the pupils are exposed to English as the medium of instruction in teaching content subjects, the better their performance will be in the subject and the language.

Probyn (2004) has carried out a case study in South Africa on the learning of Science in English in secondary schools. English is used as their official and formal language in teaching and learning. Xhosa is the language spoken at home. South Africa is a multilingual country with eleven official languages and nine indigenous languages and two colonial languages, English and Afrikaans. Therefore, this resulted in a double struggle of the teachers transmitting content in a language easily comprehensible with the need to use the official language which is English. Probyn explains since most of

the students in South Africa have to learn using a second language medium, "more skillful front-of-class teaching might be necessary, through which the teacher can extend the learner's understanding and language skills, and provide a model and source of input of the target language"(2004, p. 58).

2.9 Past Studies on the Teaching and Learning of Science in English in the Malaysian Context.

Studies in the teaching and learning of Science in English have been carried out since 2004. A study by Ambigapathi and Revathi (2004) entitled *"Mathematics and Science in English: Teacher Voice"* looked into the "reaction of teachers in re-adopting the English language as a medium of instruction for teaching Science and Mathematics in Perak" revealed that it was a wise decision to switch to English because it was found necessary (p. 52). The study also indicated that a big number of teachers agree that they had to code-switch to Bahasa Malaysia in order to explain complex Science concepts (p. 55). Ambigapathi and Revathi (2004) propose "the need for sustained content specific language input for the personal language development of teachers"(p. 58). This is because teachers are the role model of using good language in classroom learning situations.

Ganti Mathi (2004) carried out a study on *"Perceptions of teachers towards the teaching of Science in English In Form One"*. The study involved 30 teachers who attended the English Teaching of Mathematics and Science (Etems) course in October 2003 in Port Dickson. The teachers hail from 10 different secondary schools in Seremban and Port Dickson.The research focused on teachers' preference on the medium of instruction used, teachers' attitude in using English in teaching Science and their beliefs on its usefulness to teachers as well as students. The study also examined

the difficulties faced by teachers in using English as the medium of instruction to teach Science. The findings of the study revealed that perceptions of teachers had influence in the teaching and learning process. In fact, students comfort was the main factor in the language chosed to communicate the Science content in classroom by the teacher. Therefore, Ganti Mathi (2004) found that a higher percentage of the samples preferred using Bahasa Malaysia when teaching Science and communicating with students during Science lesson. The findings of the study also stated teacher's lack of proficiency in English affected their confidence in using the language and the teaching process because they were unable to provide clear explanations in English and preferred using Bahasa Malaysia. The findings on the difficulties faced by teachers in using English as the medium of instruction showed that, interaction with students and getting students feedback while teaching-learning process were the biggest problems as it slowed the teaching process.

Thilagavathi (2005) conducted a study on *"Problems and Prospects of Learning and Teaching Science in English"* in two selected urban schools in Kuala Lumpur. 84 students and 2 teachers randomly selected from the two urban school which is 49 students from Pudu Girls School and 35 students from Sri Permaisuri School were taken as sample for the study. Her study revealed that a large number of students responded not having problems in learning Science in English and they could understand well. In fact, the students admit that by learning Science in English it opened windows of opportunities to excel in English language and to compete globally. However, the teachers somehow felt worried as students' rich command of of Science vocabulary were still in the Malay language.

A study by Ainur and Sheena (2004) showed how Orang Asli students responded to the teaching and learning of Science in English. The study was conducted

in a Orang Asli settlement in Bukit Lanjan, Selangor. Their study revealed that English was an “alien language” to the children who have very minimal exposure to the language (p.1). Teachers had to spend long hours in teaching the Science content in English as students face difficulty understanding concepts and are not familiar with scientific terminologies. (p. 2). Students' interest and attention was short and they basically encountered problems in retrieving what was taught to them in the English language (p. 3).

From a different point of study, Hamidah, R., Aziz,N.,Mukheta,I. et al., (2005) carried out a major study on the teaching of Mathematics in English involving 575 teachers throughout the country. The study, though concerned on teaching of Mathematics and not Science has given the same outcome that Mathematics teachers admit having problems in using the terminologies in English as they had difficulty in expressing the content in the language (p. 3). The teachers agree that it was due to a lack of exposure and expertise in the English language (p. 4). The researcher has undertaken a parallel study on the teaching of Science in English involving 245 students in order to find out what are the problems the participants face in learning a content subject in English.

From reviewing the past studies in the Malaysian context, it can be deduced that language problems were highly encountered by teachers and students in the teaching and learning of Science in English. This is due to a lack of exposure to the academic language of Science resulting in an inability of teachers to transmit input or knowledge of the content effectively. Students, too, are in the same boat and lack motivation and concentration in the learning process due to language acquisition. The past studies too have not recommend any effective suggestions or strategies that teachers and students

can practice in the teaching and learning process that can enable content and language learning to take place effectively at the same time.

Therefore, in this research paper, problems that teachers and students face in teaching and learning of Science in English will be analyzed. In addition to that, it is recommended that teaching and learning strategies or approaches will supplement the teaching and learning process in the classroom. Teaching and Learning Strategies help in understanding content and language at the same time through appropriate strategies that suits the ability of students.