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Integrating language and content in mainstream biology classrooms - the experiences of English language learners

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Integrating Language and Content in Mainstream Biology Classrooms
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Abstract

Globalization has vastly enhanced the mobility of people and ideas, in turn changing the world's educational landscape and increasing the proportion of nonnative English speakers within English learning environments. Although research exists on English Language Learner (ELL) pedagogies and on international education as two separate bodies, few studies have examined the experiences of ELLs learning science within the multicultural environment of international schools.

The purpose of the study is to answer three questions: 1) ELLs experience the integration of language and content within mainstream science classes? 2) Which, if any, aspects of their classroom experience do they find problematic, and which, if any, do they find conducive to learning Biology in English? 3) How do mainstream teachers experience the immersion of ELLs within their classes? Qualitative means are employed to explore these questions, uncovering several findings. Firstly, the data reiterates the central role of language as a mediator for learning, in any discipline. Secondly, the importance of native language to both additional language acquisition and learning Biology is highlighted. Similarly, the importance of communicative competence, especially in scientific expression is supported by the data. Time, pace, and differentiation were also found to be fundamental aspects that require careful consideration in the design and delivery of international exam courses. Finally, the importance of fostering a supportive learning environment that promotes high self-efficacy among students is reiterated.

Introduction

Picture a nervous, panic-stricken sixteen-year-old, with beads of sweat plastering strands of ginger hair across his forehead. His big blue eyes wide with fear, betraying any attempts he makes to conceal his distress. As he sits down to complete his English placement test, standard procedure for any other newly arriving student at the school, the examiner wonders why the boy, on the verge of tears, is acting more like an elementary school student than an adolescent. After twenty minutes, he gets up, pushes his chair in and nervously hands in his paper in with shaking hands. The entire test is left blank, save the first question, which reads: “Introduce yourself in three sentences”. His three-sentence answer spoke volumes: “Hello. My name Anton. I’m orphan”.

Anton was eventually placed in a Grade 11 English Second Language (ESL) Biology class, in which he stood out as a shy and troubled boy. Communication with official representatives of his family revealed that his parents had died in a car crash a few months ago, prompting relatives to send him to boarding school shortly after. Despite his severe trauma, Anton slowly began to open up became known as an extremely polite and well-mannered young man among his teachers. Above all, he was extremely academically ambitious. To make up for his limited English, Anton worked long hours after class translating texts from English to Russian, in an effort to learn new vocabulary and improve his spelling and grammar. During school holidays, his relatives refused to have him home, meaning he was the only student who stayed back in the boarding house over Christmas and summer. During this time Anton took additional private lessons in English, and even began learning French.

By the end of the year, Anton had made tremendous progress in his English, and applied to join the prestigious International Baccalaureate (IB) course for the following

academic year. The school's IB coordinator advised him against it, saying that despite his improvements, his English was still not up to par. Furthermore, he would be held back a year if he chose to pursue the IB, which typically started in Grade 11. Despite these discouragements, Anton insisted to enroll, setting off on an extremely demanding academic journey.

He left the ESL program, and joined classes taught by non-ESL teachers, who were not familiar with his case or his linguistic difficulties. Nevertheless, Anton worked hard and thrived. His English continued to improve along with his confidence and self-esteem. He even became known among his Russian peers as the "English expert", and would be called on to help them with homework and test revision. Two years later, Anton graduated with an IB diploma, and went on to study Biochemistry in a British university. Despite his troubled past, serious language barriers, and general difficulty acclimating to a new environment, Anton managed to make a success of his last three years of school, achieving enviable academic success. Unfortunately, stories like these don't always have such a positive outcome, as the next two vignettes demonstrate.

Fahd joined the same school as a 9th Grader, having left his home in Saudi Arabia for the first time to live and study on campus full-time. As the son of a wealthy business mogul, Fahd was expected to learn English, pursue a higher degree in commerce, and return to Jeddah to run his family's empire. Although pleasant, good-humored and very friendly, Fahd struggled in all subjects. Despite being seventeen years old, his grade point average (GPA), and English level were so poor that he was placed in Grade 9 ESL Biology, among fourteen year-old peers. His handwriting resembled that of an elementary school student, which teachers originally attributed to him learning a new alphabet. However, his handwriting in Arabic, his native language, proved equally poor.

At first Fahd tried hard, despite his language difficulties to keep up with the pace of his classes. He showed up to extra support sessions and regularly went over his tests with his teacher. Unfortunately, he continued to do poorly, and seemed to take longer to understand topics than his classmates, a fact teachers attributed to his lack of language proficiency, subsequently paying it little further attention. With his continued poor performance, Fahd's motivation began to wane, which at first was expressed as less he attention to his work, but quickly culminated in utter neglect towards his academics, and involvement instead in misdemeanors that often included underage alcohol and recreational drug consumption. Concerned, the school contacted his father, whose harsh reprimands and threats to send him to an isolated military school, only estranged him further from his family, and pushed him further towards delinquency. His GPA plummeted and he repeated Grade 9 twice. Fahd was meant to graduate from high school in 2013, yet in 2015, he is still in school, barely able to pass Grade 11. So, why did Fahd struggle so much? Was it only language that held him back or was there more too it? As the final vignette shows, with English Language Learners (ELLs), it's often difficult to tell.

Xiao-Ren arrived at the school from Hong Kong and joined Grade 11 ESL. From early on, it was obvious that Xiao-Ren struggled immensely and faced not only severe language difficulties, but learning difficulties as well. Her handwriting was barely legible, and she struggled to form letters such as "d" and "b". Her written work consisted of nonsense words strung incoherently together. Her oral communication was also poor, although, interestingly enough, she had mastered the art of imitation, and would repeat, word for word, what her colleagues said, if put on the spot and asked a question in class. Assessing her was extremely problematic since her work showed absolutely no comprehension (warranting a failing mark), and yet it was painfully obvious that she was severely disadvantaged compared to her peers, and thus could not justifiably be graded on the same scale as them.

Her father's views assessment of Xiao-Ren's poor performance was that she simply was not putting forth enough effort to learn both the language and the content. He enrolled her in supplementary private lessons in English and science every evening for three hours, but to no avail. Xiao-Ren continued to perform dismally, despite spending school holidays in the company of private tutors. As the year progressed, Xiao-Ren's case became well known among teachers, who, given the lack of cooperation from her parents, tried their best to meet her needs, with little success. At a parent-teacher meeting, Xiao-Ren was asked what she wanted to be when she grew up. Xiao-Ren answered, "doctor", to which her father scoffed and replied "Xiao-Ren, this isn't funny, your teacher is asking a serious question!". Needless to say, by the end of the following year, Xiao-Ren had barely managed to achieve a GPA that allowed her to graduate. She never went on to pursue a career in medicine, or any higher education for that matter.

Despite their differences in age, background, and personal experiences, a series of unlikely similarities bind Anton, Fahd and Xiao-Ren's stories to one another. First of all, all three students arrive in a new country and new learning environment, having left home for the first time. Despite hailing from extremely wealthy families, all three students have somewhat strained relationships with their families who do not provide them with emotional support. Secondly, they all speak next-to no English and are faced with the two-tiered challenge of learning a new language as well as new subjects, at the same time. Although their teachers appear to recognize the difficulty this presents, the degree to which this realization is acted upon remains limited. As a result, it becomes up to the student to try their best to overcome their language difficulties. While this is sometimes successful, as in the case of Anton who managed to excel against all odds, Fahd's example shows otherwise. His language struggles weren't explicitly addressed by the teacher, meaning the burden of learning was left largely to him. With the fragility, self-doubt, and general sense of

uncertainty that characterizes adolescence at the best of times, it is no wonder that a student like Fahd, faltered, lost faith in himself, and eventually gave up entirely. Finally, the anecdotes above demonstrate the complexity of learning, especially in international school environments where the language of instruction is often not students' mother tongue. The challenge of learning both an additional language and new content means that language barriers often mask symptoms of other problems such as learning difficulties, as was made painfully obvious by Xiao-Ren's struggle.

Problem Statement

In the glossy world of private international education, reputation is everything. Exclusivity and prestige are built on students' international exam results, and their subsequent placement at high-ranking universities. As such, the emphasis at such institutions lies in ensuring that the most promising students excel in international courses such as the IB, the International General Certificate of Secondary Education (IGCSE), or the Advanced Placement (AP). Typically, such promising students are native English speakers who are intrinsically motivated, live in stable households with a strong parental presence. These "day students", as they are called, constitute about half of the student body of international schools. The second half is made up of the "boarders", as they are called, who come from non-English backgrounds, and typically live at the school, away from their family and community. Generally the sons and daughters of politicians, businessmen and even celebrities, these students, despite their extreme wealth, represent "the other half". Ironically, they could come from troubled family backgrounds, have poor relations with their relatives or even exhibit serious emotional and behavioural problems. Compared to their high-flying, English speaking peers, these students are quickly sidelined, and their individual learning needs often disregarded by teachers who focus on the academically promising students whose exam results will further boost the school's reputation.

Thus, the cases of Anton, Fahd and Xiao-Ren are sadly quite common in international schools, where the priority when hiring teaching staff is experience in international exam courses, rather than experience with individualized, student-centered instruction. In order for such prestigious schools to remain competitive in the market of "luxury" education, most schools use a strategy that has become known as "à la carte education", a term used to describe the wide variety of academic and extracurricular offerings such schools promise. In order to convince parents that their handsome fortunes are well invested, marketing campaigns focus on the school's academic rigor, as evidenced by the many international curricula parents may choose from. To balance out this heavy academic load, schools also compete to offer exciting extracurricular activities such as archery, horse riding, tennis, golf, mountaineering, and skiing. Thus, such schools appear to offer the perfect blend of academics and extracurricular which ensures students a well-balanced educational experience. But with so much focus placed on students' academic and extracurricular achievement, students are inevitably funneled into a "factory line", so to speak, in an attempt to churn out highly performing young adults who stand out amongst other university applicants. Although this goal is certainly important, it opens the floor to a few important questions: Are their emotional needs acknowledged or addressed? Is teaching flexible enough to take into account their individual learning styles or difficulties? The "privilege" associated with attending high-profile institutions, often leads to the assumption that an expensive education is surely a high - quality one. But are all wealthy students, happy students? The answer is not so simple.

Although miniscule when compared to the global student body, the niche of students from nonnative English backgrounds who attend expensive boarding schools such as those described above presents a poorly understood, but pressing problem. The exorbitant fees their families pay, in addition to the glossy academic and nonacademic offerings paint an overly

simplified, rosy picture of their educational experience. One is left wondering, "Well, how could they *not* be happy?" However, it is this very emphasis on academic and extracurricular rigor that brings into question whether the school is meeting students' more basic and individual needs. Efforts to push students towards academic success come at a cost to the actual educational experience itself, leaving no time for differentiated instruction, or the development of language proficiency in tandem with content proficiency.

Without language support, students are left to their own devices as they navigate learning a new language at the same times as learning new content. Sometimes, like Anton, students succeed admirably, but more often than not, their efforts are thwarted by learning obstacles that hold them back and eventually erode their motivation. The assumption is that all students experience these difficulties initially as part of the experience of immersion, and that their performance will improve along with their proficiency. However, this leads to another dangerous assumption which is that all difficulties are language based, thereby masking potential cognitive difficulties. The implication of this is therefore, that so-called "privileged" students actually constitute disadvantaged and underserved learners.

Background

As an alumna of international schooling, the personal investigator (P.I.) directly experienced the gaping rift between the two, abovementioned categories of students. Being the daughter of a diplomat, she was introduced to international schooling by the transient nature of her father's job, which had her family moving around often, from country to country. As a native English speaker, coming from a stable environment with highly supportive parents, she always did well academically, achieved high marks on international exams and went on to pursue higher education in North America. Thus, like many children of expatriates in international schools, her educational journey was generally smooth, in sharp

contrast to “the other half”, who like most day students, she saw as spoiled, unambitious “rich kids”.

It wasn’t until she began working at an international school herself, that the P.I. began to see “the other half” in a very different light. In reality, their “privileged” status did them very little, if any good, at school. Beyond simplistic labels of “spoiled”, “rich” and “capricious”, she saw first-hand how disadvantaged and underserved these students were, and how their poor academic performance, delinquency and general misbehavior were all symptoms of a pressing, complex, yet poorly-understood problem. The vignettes mentioned in the introduction in fact, are real-life examples of the P.I.’s students, chosen among countless similar cases. The P.I. noticed that the scope of the problem went far beyond the classroom, with negative stereotypes about these students perpetuated throughout the school community. So terrible was their reputation, that newly-qualified teachers, such as the P.I. herself, were assigned English Second Language (ESL) subject classes, leaving the “well-behaved”, native speakers enrolled in IB, IGCSE and AP courses, to more experienced teachers.

After three years of teaching in this multicultural environment, the P.I. had grown quite attached to her ESL students, and increasingly affected by their struggles. As such, she enrolled in a Master’s program that culminated in this study, which attempts to shed a light on the poorly understood case of “privileged” English Language Learners, as they integrate language and content within international schools. It is the hope of the P.I that exploring their experiences would draw attention to their struggle and perhaps offer strategies or solutions to better support these underserved learners. Ultimately, the goal of the study is to add the voice of students like Anton, Fahd, and Xiao-Ren, to the conversation on contemporary educational strategies.

Literature Review

The issue of how human beings learn is a question as old as time itself, one pondered by great Greek philosophers such as Plato, Aristotle and Socrates. They were the first to inquire about the nature of learning, and the role of the outside world in this process. Thus was born the debate of empiricism vs. rationalism. The two schools of thought differ in the extent to which experience is believed to play a role in knowledge acquisition, that is, whether knowledge is gained through intrinsic or extrinsic processes. Rationalists believe that knowledge is innate, and is acquired through intrinsic processes of deduction (Hjørland, 2005). They believe in the existence of "*a priori*" knowledge, where conclusions are deduced based on inductive associations, forming the basis of logic-based disciplines such as Arithmetic and Geometry. The key to rationalism is the belief that deductive reasoning unlocks knowledge that is both certain and unchanging (Hjørland, 2005).

Empiricism on the other hand, is based on the value of experience in knowledge acquisition, that is to say the role of the senses or the mind in interpreting extrinsic factors (Hjørland, 2005). Empiricists posit that no "belief" can be accepted as knowledge unless it has been tested by experience. This position forms the basis of the scientific method, whereby claims are tested through observation and manipulation before being accepted as true. The basis of acceptance is only the failure to reject a given hypothesis, meaning that any given fact is only "true", until disproven by new evidence (Feyearabend, 1985).

Plato believed that truth is discovered through the intrinsic process of self-reflection. Aristotle, one of Plato's students, believed instead that knowledge must be sought after by observing the world surrounding one's self (Meyer, 1980). From this standpoint, Aristotle developed the empiricist epistemology, which was based on a scientific and systematic way of collecting data in order to validate truth. Socrates on the other hand believed that truth was found in interactions and conversations with other thinkers (Meyer, 1980).

The idea that knowledge was acquired through interaction with one's environment did not immediately however, lead to constructivism as a dominant learning epistemology. In fact, following the fall of the Roman Empire, and the subsequent centrality of the Catholic Church to like in Europe, early education was actually characterized by rote memorization. This took the form of transmission of memorized religious scripture from priests to laymen (Monroe, 1925). The Renaissance saw a revival of inquiry and freedom of thought in education, culminating in the move towards humanism towards the end of the 15th century (Dai & Liu, 2004). Humanism is itself a more secular epistemology that is based on the agency of human beings in uncovering knowledge through critical evidence rather than accepted doctrines. This was the beginning of the wedge that began to form between theology and reason, whereby scientific reasoning rather than religious dogma were increasingly favored as a basis for understanding the world (Dai & Liu, 2004).

Constructivism as a Learning Epistemology

Today, constructivism has become the dominant learning epistemology, forming the basis of most contemporary instructional strategies. Rather than being a *theory* per se, it is a philosophical perspective on the way we come to "know" (Goicoechea & Packer, 2000). In contrast to the historical view of education as the transfer of a body of knowledge that remains largely intact, constructivism argues that knowledge is, by nature, subjective. As it's name suggests, constructivism postulates that an individual constructs knowledge based on their unique experiences with their environment. Consequently, truth is not a static, totalitarian entity. Rather, it exists in many forms and is derived in many ways. Contrary to empiricists, constructivists reject the notion that truth is a totalitarian entity that can be verified scientifically. Rather, because truth is subjective, no one statement is assumed to be universally correct because alternative perspectives will always exist. This follows therefore,

that all knowledge is a product of personal cognition and is linked directly to the context in which it is constructed (Bredo, 1994; Bredo, 1997; Hasan, 2002; Karpov & Haywood, 1998).

Within the school of constructivism itself, there lacks a consensus on how knowledge is actually constructed. Exogenous constructivism for example, posits that knowledge is constructed largely through social interactions with the outside world such as exposure and experience. Endogenous constructivism on the other hand relies more on the concept of cognitive development, suggesting that knowledge is constructed through a process of reflection on previously acquired knowledge. Finally, dialectical constructivism presents a middle ground between exogenous and endogenous constructivism, suggesting that knowledge is constructed through cognitive processes that are influenced by interactions with one's environment (Bruning, Schraw, Norby, & Ronning, 2004).

Despite differences among constructivist approaches, there appears to be a general consensus that personal interactions with various social and environmental factors are necessary for knowledge construction (Haney & McArthur, 2002). Cognitive processes therefore, are "situated" within physical and social contexts. Situated cognition postulates that reality, knowledge, and learning are all social constructs, shaped by human interactions with one another and their environments (Kukla, 2000). Learners therefore, are part of a socially constructed environment, which in turn reflects back onto and shapes the individual learner him/herself (Bredo, 1994; Gredler, 1997). One of the most influential constructivists whose work builds upon the concept of situated cognition is Lev Vygotsky, Russian developmental psychologist, and pioneer in the field of learning and cognition.

Vygotsky believed that meaningful learning occurs as a reciprocal process of exchange between individuals and their environments. Interactions with others and with the environment, shape individuals, who then go on to shape their peers and environment in a cyclical fashion (Schunk, 2012). However, rather than information being passed to and fro

unchanged, Vygotsky believed that it is transformed by cognitive processes. These transformations he believed, led to meaningful learning experiences. Social interactions influence cognition through the use of cultural "tools" such as language, symbols and signs (Bruning, et al., 2004). Young children learn to manipulate these tools from adults first, and as they master them, they begin to use them more independently as mediators in more advanced psychological processes (Karpov & Haywood, 1998). The most salient of these tools is language.

Language in Learning

Language plays an important role in the transforming and internalizing of experiences from the environment through the conversion of *social speech,* to *private speech* and finally *covert speech* (Schunk, 2012). Like Vygotsky, Alexander Luria, another Soviet developmental psychologist, believed that language mediation was key to self-regulation, which is the coordination of cognitive processes such as planning, synthesizing and forming coherent thoughts (Luria, 1960). The process of self-regulation, especially in young children, depends heavily on interactions with others in the environment. Private speech refers to internal, self-directed thoughts that are not socially communicated and instead serve the function of promoting self-regulation (Schunk, 2012). As children develop their language and communication skills, they begin to internalize the socially constructed meanings and implications of words spoken by those around them. This internalization then directs their subsequent behavior. Related to the idea of *social speech* being transformed into *private speech* and finally *covert speech,* is the concept of verbalization, which, as it's name suggests, refers to the emphasizing of rules and procedures verbally by teachers (Schunk, 2012). Verbalization helps students, especially young ones, stay on task and rehearse procedures and methodologies, which in turn helps them internalize them (Hallahan, Kneedler & Lloyd, 1983; Schunk, 2012). As Luria and Vygotsky propose therefore, language

is the vessel by which ideas are presented to a learner, reflected upon by him/her and subsequently modified. By facilitating the connection between action and meaning, and organizing human perceptions of reality, language mediates thinking, and subsequently learning (Duran, Dugan & Weffer, 1998). Although valid for any discipline or learning experience, the centrality of language to learning is of particular importance to science.

Using Bloom's Taxonomy as a framework for meaningful learning, the cognitive domain prioritizes skills such as comprehension, application, analysis, evaluation and synthesis (Bloom & Krathwohl, 1956; Forehand, 2010). These last three skills are described as higher-order thinking skills, and lend themselves well to the inquiry-based nature of science, in which language is used as a discourse of reasoning, to hypothesize, predict, explain, infer, generalize, classify, and problem-solve (Alvermann & Wilson, 2011; Lemke, 1990; Matthews, 1993). The mastery of linguistic tools therefore, is a necessary precursor to the mastery of the content itself. This emphasizes the importance of literacy within science instruction in order to enable students to fully engage with the material, through reading, writing, speaking and listening (Alvermann & Wilson, 2011; Matthews, 1993). A discussion of the cognitive processes involved in learning science may elucidate this point further.

In neurophysiology, the brain is an information-processing system, largely responsible for receiving sensory input, processing it, and subsequently eliciting motor responses. In terms of receiving sensory input, three registers are involved: short-term memory, working memory, and long-term memory (Schunk, 2012). Essentially, sensory input is received by the cortex and medial frontal lobe. The input is now stored in short-term memory, and filtered by relevance before making it's way to the working memory. From here, it is lost within a matter of seconds, unless it is processed through the formation of neural networks, which allow it to be stored in long-term memory. With repeated exposure to the same stimulus, neural networks are reinforced through the strengthening of synaptic

connections. Meaningful learning therefore, occurs when students are exposed to similar, or the same concepts in multiple ways, each time allowing neural networks to be reinforced until those concepts become permanently stored within their long-term memories (Schunk, 2012). Verbalization and repetition therefore, help students to consolidate information they receive in the classroom. Elaboration, which is the process of adding context and meaningfulness to this new information, ensures that it remains stored in the long-term memory (Schunk, 2012).

Using the example of teaching a complex metabolic pathway, students would benefit from a teacher breaking down the pathway and going through it several times in a step-wise manner. Once the students have grasped the technicalities of how the pathway works, the teacher may elaborate by explaining the physiological context the pathway operates in, thus attaching meaning to the new information and ensuring students will retain it. In lay terms, the learning process can be simplified into a three-step process of "input", "processing" and "output", and at each step, students with incomplete English proficiency encounter unique obstacles.

The Struggles of English Language Learners

English Language Learner (ELL), is a term used to describe students learning English as an additional language. ELLs come from non-English-speaking homes or backgrounds, exhibit limited language proficiency and require modified instruction within mainstream schools (NEA Online, n.d). Within public schools in North America and the United Kingdom, ELLs typically come from immigrant or ethnically marginalized backgrounds, and often live in disadvantaged communities (Arias & Morillo-Campbell, 2008). Following changes in demographics among students in American public schools within the last twenty-five years, ELLs now represent roughly 10.5% of total public school student enrollment in the United States (Arias & Morillo-Campbell, 2008).

Despite these changes, most contemporary teacher training programs don't take into account the linguistic needs of ELLs, except programs aimed at future English Second Language (ESL) teachers. The United Kingdom's Post Graduate Certificate in Education (PGCE) for example, vaguely covers "inclusive teaching" in one of its modules, with no specific emphasis on ELLs (University of Exeter Online, n.d). In the United States, licensing involves having a bachelor's degree, successfully completing a postgraduate program and finally, obtaining state or national certification by completing all requirements. Much like the PGCE, the teacher training programs include aspects of inclusive and multicultural teaching, but do not directly or explicitly address pedagogy related to ELLs (Institute of Education Online, n.d). In both countries, teacher trainees are required to pass content exams in the subjects they wish to teach, but are not assessed on their understanding of ELL instructional strategies (Institute of Education Online, n.d; University of Exeter Online, n.d). Given the increase prevalence of ELLs in public schools, the question arises as to why their needs are not being addressed in teacher training programs? Has a "fully-qualified" teacher rightfully earned such a title if they lack the skills to reach a sizeable proportion of their future students? With this question in mind, the next section describes the unique language-based difficulties that ELLs face at each step in the learning process.

The first is a lack of overall communicative proficiency. The second is the struggle to comprehend the technicalities of scientific terms, which extend beyond their use in "regular" or conversational English. Finally, the third difficulty is the nature of scientific discourse as a "social" rather than national language. When learning an additional language for use in academic or professional settings, full proficiency is termed "cognitive academic language proficiency" (CALP), and may take up to seven years to fully develop (Allen & Park, 2011; Carrier, 2005; Lemke, 1998). Even for ELLs who appear to be fully proficient within English Second Language (ESL) classes, the use of English in an academic or subject-specific

context, such as a Biology class, goes beyond the level taught in traditional ESL programs. This difference in level between the "general" English used in ESL classes and it is more "technical" counterpart used in subject-specific contexts results in a discrepancy in CALP meaning there generally exists a two-to-three year gap between ELLs acquisition of academic English versus general English (Allen and Park, 2011).

To illustrate this point, it is useful to consider the types of questions a grade 9 student may be asked in ESL versus subject courses, taking note of the differences in CALP required of the student. In an upper-intermediate grade 9 ESL class for example, a student may be asked the following question:

Read about Jake returning to his hometown after being abroad for ten years. Then answer true or false to the questions.

I have returned to my hometown of Wilson Creek after an absence of 10 years. So many things have changed around here. When I left Wilson Creek, there was a small pond on the right as you left town. They have filled in this pond and they have built a large shopping mall there. A Chinese and an Italian restaurant have opened in the town center and a Mexican restaurant has opened near my home. Which is where I am going tonight!

a. Jake is going to eat Italian food tonight.

b. There is a small pond on the right, as you leave town. (ESL Lounge Online, n.d)

According to the teaching resource bank from which this question comes, it is meant to test comprehension and interpretation of text (ESL Lounge Online, n.d). In an equivalent grade 9 Biology class, the same student may be asked the following question:

(a) Match the following descriptions to the terms (i) 'drug tolerance', (ii) 'drug dependence':

A - If the drug is not taken, there are physical withdrawal symptoms.

B - A steadily increasing dose of the drug is needed to achieve an acceptable effect.

(b) Which of these conditions is also known as ‘addiction’? (Biology GCSE & IGCSE Exam Question Bank Online, n.d).

According to the International General Certificate of Secondary Education Biology question bank, from which this exam question comes, it is designed to test the comprehension and interpretation of scientific text, general recall, and the application of biological information (Biology GCSE & IGCSE Exam Question Bank Online, n.d).

The difference between the two questions is that; while the first simply tests reading comprehension (one skill), the second tests four: comprehension, the interpretation of scientific writing, information recall and finally, the application of said recall to a hypothetical problem. Therefore, it can be concluded that while the second, subject-specific question, requires the student to have mastered CALP, the first does not necessarily require the same.

Unfortunately, mainstream science textbooks fail to take into consideration this discrepancy in the acquisition of academic versus general English, using metaphors and analogies that lie beyond the scope of ESL classes (Bailey & Butler, 2003; Charmot & O’malley, 1987; Crandall, 1987; Santa & Alvermann, 1991). A second difficulty faced by ELLs during the “input” stage is grappling with the interpretive meanings of words and their associations. Beyond their use in simple labeling, words are used to associate different ideas to broader concepts, both directly and indirectly through the use of metaphors, for example (Lemke, 1998). Consider the term “light”, as used in physics to describe a type of particle. Conventionally, the word “light”, is merely a label for the abstract concept of this type of particle. Lemke however, argues that the word itself, it’s symbol, γ, a visual representation of a photon, and any other association to this term, all collectively form a semiotic representation of this concept (Amin, Leitão, & da Rocha Falcão, 2009). Scientific terms therefore, cannot be understood in isolation, or as discrete entities, separate from the

sociolinguistic context they occupy. In addition to this, most scientific terms are rooted in Latin, and are easily broken down into understandable morphemes such as the word "heterosexual", which can be broken down into "hetero-" (Greek root of "different") and "sexual" (referring to sex). This breakdown would help a native English speaker understand the definition of heterosexual as an organism sexually attracted to the opposite sex. Such morphemes, prefixes or suffixes do little to clarify the meaning of scientific terms to ELLs and often add on a layer of intricacy to already complex concepts (Jaipal, 2002). This again goes beyond the scope of ESL instruction, which is based on achieving basic communicative goals and therefore focused more on the acquisition of basic grammar, spelling, syntax and vocabulary.

A final challenge to ELLs in this phase is the notion of scientific discourse as a social, rather than national language. Originally proposed by Mikhail Bakhtin (1986), the example of Russian as a national language was proposed versus a socially constructed dialect of any given language, used within a particular context such as a school or workplace. Bakhtin posits that while Russian is used as a national language for the general purpose of communication, scientific discourse in Russian is made up of technical jargon, which is socially constructed to serve the purposes of observing, hypothesizing, analyzing and concluding. As such, proficiency in the "general" form of a language, used for purposes of communication doesn't translate into proficiency in the technical jargon of the same language. The latter takes a longer time to master, and is known, as previously mentioned, as CALP. In terms of academic versus general English, the former, used within science classes, would be considered a "social" language, where the latter would be considered a "national" one (Bakhtin, 1986). This "social" English, used in science classes, is not taught to students within their ESL classes.

During the "processing" phase of learning, ELLs also face three unique challenges. The first involves making sense of multiple semiotic representations of scientific phenomena. The term semiotic refers to the process of meaning-making (Hasan, 2002), and in the case of science, a single method of communicating a concept is not always adequate to arrive at the complete meaning of a particular scientific concept. For example, the process of photosynthesis, may involve mathematical, graphical, visual as well as verbal representations. A complete understanding of it therefore, is gained by comprehending these different communicative representations (Lemke, 1998). This again poses additional difficulties for ELL students because they often lack the language proficiency necessary to fully engage with these different representations.

The second challenge ELLs face in the "processing" phase, is understanding the taxonomical and hierarchical nature of related scientific terms. Such terms, which already differ in meaning from their non-technical, general definitions, cannot be fully understood in isolation, and must instead be studied with respect to their placement within taxonomies or hierarchies (Jaipal, 2002). For example, a term like *cell "cleavage"*, has a very particular definition in embryology, and can only be fully understood as part of the complex process of cell division. Cell cleavage refers to the splitting of one cell into two, once genetic information has been duplicated. Although they share the same root, the scientific and lay definitions of the word "cleavage" are somewhat different. Similarly, in cell biology, the term *"invagination"* refers to the infolding of a cell membrane by which a given cell takes in molecules from its environment. Unless a student understands the physiological process of invagination, they may incorrectly associate it with the term vagina, which is completely unrelated to this process. As these examples demonstrate, language in science was historically developed to meet the needs of researchers and practitioners in this field rather than students (Clark, Touchman, Martinez-Garza, Ramirez- Marin and Drews, 2012).

The third disadvantage ELLs experience during the second phase of learning is the inability to link new concepts to prior knowledge. According to Schunk (2012), new knowledge is built up on existing information stored in the long-term memory. Part of information-processing theory suggests a dual channel model for memory, by which information is encoded and stored in different ways such as visual, verbal and through writing (Schunk, 2012). For ELLs, this process requires more time and effort because the new information must first be translated from the students' native language to English (Jaipal, 2002; Clark et al., 2012), which in itself is cognitively demanding. By the time they have managed to consolidate new information with existing knowledge, the teacher may have moved on to new content, or may expect them to apply what they have just learned. The implication of this is that ELLs essentially require more time and cognitive effort to understand the same amount of material. When teachers fail to take this into consideration, ELLs often struggle to keep up with the pace of the course, falling behind and ultimately underperforming compared to their native peers.

The third step of this simplified learning model is the "output" stage, arguably the one that puts ELLs at the biggest disadvantage. Before discussing the coping strategies ELLs use to express their learning as a meaningful "output", it is important to consider why they need to resort to coping methods in the first place. The reason ELLs resort to different coping strategies is because they lack communicative proficiency. While this deficiency affects all school subjects, it is particularly problematic in science because language is used in this field as a discourse of reasoning.

Communicative Competence & Coping Strategies

In order for any given student to be able to communicate their ideas with ease, they must develop several writing/speaking competences (Canale and Swain, 1980). The first is sociolinguistic competence, referring to the student's ability to express their message

appropriately given the person being addressed and the social context of this communication. The second is discourse competence, referring to the ability to select words and structure them in a way that allows the intended message to be clearly delivered. *Linguistic competence* refers to the grammatical accuracy of the sentences themselves. Finally, *strategic competence* refers to a student's ability to use effective compensatory methods to circumvent any weaknesses they may face in verbal or written expressions (Canale and Swain, 1980; Leki, 1995). These competencies take years to fully develop, leaving ELLs significantly behind their native English-speaking peers in mainstream classes.

As aforementioned, a lack of communicative proficiency is particularly problematic for science, where language is used in the activity of reasoning. Effectively constructing discourses of reasoning in science requires a mastery of the scientific register, which in turn, is a collection of meanings specific to a particular context (Halliday and Hasan, 1985). Similar to Bakhtin's idea of the technical jargon that differentiates "social" and "national" languages, a complete scientific register of vocabulary and terminology is needed to engage fully with a body of text (Halliday and Hasan, 1985). Linguistic barriers prevent ELLs from acquiring this complete scientific register, therefore limiting the extent to which they can engage with scientific material in class.

In scientific discourse, analogies and metaphors are often used and form an integral part of the scientific register. Furthermore, logical connectors such as "because" and "however" are used to connect similar ideas or to create logical progressions between concepts (Jaipal, 2002). In order for students in science classes to convey their reasoning, they must master the multiple communicative competencies mentioned above. Failure to do so results in the diminishing of their intended message. As a result, ELLs often resort to coping strategies, which are adjustments to the original message, made to compensate for deficiencies in the linguistic resources required to communicate competently (Chimbganda,

2000). According to Chimbganda, (2000), the different strategies fall into four categories: L2-based strategies, risk-avoidance, message reduction, semantic simplification, and finally risk-taking strategies. In the following section, these strategies are discussed in more detail, and examples of each are provided.

L2-based strategies. L2-based strategies include paraphrasing; repeating information in an attempt to accurately convey it's intended meaning, generalization; incorrectly extending grammatical rules to items not covered by that rule, and circumlocution, which is avoiding directly answering the question by elaborating instead on background information (Leki, 1995). Often, ELLs will attempt to translate directly from their mother tongue language and then paraphrase into the target language (Chimbganda, 2000; Jaipal, 2002). For example, a native French speaker learning English might say: *"the seed of the cell contains it's DNA",* when what they mean is: *"the nucleus of the cell contains it's DNA"*. The mistake comes because the scientific term "nucleus" in French, is "noyau" (Collins Dictionary Online, n.d), which when translated directly into English is the "pit" or "seed" of a fruit (Oxford Dictionary Online, n.d).

Risk-avoidance. As the term suggests, risk-avoidance involves strategies to mask communicative incompetence by avoiding direct engagement with the topic of the question itself. This results in a reduction of the intended message (Leki, 1995). When ELLs wish to convey a message but lack the linguistic resources to do so, they often either relinquish their initial communicative goal entirely, or avoid expanding on their ideas by using relative clauses (Chimbganda, 2000), such as "whom" and "which". For example, a sentence such as: "The virus which causes the disease, multiplies inside the cell", would be expressed perhaps as: "The virus multiplies, who [sic] is causing the disease", effectively diminishing the intended communicative goal.

Semantic simplification. This is the process of using a simplified repertoire of reasoning or hypotheses to facilitate communication (Chimbganda, 2000). For example, consider the following generic question: "Using three examples, describe how structure is always related to function in Biology". Answers may include examples such as the rounded, flattened shape of red blood cells, the flagellum, or tail on a sperm cell, and the large, central vacuole found in plant cells. A typical ELL answer, using the semantic simplification strategy may be: "Structure in Biology always related to function. This helps the function cells in Biology." As this example demonstrates, the student understood the correlation between structure and function, but vastly reduced their message as a means of coping with very limited linguistic tools.

Risk-taking. Sometimes, a student decides to keep the intended communicative goal, compensating for a lack of linguistic resources by using incorrect grammar and sentence structures to get their point across as accurately as possible. Using the same example as above, a risk-taking student may answer: "Structure is relat [sic] function. Red cell shape help to carrying oxygene [sic] is round. Sperm cell have taile [sic] to moving and plant big storage for having food." This answer demonstrates that despite limited linguistic tools, the student still tries to make themselves understood, sacrificing correct spelling, grammar and sentence structure.

Gaps in Literature

Collectively, these coping strategies illustrate the main difficulty faced by ELLs in written expression. Oral communication involves body language and immediate feedback through facial expressions, which together facilitate a degree of shared meaning between interlocutors, any may compensate to some extent, a lack of language proficiency. Written expression on the other hand, is more limited and requires a mastery of CALP to make one's self fully understood. In academic writing therefore, difficulties in written expression make

ELLs appear academically deficient compared to their native peers, which in turn often lowers content goals and teachers' expectations of them. When ELLs meet these simplified, basic learning goals, they gain the false impression of having succeeded, only to be severely disappointed by low achievement on standardized assessments (Duran et al.,1998). Furthermore, because research suggests that new information is built up on existing knowledge (Clark et al., 2012; Jaipal, 2002; Schunk, 2012), failing to acknowledge what students have studied in their native language, and relying on the oversimplification of content, actually impedes students' learning new information (Clark et al., 2012).

Until about the 1980s, Science was overwhelmingly viewed as a fact-based, empirical discipline rather than a language-based one (Guzetti & Bang, 2010). More recently, sociolinguists and other language experts have taken an interest in the nature of students' learning of science, highlighting the importance of literacy in developing communicative competence. However, most existing research focuses on the development of science literacy irrespective of a student's native language. This assumes that science, with its technical terms and context-dependent terminology, can be likened to learning a new language all together (Duran et al., 1997). This is an assumption held by many science teachers, often used to justify teaching content without differentiation, and with no regards for ELLs' language-based struggles. However, assuming that ELLs experience science instruction within mainstream classes in the same way as their native peers, poses two problems. First of all, it masks the fact that many of the impediments ELLs face are language-based, further perpetrating the misconception that ELLs are simply less academically capable than their peers. Secondly, and more importantly, it completely disregards ELLs' native language, both as an instructional support when learning science in English, and as the vessel by which prior knowledge (encrypted in their own language) can be connected to new information learned in English.

The Question of International Schools

With Globalization facilitating the cross-cultural integration of ideas and practices, international schools have become common landmarks in the global educational landscape. In terms of teaching and learning, two observations can be made about international school education. First of all, most school teachers are native English speakers, many of whom have no ELL training (Deveney, 2007). In addition, most international schools offer a wide variety of international diplomas, in the aim of giving their students a competitive edge when applying to university. Such programs, like the International General Certificate of Secondary Education (IGCSE), the International Baccalaureate (IB), and Advanced Placement (AP) courses, despite their decidedly "international" emphasis, use native English speakers as a reference point, from which curricula are designed (Carder, 2006; Tosi, 2012).

The second observation is that ironically, many students in international schools are not native English speakers, and many are what Sociologist Ruth Hill Useem calls "third culture kids" (TCKs) (Dewaele and Van Oudenhoven, 2009). The term is used to describe "children who have grown up outside of their parents' cultures for a significant number of their developmental years" (Dewaele and Van Oudenhoven, 2009. p 445.) Often TKKs themselves come from mixed ethnic backgrounds. Many are the children of expatriates who move frequently from country to country, often switching between school systems. A common characteristic among such students is incomplete English proficiency (Dewaele and Van Oudenhoven, 2009). While they may (or may not) be fluent in spoken English, as research in multilingualism suggests, they don't often fully master the language of instruction (Cenoz, 2003; Quay, 2008) due in part, to constantly switching between different languages in different social environments. While their schooling is in English, they may speak their parents' native language at home, and yet another in interacting with locals in their host country. This incomplete proficiency makes it difficult for teachers to pinpoint language as a

possible factor contributing towards the discrepancy in performance between native speakers and ELLs in international school settings. This is precisely where this study fits in, and where the value of its findings lay.

The phenomenon of TCKs presents two important implications. First of all, TCKs demonstrate that language proficiency is a spectrum, rather than a graded scale consisting of discrete levels. Secondly, TCKs highlight the role of the social environment in language learning, and subsequently the sociolinguistic aspect of scientific discourse. Instructional approaches that fail to accommodate these two implications compromise the overall ELL learning experience.

Although research exists on ELL pedagogies and on the phenomenon of TCKs as two separate bodies, there is a gap in the literature where these two overlap. That is to say, few studies have examined the experiences of ELLs learning science within the multicultural environment of international schools. What makes their experiences unique is that they represent ELLs, with limited English proficiency, enrolled in international curricula designed for native speakers. Not only are most of their teachers from English-speaking backgrounds, the exams they sit after completing these content-heavy courses are assessed against pre-written mark schemes, by native speakers (Tosi, 2012). While ELLs in public schools often attend modified classes, tailored to their English levels, those in international schools who are enrolled in demanding exam courses are completely in immersion and expected either explicitly or implicitly, to “sink or swim”. Their language difficulties therefore, go largely ignored despite being clearly apparent.

This is precisely the gap this study attempts to fill by exploring the experiences of ELLs in an international school, as they study Biology in immersion with native peers. By exploring both the students’ experiences and their teachers’ perspectives, the goal is to better

understand what struggles ELLs face and how science instruction can be better tailored towards them within the confined, and poorly studied niche of international schools.

Given the saliency of language to learning, and the sociolinguistic aspects of science education, it is clear that language proficiency in general English differs from the CALP required to fully engage with scientific content. Due to globalization, international schools are becoming increasingly prevalent, as is the emergence of demanding international curricula, designed to give students a competitive edge when applying for placements at renowned universities. As previously discussed however, the design of such international programs appear to have entirely left out ELLs, despite them comprising the overwhelming majority of the student body within international schools. Language proficiency appears to be a prerequisite for enrollment into such programs, which results in one of two inherently unfair outcomes: either ELLs are allowed to integrate these courses but no accommodations are made for the language difficulties they face, or they are not allowed to enroll at all, effectively preventing them from accessing curricula that are highly esteemed by recruiting universities.

The most obvious conclusion based on the above observations is that ELLs are not granted the same academic opportunities as their native peers. For those who are allowed to enroll but who may not have fully mastered CALP, the question arises as to how they navigate science courses designed with native English speakers as a target group? How do these students experience integrating language and content within mainstream biology classes? What struggles do they face taking in, processing, and subsequently applying new information? How do teachers experience the presence of ELLs in such advanced, content-heavy classrooms? Are they aware of the language barriers ELLs face, and if so, do they make accommodations for them? Through anonymous student interviews, followed by semi-structured interviews with teachers, these questions were explored in the overall aim or

adding the voice of ELLs to the wider field of science education in the international school arena.

Methodology

This section explores the methodology used in conducting this research. It begins by contextualizing the problem, describing its relevance, and subsequently describing the theoretical framework within which the data is collected. A description of the sample and how it was selected is then given, followed by a discussion on the process of data collection itself, including the instruments used.

Overview of Study & Relevance

Although arguably one of the oldest disciplines to have been studied in an academic context, science is considered an empirical or evidence-based subject, taught with an emphasis on content, process, research and inquiry. Perhaps this is why it has traditionally been taught with this very emphasis on content. Today, in many places around the world, rote memorization and traditional forms of "chalk-talk" still dominate science instruction (Odubunmi & Balogun, 1991; Watters and Watters, 2007). These archaic teaching methods are prevalent even in higher education, especially in content-heavy subjects such as Engineering. In many disciplines, instruction at the university level is still largely teacher-centered, and aptitude to teach is still determined by content mastery rather than instructional prowess (Qualters, Sheahan, Mason, Navick, and Dixon, 2008).

Not only is rote memorization an ineffective and obsolete instructional strategy, it fails to engage students' higher order thinking skills, and remains shallowly cognitive. Referring to the cognitive processes domain of Bloom's Taxonomy, "remembering", which involves the recognizing or identifying key information, and recall, which involves retrieving stored information, are actually classified as lower order thinking skills (Bloom & Krathwohl, 1956; Forehand, 2010). Although applicable to all disciplines, higher order

thinking skills are particularly important in science in which students must go beyond "remembering", towards "applying", "analyzing", "evaluating" and "creating". According to Bloom's Taxonomy, the ability to apply, involves implementing learned information and using it to execute tasks. Analyzing, involves differentiating, organizing and attributing traits of characteristics coherently. Evaluating includes monitoring, coordinating and critiquing, and finally, creating involves planning, generating and producing new content (Forehand, 2010). The importance of these skills goes beyond the classroom for aspiring scientists. After all, what is an engineer or a doctor if they can only recall information, without applying it creatively to solve problems or arrive at practical solutions?

In the last two decades however, innovative approaches to teaching science have begun to emerge, shifting the emphasis from content to process. These new approaches are based on the acknowledgement of science as an inquiry-based discipline that is founded on the ability to observe, reflect and hypothesize critically. Well-known instructional strategies that facilitate the cultivation of these skills include problem-, project- and inquiry-based learning, which are becoming more and more prevalent in science classrooms (Hmelo-Silver, Duncan, Chinn, 2007; Keys and Brian, 2001). Furthermore, research on the role of language in science education has also begun to emerge, highlighting its semiotic role in the construction of meaning (Amin et al. 2009; Lemke, 1998). Language as previously mentioned, is used in science as a discourse of reasoning in processes such as: predicting, exploring, inferring, generalizing, clarifying and problem solving (Jaipal, 2002). Although still in its infancy, a growing body of research is now beginning to emerge on the role of language in scientific discourse, and it's implications to teaching practice.

Research Methodology

This study was designed within the inquiry paradigm of social constructivism, in which it is assumed that multiple realities exist and knowledge is a human construction

(Lincoln and Guba, 1994). Subsequently, both the researcher and the participants construct their own realities (Hatch, 2002). The purpose of the study is to add the perspectives of ELLs to the global discourse on science education. Specifically, it seeks to answer three questions: 1) How do English Language Learners (ELLs) experience the integration of language and content within mainstream science classes? 2) Which, if any, aspects of their classroom experience do they find problematic, and which, if any, do they find conducive to learning Biology in English? 3) How do mainstream teachers experience the immersion of ELLs within their classes?

Qualitative means allow for a rich and colorful portrayal of these perspectives, highlighting the tight coupling of language with learning in science. While quantitative studies use deductive means to establish causality or correlations numerically, qualitative means employ inductive methods, exploring phenomena in their "natural" environment as opposed to exploring them, in isolation (Ackroyd & Hughes, 1981; Hatch, 2002). Furthermore, qualitative research methods are less concerned with generalizability to the entire population, and focus more on an accurate portrayal of how the sample in question constructs their reality of a given phenomenon (Lincoln and Guba, 1994; Hatch, 2002). In this case, the focus is on how ELLs construct their reality as students of science. With this in mind therefore, inductive methods are used to better understand how these students construct their reality within this particular context, rather than attempting to generalize these experiences to the wider population.

Sample Selection and Description

In terms of sampling, there is no "best" technique, as different contexts are better fitted to different sampling techniques. Therefore, sampling methods are based on the nature of the research. In this case, purposive sampling is used because the aim of the study is to

understand how a particular category of students construct knowledge in science (Tongco, 2007).

The sample was chosen from within a private, international boarding school, where the P.I worked for a number of years as a high school Biology teacher. During her time there, the P.I noticed ELLs facing more difficulties within mainstream science classes than native speakers, and they were particularly academically disadvantaged within exam classes such as the International General Certificate for Secondary Education (IGCSE), the International Baccalaureate (IB), and the Advanced Placement (AP). This is where her interest in the specific learning experience of ELLs was born. Subsequently, the P.I left the school to pursue higher studies and conduct educational research, and currently has no affiliation with the institution. Her familiarity with the school administration, and her particular interest in the profile of students at this type of institution however, inspired her to choose students and teachers from the school to participate in this study. The sample of this particular study therefore, consists of two groups:

Group one, the students. Forty-five students from an international boarding school, aged 16 – 21 participated in the study. Twenty-seven stated they were boys, 10 stated they were girls, and 8 left the question blank. They were also asked to state the number of years they have studied English for, with the average number of years being 3.

They all rank as B1 according to the Common European Framework of Reference for Language, which describes different levels of reading, listening, speaking and writing of foreign language learners. Level B1 is labeled “independent speaker” and describes students who have achieved an intermediate level of proficiency (Exam English Online, n.d) . Specifically, B1 students:

Can understand the main points of clear standard input on familiar matters regularly encountered in work, school, leisure, etc. Can deal with most situations likely to arise whilst

travelling in an area where the language is spoken. Can produce simple connected text on topics which are familiar or of personal interest. Can describe experiences and events, dreams, hopes & ambitions and briefly give reasons and explanations for opinions and plans. (Exam English, n.d).

Thus, all of the student participants exhibit partial proficiency, making them ideal candidates to study how partial acquisition of CALP affects the integration of language with content in mainstream biology classes. The participating students effectively represent an intentionally targeted subgroup of ELLs that are neither fully proficient, neither at the elementary level of English.

Because some of the students participating are minors, consent from their guardians was required, in keeping with regulations from the Institutional Review Board (IRB). The IRB approval form can be found in Appendix A. The case of these students is particular in that the head of the boarding house is their legal guardian for all academic and pastoral matters. When enrolling their children at the school, it is understood that the head of the boarding house assumes full responsibility of the students while they are away from their parents. Additionally, because these parents are often tied to professional commitments that included international travel and long working hours, it was difficult and impractical for them to be in regular communication with the teachers. The teachers therefore, never deal directly with parents, and instead refer to the pastoral head for all academic and behavioral issues. It was from the head of the boarding house therefore, that official consent was provided, through email, for the students' participation in the research. A copy of this email exchange can be found in Appendix B.

Group two, the teachers. Four female Biology teachers participated in semi-structured interviews that lasted between thirty minutes and an hour, with the average being about forty-five minutes. Details of each teacher's professional background, qualifications

and years of teaching experience were divulged during the interviews, and are summed up in the findings section further on.

Data Collection

Data collection took place in two parts, using two different instruments. The first stage of collection involved the administration of an anonymous questionnaire on the Internet. Following the analysis of survey answers, the second stage of data collection employed semi-structured interviews in an effort to dig deeper into themes uncovered by the surveys. Before any data collection took place, a proposal was submitted to the American University in Cairo's Institutional Review Board, which approved the research and confirmed that participants' safety and privacy were guaranteed. Consent was then given for the P.I to begin collecting data.

Online anonymous questionnaire via Survey Monkey ©. An anonymous online questionnaire was generated using a free online software called Survey Monkey ©, which allows individuals to create customized surveys based on pre-existing templates. The survey consisted of three parts: The first few questions asked for background information about the student such as gender, age, and number of years spent studying English. The second part consisted of multiple-choice questions about individual students' experiences receiving, processing and expressing scientific information in English. The final part consisted of open-ended questions that asked students to elaborate on their attitudes towards the subject and any other information they wished to add. The questionnaire took approximately twenty minutes to complete. A copy of the questionnaire can be found in Appendix C.

The use of Survey Monkey © as an online platform, and the design of the questions themselves, ensured that no personal identifiers are recorded and there is no way of tracking back answers to individual students. In keeping with IRB regulations on anonymity, an introduction was added to the questionnaire reiterating the anonymity clause and also

reminding students that participation would not affect their grade in the course in any way . Results of the surveys have been stored digitally in a password-protected folder, and will be destroyed of six months following the completion of this research project. The only individuals who have access to this folder are the P.I and her thesis supervisor. Because not all participants are eighteen years old, consent through email was granted by the head of the boarding school, who is their acting guardian for all pastoral and personal matters that concern the students.

The benefits of using an online survey are that a large number of responses may be collected in a relatively short period of time, for free. Furthermore, the survey can be administered by persons other than the P.I, with limited effects on the reliability and validity of results, from participants in geographically remote areas. However, the use of a survey does present certain limitations, especially with regards to minors with limited English proficiency. Emotions and feelings may be not be accurately conveyed through survey answers and may be misconstrued by the P.I. Furthermore, there is no way to ascertain exactly how much thought an individual is putting into his/her responses, or the extent to which they are being honest. The survey questions themselves may be read subjectively by different respondents, resulting in different understandings of generic terms such as “poor” or “fair”. Finally, the imposition of the questions themselves, created by the P.I mean that certain issues that may be of relevance to the research question are not identified, by virtue of being omitted from the survey itself (Wright, 2005).

To minimize the effects of these limitations on the reliability and validity of the data set, the questions were designed by the P.I to be as simple and straightforward as possible. They were then reviewed by: 1) the thesis supervisor, 2) a staff member at the American University in Cairo’s Center for Learning & Teaching (CLT), who specializes in survey design, and finally, 3) an ESL teacher. Based on feedback from the CLT staff member, edits

were made such as the removal of double negative statements. The supervisor also suggested shortening certain sentences to make them more straightforward. Finally, the ESL teacher suggested a few word swaps to better accommodate students' limited English. Once all of the recommended changes were made, the final survey was launched online.

After the survey was created, it was launched online and the link was sent by email to seven homeroom teachers who asked their students to fill it in during lesson time. The decision to administer the survey during homeroom time rather than directly during the science class was taken for two reasons. First of all, the mainstream classes are mixed, meaning that they include both ELLs and native English speakers. Because the target group of the study is the ELL population, administering it during science class would mean that only part of the class would be involved, which may cause a disruption. During homeroom class however, ELLs are grouped all together, meaning all students in class would be taking the survey. Secondly, although anonymity was emphasized in the introduction to the survey, some students may feel sheepish filling in a survey about their classroom experiences while their science teacher is around. Administering it during homeroom therefore, also removes this potential source of discomfort.

A total of forty-five responses were collected over a period of seven days. During the first step of data review and analysis, basic demographics such as gender, date of birth, and number of years spent studying English were tallied. Since the questions were also organized into the aforementioned "input", "processing" and "output" categories, analysis was also conducted in this order, with the most and least common answer noted for each multiple choice question. Any noteworthy comments in the "other" section were also highlighted, as were the answers to the free-response section at the end of the survey. Recurring words and concepts were also highlighted. Certain answers did not make sense to the P.I., and appeared to contradict what she had observed during her time teaching. Because

students were not available for subsequent interviews, answers that appeared "odd", or contradictory to expected responses were taken note of, to reflect on with teachers during the interviews. Did the answers make sense to the teachers? Are the actions described by the students in line with what teachers observed in class? If not, what possible reasons would students have to answer dishonestly?

Semi-structured interviews via Skype ©. Following the review and analysis of the student surveys, broad interview questions were prepared, in the aim of probing further into themes, challenges, and questions that arose from the surveys. The interviews had two main purposes. First of all, to attempt to clarify or fill in any gaps identified in student answers and most importantly, to understand the teacher perspective of teaching ELLs in immersion. Ideally, it would have been most effective to interview the students themselves, in order to gain a deeper understanding of their experiences and allow them to elaborate on their answers. However, because this was not possible, teachers were used for this purpose instead, since they are the individuals who work most closely to students, and therefore assumed to have the most accurate understanding of their experiences. Nevertheless, discussing student responses with the teachers necessarily required the P.I to acknowledge the subjectivity of teacher interpretations of student answers. Acknowledging this would prove essential to an objective analysis of the interview data. Thus interview questions were divided into five parts:

1. Introductory questions about the teacher's professional background and experience.
2. Questions about the "input" phase of ELL learning.
3. Questions about the "processing" phase of ELL learning.
4. Questions about the "output" phase of ELL learning.
5. Any conclusions, observations or reflections teachers may want to contribute towards future research in this field.

The four interviews took place using Skype©, a software application that allows individual to have real-time conversations with others over the Internet, often using a Webcam. The interviews were audiotaped using an application called QuickTime©, and saved in a password-protected file on the P.I's personal computer. The files will be destroyed six months following the completion of this research project. Confidentiality was emphasized within the consent letter that was read and signed teacher participants, ensuring them that no personal identifiers would be recorded, and that their participation had no impact on their professional activities. A copy of the teacher consent form can be found in Appendix D and the interview questions can be found in Appendix E.

The benefits of using semi-structured interviews are that the questions are at least partially planned, allowing standardization between participants' responses. This allowed the P.I to draw parallels between the responses of different individuals, which in turn allowed for stronger triangulation between the student data, the teacher data and the existing literature. Triangulation itself increases the reliability of the data (Hatch, 2002). However, the "semi"-structured nature of the questions, allows for more flexibility, since spontaneous questions may arise based on the respondents comments. Finally, the nature such interviews allowed respondents to interact in real time with the P.I, encouraging them to answer candidly in a relaxed and comfortable environment.

There are however, certain limitations associated with semi-structured interviews. Spontaneous questions by virtue of being unplanned may make the overall analysis of the interviews more difficult, as they compromise the standardization of the process, making it more difficult to draw parallels between participants' comments. Furthermore, like any interview, the process is time-consuming, subject to participant bias and data is not widely generalizable. Finally, the process of coding itself is highly subjective in nature, as it depends on how the P.I interprets respondents' comments (Opdenakker, 2006).

In an effort to counter these limitations and ensure that data collection and analysis remained objective, the interview questions were also reviewed beforehand, by the aforementioned staff member of the American University in Cairo's Center for Learning and Teaching. Little emphasis was placed on asking the questions in a particular order, as long as by the end of the interview all issues has been discussed. The P.I exhibited a relaxed body language, tried to make the interviewee comfortable by showing interest at all times, and keeping personal opinions in check. Questions that simply required "yes/no" were avoided, as were guided ones such as "so you're saying that…" A natural and relaxed flow of conversation was maintained throughout each of the four interviews.

Despite both the benefits and limitations of the online questionnaire, it has been chosen by the P.I as the most practical method of gaining the most student responses as feasible, given that the participants are found in a different country. The semi-structured interview, despite being potentially subject to bias, has been selected as the most appropriate tool to gain teacher perspectives on the obstacles identified by students in the survey.

Data Analysis

Much like data collection, data analysis was divided into two stages: Student survey analysis and teacher interview analysis.

Analysis of Student Surveys

Demographics. Forty-five responses were collected for the student surveys. In terms of student demographics, twenty-seven students were boys, ten were girls, and eight did not fill in their gender. Birth dates ranged from 1995 - 2000, with 25 out of the 45 students falling in the bracket between 1997 and 1999. The number of years students spent studying English proved somewhat problematic to accurately quantify. Many students didn't know whether to discriminate between years studying English as a foreign language, and years pursuing all of their schooling in the English language. This proved to be a limitation in

accurate analysis of responses to this question, as a clearer definition of the statement "years spent studying English", would certainly have yielded more accurate information. Answers to this question ranged from 1 - 10 years, with 13 out of the 45 students falling in the bracket of 2 - 3 years.

Data analysis. The survey questions were designed to gain insight on the experiences of English Language Learners (ELLs) as they study Biology in English. As such, questions on the survey were divided up into three categories: questions about the "input" phase, questions about the "processing" phase, and questions about the "output" phase. For purposes of organization, the analysis below is also divided in the same way.

The format of the survey itself included multiple choice, Likert scale as well as open-ended questions. Likert scale questions were based on a five-point scale as follows: strongly disagree, disagree, neither agree nor disagree, agree, strongly agree. Psychometric literature lacks consensus on whether a five- or seven-point scale is preferable. Some research suggests that a seven-point scale is more accurate than a five-point scale because it allows users more discrimination (Dawes, 2008). However, after consulting the ESL teacher who also reviewed the survey before it was launched, it was deemed preferable to use a five-point scale. The justification being that a seven-point scale may have overwhelmed the students. Thus, the simpler five-point scale was adopted.

Analysis involved the use of quantitative descriptive frequencies in order to determine modal answer choices (Saris & Gallhofer, 2007). This method was used for both multiple choice and Likert scale questions. Qualitative thematic coding was used to analyze any comments written in the "other" section of multiple choice questions, as well as in those that required open-ended responses (Saris & Gallhofer, 2007). For these questions, the most frequently used terms were identified as were recurring comments or observations. These were then coded and subsequently folded into the design of teacher interview questions.

Information input questions. Question two asked students to rate a series of statements on a Likert scale, ranging from strongly agree, to strongly disagree. Statement e) read: "The vocabulary in textbooks is hard to understand", and statement f) read: "Test questions are hard to understand". Both questions tackled the difficulty associated with circumventing language barriers when receiving information. In both cases, the majority of students (14/45), students answered: "neither agree, nor disagree". This response implies that they didn't feel that the wording of tests and textbooks was particularly difficult (but that it wasn't particularly easy either). Based on the P.I's teaching experience, ELLs struggle with the wording of mainstream texts more than their native peers, bringing into question the honesty of these answers. Is this how they really felt, or were students avoiding admitting they struggle out of pride? Because it is difficult to assess how honest respondents are being when filling out written surveys, the question was brought up to teachers in the hope of elucidating the issue further (see next section on teacher interview analysis).

Question three was multiple choice and asked: "When a teacher uses a word I don't understand, my reaction is to…", with a list of answer options that included an "other" comment box. While the majority of responses (18/45), were: "immediately ask the teacher", one of the comments in the "other" section was particularly interesting. The student wrote: "Understand the meaning by memorizing the sentence". Although this statement is somewhat unclear, the coupling of "understand" and "memorize" in the same sentence, suggests a coping mechanism by which the student attempts to mask their lack of understanding by memorizing the way in which scientific terms are used. Reflecting on her own experiences with ELLs, the P.I found this to be a very common coping mechanism, whereby students would incoherently string short phrases or statements together that they believed were related. Similarly to a parrot that may memorize a series of words without actually understanding their meaning, ELLs often do so in an attempt to demonstrate perceived

understanding. This statement was also brought up during teacher interviews in order to gain further insight on its significance.

Information processing questions. Question 2 b) stated: "Learning new vocabulary in science class is the same as learning new vocabulary in English class", a statement that divided respondents with 32% agreeing and 25% disagreeing. Although, more students agreed, the proportion of those who disagreed was quite close, and 23% felt they neither agree nor disagree. Once again, the responses suggest ambiguity towards the statement, perhaps due in part to misconstruing it and perhaps due to a reluctance to admit facing difficulties. Question 2 g) stated: "I can easily connect what I learn here in science class (in English), with what I learned in my old school's science class (in my own language)". 34% of students 'agreed'. This was a promising finding, suggesting that despite language barriers, ELLs are able, by and large, to connect what they learn in English to prior concepts, studied in their own language.

Similarly, question 8 asked: "When revising for science tests, I think in…", followed by a series of answer options. 52% of respondents chose "mostly in English but also in my own language". Interestingly, 5% chose "only in my language". One respondent commented in the "other" section saying: "I try to read in English and if I do not understand I read in my own language", suggesting the use of mother tongue as a learning support. This comment is highly significant in that it reiterates existing research which hihglights the importance of incorporating students' mother tongue when learning content in a foreign language (Chimbganda, 2000; Clark et al., 2012; Duran et al., 1997; Jaipal, 2002). Because students build new memory networks by making connections to existing ones (that may be coded in their native language), encouraging rather than preventing students from accessing cognitive resources stored in their native language helps them to better grasp scientific concepts in

English. This in turn, offers new insight into ELL teaching strategies that traditionally prohibit students from using their own language as a support tool.

Finally, question nine asks students to identify the hardest thing about learning Science in a language that is not their own. Twenty-seven students used the word "vocabulary" in their answers, stating that learning new words and terms in Science was the biggest challenge. Communication itself was identified as a barrier, both in terms of teachers communicating with students, and students in turn communicating with teachers. One student said they found it difficult to ask their teacher questions and make themself understood. Another said the words that the teacher themself uses, make it hard for students to understand them. One student summed up the difficulties of the back-and-forth exchanges between teacher and student, as well as the challenge of assimilating the new content, by saying:

The hardest thing is to know science in your languagw [sic] but you need to start knowing in english [sic] the same thing even is not ur [sic] language and is very hard even u kbow ib english u [sic] will not be able to understand like in your own language.

Despite the errors in spelling and grammar, the student's point is highly significant: not only is learning science hard to learn in one's own language, learning it in English is even more difficult because one must master the linguistic tools first, before mastering the scientific content. Because of the challenges associated in mastering these tools, reach the same level of scientific understanding when learning in a different language is more difficult, demanding both more time and cognitive effort.

Information output questions. Question two a) stated: "It's easier to explain my thoughts by speaking than by writing", an observation often made to the P.I by her own students, during her time teaching. 41% of respondents neither agreed nor disagreed, 30% agreed, and 9% strongly disagreed. This result was again, inconclusive, and was thus brought up during teacher interviews (see teacher interview analysis below). Question two c) stated:

"On tests, if I don't know how to say a word in English, I replace it with a simpler word that I know, even if it is not the exact one I'm looking for". 47% of students agreed and 20% of students disagreed. Similarly, Question five, asked: "If I don't know how to say a word in English, my reaction is to…" 45% of respondents chose the option of "describe the word to my teacher so he/she can help me find the name in English", implying that students felt comfortable enough to seek help. 30% reported using an electronic translator to find the word, reiterating the importance of allowing children to exploit cognitive resources in their native languages (Chimbganda, 2000; Clark et al., 2012; Duran et al., 1997; Jaipal, 2002).

Although some teachers are not in favor of allowing students to use electronic translators, fearing that students may become overly reliant on them, their use often allows students to express themselves more accurately, avoiding the frustration often experienced by students who "know the answer", but don't know how to express it in English. Noteworthy comments were made in the "other" comment box, such as two students who stated that their solution was to use simpler words (message reduction strategy), or one student who said they simply skipped the question without asking the teacher at all (risk avoidance strategy). Finally, question seven asked about students' preferred mode of project presentation. 52% of respondents chose oral presentation. Research shows that students often acquire oral proficiency before written proficiency (Canale and Swain, 1989), which may explain why the majority of students preferred oral presentations. Alternatively, they may, as many students mistakenly think, that oral presentations involve less work than written assignments. With hindsight, the question should have included a follow up that asked students to explain why that particular mode of presentation was their favorite. In any case, the question was discussed with teachers during the interviews.

In addition to the multiple choice and Likert scale questions, the answers to open-ended questions yielded noteworthy responses. When asked what strategies their teacher uses

that help them the most, students' responses fell into two categories. The first category involved strategies that helped with the input phase of student learning. For example, nine respondents mentioned the teacher simplifying or avoiding complicated words. Two students said it helps that their teacher speaks slowly, enunciates words clearly and goes over explanations after class. The second category involves strategies that helped students to process material. Two students said they appreciate the additional support material their teacher gives them, such as vocabulary lists, practice homework and revision sheets. Students also appeared to appreciate teachers' efforts to differentiate based on learning style, with one student answering "telling us the meaning in different ways". Six students mentioned the use of diverse media such as pictures, PowerPoint presentations, and one student said practical laboratory work helped him understand better.

Analysis of Teacher Interviews

The sample. Four biology teachers were interviewed using the online platform Skype© and asked about their experiences teaching ELLs Biology. Before being asked about their views on the integration of ELLs within their mainstream classes, some background information on each individual was collected, in an effort to understand how their teaching qualifications, years of experience, and variety of courses taught may influence their classroom time. Below is a table summarizing this information:

Table 1. Summary of teacher backgrounds including teaching qualifications, years in the profession, and courses taught.

Teacher:	Teaching Qualification	Teaching Experience	Teaching Experience with ELLs	Courses Taught
A	IPGCE	3	3	• IGCSE • ESL Bio
B	PGCE	18	3	• IB • IGCSE • Regular
C	None	14	2	• IB • Pre-AP & AP

D	PGCE	9	4	• IB • IGCSE • Regular

Key:

IPGCE – International Post Graduate Certificate of Education.

PGCE – Post Graduate Certificate of Education.

IB – International Baccalaureate.

IGCSE – International General Certificate of Secondary Education.

Pre-AP/ AP – Pre – Advanced Placement/ Advanced Placement.

Regular – Standard-level biology course that fulfills high school science credit, but doesn't include an external assessment.

ESL Bio –English Second Language Biology. Course offered to students who have not reached the "B1" level of English proficiency, according to the Common European Framework of References for Languages.

Data analysis. Grounded theory was used as a "bottom-up" inductive approach when analyzing the body of data, using interview responses as a starting point, from which themes were uncovered and hypotheses were subsequently proposed (Boyatzis, 1998; Strauss and Corbin, 1990). The first step of the analysis involved replaying each interview, in order to identify important keywords, concepts, observations or any other noteworthy pieces of information, which will hereafter be referred to as "codes". The next step was to conduct a cross-sectional comparison of answers to each of the questions, in order to identify differences and similarities among responses to the same question. From here, different codes were grouped together into related "themes". These themes were then compiled into broader groups that will hereafter be referred to as "categories".

Figure 1 shows a breakdown of this analysis, starting with the broad categories, moving into themes, and finally codes. The themes uncovered fell under two broad categories: "technical" and "emotional". Technical themes describe data on the practical

application of language to learning in Biology, and the obstacles students face in doing so, given their limited English proficiency. Emotional themes tackle the affective aspects of the learning experience, and address how integrating language and content in such settings affects students' motivation, self-efficacy, and morale.

Although the codes are arranged in discrete categories in Figure 1, this is largely for purposes of clarity and organization. Given the rich, descriptive nature of interview data, an accurate and profound analysis cannot treat the codes as mutually exclusive entities, and must instead consider the way they interweave between different themes. The same is true for the themes that are also related to one another, and cannot be considered alone. With this interrelatedness in mind, the following section uses Figure 1 as an organizational framework to analyze the interview data.

TECHNICAL

i. INPUT	ii. PROCESSING	iii. COMMUNICATIVE COMPETENCE	iv. TIME
- Vocabulary - Exam Questions - Latin-based reference - Native-language Support	- Biology Background - Native language support	- Expression in science - Framing Questions	- Differentiation - Curriculum Design

EMOTIONAL

i. SELF EFFICACY	ii. COPING MECHANISMS	iii. TRAINING	iv. CULTURE
- Shame - Stigma - Confidence - Frustration - Trust - Rapport - Shyness	- Plagiarism - Lying - Disinterest - Misbehavior - Group Work - Native Language Support	- Teacher Training - Simplifying Questions (yes/no) - Differentiation - "Lazy" Stereotype - Learning difficulty vs language difficulty	- Shyness - Group Work - Willingness to ask questions

Figure 1. A breakdown of the categories, themes and codes uncovered by interview data.

Technical themes. The first category is called "technical", and includes data that relates to the technical aspects of ELL teaching and learning in science. It is divided into four

themes: information input, information processing, communicative competence and finally, time.

Information input. Information input, describes any data relating to how ELLs take in new information. When discussing what they believed ELLs struggle with (in comparison to native speakers), all four teachers mentioned vocabulary, specifically in relation to the complexity of terminology in Biology. Two teachers also mentioned that the detail-oriented, and precise nature of scientific discourse itself makes it difficult for even native speakers to grasp difficult concepts, adding that for ELLs this difficulty is compounded by their limited vocabulary repertoire. Teacher B, describing the experiences of ELLs within advanced exam classes said:

Even just reading one sentence might take them a long time to absorb, not just the English, but the complex vocabulary. I'm not sure they're getting the concepts. They're so focused on understanding each word that they get lost in the sentence and by the end of it they don't know what it's all about.

She added that even after translating vocabulary into their own language, the subtleties of what the teacher is saying are most probably lost on them, meaning they inevitably miss out on some of the content. Similarly, Teacher D said:

It's very difficult to understand something when it's not in….your native tongue. If I was told something in German, I would have to sit there and think about it, translate it into my language. The chances of me mistranslating it are high.

In both examples, teachers expressed the inevitability that ELLs would effectively take in less content than their native-speaking peers.

Teacher A, the only one who teaches ESL biology in addition to exam classes, added an interesting point about how native language itself affects additional language acquisition. According to her, students who have a Latin-based reference point, and whose mother tongue

also share Latin roots, struggle significantly less than those who come from Asian or Arab countries, for example. She attributes this difference to the fact that most biological terms have Latin or Greek roots. The word "lactation" for example, comes from the Latin word "*lactis*", meaning milk. Students with backgrounds in French, Spanish, Portuguese or other European languages may find it easier to understand lactation as breastfeeding, by associating the term to milk. This observation is significant for several reasons: First of all, it reiterates the importance of language in describing, labeling, or otherwise associating words with objects or phenomena in the world around us. Secondly, it implies that even among ELLs, differences is native languages means they face different language-based difficulties, a point which will be explored more deeply in subsequent sections. Finally, it reinforces the importance of native language as a learning tool while learning an additional language. This final point conveniently opens the floor for a discussion on teacher perceptions on native language support.

One recurring theme throughout the interviews, is the role of native language support when learning science in English. All four teachers allowed, and even encouraged, the use of electronic translators during classes. When used responsibly, they all agreed that translators helped students "unlock" the meaning of difficult words, which increases the amount of new information they take in. Teacher C, the most experienced of those interviewed, believes that this practice also has the reciprocal benefit of helping them learn English, because "unlocking" the meaning of a new word, not only allows them to better understand the scientific concept, but quite simply, adds to their growing repertoire of English vocabulary, which is useful both inside and outside of the scientific context. Understanding the meaning of a word like "estimate" for example, would not only help the ELL in Biology class, but perhaps in Math class, or even during a social, conversational exchange outside of the academic environment.

Teacher D mentioned that one of her Chinese students actually audiotapes parts of her lessons, then goes home and translates them slowly into Chinese. Teacher B said that her students often annotate their worksheets, adding footnotes in their own language to complicated parts of the text. Finally, Teacher A said she allows students to discuss work among peers who speak the same language, saying the collaboration helps them gain more out of the lesson. She added however, that she only allows this when she can see that students are behaving seriously and looking at their papers, rather than idly chatting or laughing.

Information processing. The second theme is information processing, and includes data related to the way ELLs assimilate new information. Similarly to the input phase, the role of native language integration appears to play an important role in the way students make meaningful connections between new and existing information. When asked if teachers feel ELLs can easily connect new information (learned in English), with existing information (that may have been learned in their own language), responses varied. Teacher D said she didn't believe students could easily make these connections, and that ELLs struggle to connect different concepts together into a bigger picture. Teacher B, who had no teaching degree but a significant number of years of experience, said that those who had studied Biology in their own school appeared to make connections. She added that they certainly seemed to perform better than those who did not have a Biology background. She believes that having some degree of scientific background facilitated the understanding of material taught in English due to an element of familiarity. According to her, this familiarity to scientific content somehow helped to fill in gaps caused by a lack of language proficiency. Teacher A and C concurred:

I think they do, very often. When I'm teaching them something they'll be like 'oh yea, I learned this in Cairo', or wherever it might be. When they do that you see a big smile on their face because they obviously understood it in their language. I see it a lot, those

connections. I think it gives them a lot of confidence when they can see that they understand, they just don't understand the language. (Teacher A)

They can use simple words and they manage to show me that they get it. They try with the knowledge even if they don't have the keywords or the evidence. Even if it's so badly phrased or so badly said, but you at least get the little understanding. (Teacher C)

Another recurring concept that came up often in relation to information processing was the notion of time, and it's role in the learning process. As per the information in Table 1, which gives a breakdown of each teacher's background as well as the courses they teach, it is worth noting that while all four teach both exam and "regular" courses, only teacher A teaches ESL Biology courses, where all students are ELLs. This distinction is of significance to the next point of discussion because the notion of time was interpreted differently by teachers depending on which classes they were referring to at different points in the interview. Their comments about time differed based on whether they were talking about their exam classes which culminate in externally-assessed exams, or their non-exam classes which culminate in exams written and graded by the teacher herself.

When discussing exam courses, time was mentioned as a constraint to the information-processing stage of ELL learning. Teacher B noted that the sheer process of translating words, itself takes time and slows down the rate at which information is assimilated. She added that any extra time she allots to helping ELLs in particular, holds back the rest of the class and delays their progress towards program completion in time for exams. Interestingly, Teacher A, who is the only one who teaches ELLs in isolation, cited the lack of a time pressure as one of the main facilitators of meaningful information processing among ELLs. When asked if differentiation is a realistic possibility, she was the only teacher who not only believes it is, but also regularly incorporates it into her teaching. In contrast to exam classes, she said time was not a problem because she sets the benchmarks of the course,

meaning unit tests reflect only what was actually covered. These two views of time reflected distinct teaching approaches: whereas teachers in exam courses focused on the entire class collectively covering a set program, those teaching non-exam classes focused instead on individual student development, even if fewer topics were covered overall. It is important to note that neither approach is a reflection on teachers' personal perceptions of ideal teaching. Instead, they reflect externally imposed priorities and brings into question the degree of inclusion such courses afford.

The interplay of curriculum design, time and differentiation, are highly significant to the ELL learning experience. Teacher A who is the only one to teach ESL biology, in addition to exam classes was generally both familiar, and in support of, differentiation. For example, she mentioned modifying mainstream instructional material (PowerPoint presentations), by removing some of the text and adding more visuals. This modification reduced the "volume" of information, while ensuring that ELLs were still following the same course framework. In terms of the curriculum, she specified that her priority was thorough student understanding, even if it meant fewer topics were covered overall. She added that this was possible because she wrote the unit tests according to the amount of material that was actually covered, rather than needing to rush students through a pre-planned set of topics.

The three other teachers, who teach only mixed classes composed of both ELLs and native speakers said that the content-heavy nature of the course made differentiation difficult to implement while ensuring that students completed the program on time, especially with large class sizes. As Teacher B said:

The problem really is time. Going back and re-explaining the same thing in different words again isn't always possible because you have to get through material fast. I try to do that when I do have time, by setting a task for the more accelerated students and then going around to the ESLs one by one. I find that really helpful, you make eye contact, they

listening and are focused and seem to absorb it better as I speak more slowly. When I did that I had four students but now I have so many more so it's no longer possible in terms of time. I try to give them simplified questions and different tests, but it's just double the work and not enough time.

She also said that on top of requiring more time, differentiation also represents "double the work", in classes where teachers themselves have larger workloads due to the advanced level of the course itself. Finally, she feels that allocating extra time and resources to ELLs through differentiation, holds back the exam students by slowing down the pace of the class as a whole.

Communicative competence. The third theme in the "technical" category is communicative competence, and relates to ELLs ability to make themselves understood, or to express what they have learned in a coherent manner. One of the recurring observations among all respondents was that science, and Biology in particular, is a discipline that relies on precise and accurate expression to convey ideas, describe phenomenon, or defend hypotheses. All four teachers agree that while all students struggle to develop their communicative competence in science, a lack of language proficiency, exacerbates this difficulty for ELLs:

I find it difficult to teach them to express themselves about scientific concepts, add to that the difficulty of the English, then add to that the difficulty of the scientific vocabulary! It's extremely challenging for them and for me. Giving them a list of vocabulary is not enough, they often need help on basically constructing sentences, expressing themselves correctly. Even native students have problems with that, saying 'volume' instead of 'amount', so ESLs have additional challenges and I'm not sure how to deal with it. (Teacher B)

This lack of communicative competence appears to frustrate some students:

They shown frustration. They're like, 'I know, I know this process, but I can't explain it'. Or they say 'I've done this, I know this, but in my own language!'. So frustration is really what comes out of them. Some express it loudly and some express it by being more in a cocoon, but it really does annoy them when they know. (Teacher C)

Another difficulty that ELLs face is framing questions, which makes it difficult for teachers to ascertain what exactly a given student is struggling with:

I try to make them at ease, because I know who they are. So if they try to ask me a question, I try to be extra patient and rephrase their question to make sure it's what they want, and I use a different method like a visual to try and explain it on the board. (Teacher C)

They often don't know how to frame a question, so they just stay quiet. Very often they ask, and you cannot understand what they're asking. So you encourage them, try to break their question down piece by piece. It takes a long time. (Teacher A)

Teacher B, despite her many years of teaching experience, reiterated several times throughout the interviews how students' frustration distresses her because she is new to teaching ELLs:

I find it difficult myself because I'm not used to dealing with it, and I have no training in ESL. If I have a student I see is confused, I don't know how to get the question out of them in a way they feel satisfied with, and I don't know how to answer it in simpler words. I speak more slowly and I try to use simpler words but it's a huge challenge. And sometimes I can tell they don't follow my answer.

Emotional themes. The second category involves all themes relating to the emotional component of the ELL experience, within science classes. The four themes are self-efficacy, coping mechanisms used by ELLs, the role of teacher training, and finally, culture.

Self-efficacy. The first, and perhaps most significant theme that has been uncovered is that of self-efficacy, a term used to describe an individual's belief in their ability to

successfully fulfill a goal or objective (Bandura, 1982). Like positive reinforcement, an affirmative belief in one's ability to accomplish a task, boosts morale and actually improves performance (Bandura, 1982; Schunk, 2012). In the classroom setting, a student's belief in his/her ability to achieve a goal, along with their teacher's belief in their student's abilities have a positive effect on student performance (Caprala, Barbaranelli, Steca & Malone, 2006; Zimmerman, Bandura, Martinez-Pons, 1992). Unfortunately however, the converse is also true, meaning that self-doubt and lowered teacher expectations negatively impact not only student performance, but their overall morale and self-esteem (Zimmerman et al., 1992) Before exploring how this theme played out in the data, it is useful to first contextualize the ELL student body within the school in question.

Although official statistics on student demographics were not made available to the P.I, her time working at the school familiarized her well with the general make-up of the student body. Approximately half of students are the children of expatriates and have studied in English for most of their lives. These students are generally highly motivated individuals who enroll in exam courses such as the IB, IGCSE or AP. After course completion, they sit externally assessed examinations, which, when successfully completed, grant them placements at reputable universities. For the most part, these students come from stable family backgrounds, live at home with their families, and enjoy strong parental support. The other half of the student body consists of ELLs with mixed proficiency levels. These students come from the Middle East, West Africa, South Asia or Eastern Europe, and live in the school's boarding house. Many come from troubled families, with absentee parents involved in international business or politics. It is well known that ELLs at the school often suffer from a variety of emotional issues, and don't often have much contact or support from their families. These issues are often expressed in behavioral problems, whereby ELLs are often

involved in cases of delinquency, and academic dishonesty, further perpetuating negative stereotypes of them within the school community.

Despite their large representation among the student body, ELLs remain relatively "invisible" at the school. The focus of faculty and administration lies primarily among the fully proficient "high achievers", whose success in external exams, and subsequent placement in high-ranking universities, boosts the school's overall reputation. Teaching these exam courses therefore affords teachers a sense of prestige, as does being enrolled in them, for students. ELLs and their teachers experience the opposite. The students are seen as less academically capable, and there is a stigma attached to teaching ELL subject classes, which are seen as "easier to teach" than their mainstream equivalents given the lack of pressure to prepare students for the external examinations. These perceptions are embodied in two interesting observations: First of all, English language teachers are the only ones required to have an ELL teaching certification. Subject teachers who teach ELLs are not required to have any training in ELL pedagogy. This is directly linked to the second observation, which is that most ELL subject classes are given to newly qualified teachers with no experience, because more experienced teachers prefer to teach exam classes. With this context in mind, self-efficacy is now explored through the data.

All four teachers agree that ELLs are more shy than their native peers and more reluctant to ask questions, because of the difficulties they face framing questions (as previously discussed), but also, as noted by Teacher A, who is newly qualified and hence teaches ESL classes:

There's no pride in teaching those kids, other teachers feel sorry for you as an ESL teacher, but the progression they [students] make is incredible. It's a challenge, in a different way. But you're not given any credit for it, and the kids feel it too.

Naturally therefore, many ELLs have very low self-confidence, making it difficult, but all the more important, that teachers foster rapport and trust between themselves and their students. This cultivates a safe learning environment in which ELLs feel comfortable enough to expose their vulnerabilities:

They don't have the confidence to speak up. But I also think, that because they lack the language skills, they have lower confidence and are ashamed to admit they haven't understood. They feel it's a reflection on their English, so they just nod and say 'aha, yea', when you ask if they understand. I really enjoy teaching ESL classes because I believe it's more than teaching them science, it's building confidence and rapport so they feel comfortable enough to ask questions. (Teacher A)

I really show them that if they dare [to ask questions], I will really make an effort to change the way I explain, or give them extra support. I can't spend too long, but I'll definitely try. It's like an exchange you know, with time I can see that they ask more. But if you repeat the explanation in the same way without trying they're like 'oh she's using the same language, yea I don't understand', and they stop asking. Perhaps I improved over the years, I'm not saying I'm the best ESL teacher, but I must say I try to show them like 'listen, I will make a real effort without the others realizing to explain things in different ways'. It really works because I see them asking questions, and they dare because I show them they shouldn't be ashamed. (Teacher C)

The fragment *"I will make a real effort without the others realizing…",* shows that this teacher is aware that students feel ashamed of their difficulty, and that she is willing to help them without drawing unwanted attention to their struggle. It also shows her willingness to establish trust between herself and her students. Teacher B said she knows they are often "lost" and admitted that she never really knows how much information they have actually understood. When asked if low self-efficacy affects their motivation and performance, she

said it does, adding: Yea one guy is lost already. I try to give him other material, and he doesn't even bother anymore, he just tries to sleep in class.

Interestingly however, Teacher A said that, when students connect things they learn in English to what they have learned in their own language, they feel a sense of accomplishment. She also noted that often ELLs take pride in the successful completion of tasks that are not language-based:

I find it rewarding to do practical work with ESLs because I can see they enjoy it, and they have a sense of satisfaction doing something that's not language-based. They can be successful at mixing chemicals or whatever it is, and not have to read or write. With practical work they can just be good at it!

This last point is significant, as it is emphasizes the importance of building self-esteem by allowing students to discover and practice different skills, that are not all rooted in language proficiency. Engaging students in activities that are not necessarily language based "levels the playing field", and removes the barrier of language to their performance.

Coping mechanisms. The second theme that falls into the emotional category are the various coping mechanisms used by ELLs to overcome the challenges they face. When asked whether ELLs ever try to mask their lack of understanding, all four teachers said yes, citing nodding, smiling, and saying "yes", as means of feigning comprehension. Teacher D added that students would copy each other's homework to avoid exposing that they didn't understand. Finally, teachers reported that students often use complete disinterest, or alternatively verbal disruptions as a means of coping with, or at least expressing their sense of frustration.

Interestingly, a number of positive coping mechanisms were also used, whereby students used native-language supports to surmount difficulties in both comprehension and expression. Both Teacher A and B mentioned that motivated and keen students preferred to

work in groups, with peers of the same ethnic background, compared to less motivated ones who give up entirely. The use of translators or recorders to audiotape and later transcribe and translate lectures was also mentioned by Teacher B and D, as a means by which students scaffold their own learning.

Teacher training. The role of teacher training, specifically in ELL pedagogy, came up both explicitly and implicitly throughout the interviews. All teachers appeared to have mastered basic strategies such as simplifying questions, offering "yes" or "no" options, and speaking slowly. All teachers, whether they believed they had the time to do so or not, agreed that differentiation is key to meaningful learning, specifically for ELLs. However, only Teacher A exhibited positive perceptions of ELL students, a strong belief in their potential to succeed academically, and a sense of empathy towards their struggle. She also happens to be the most recently qualified teacher, and the only one to have been exposed to elements of ELL pedagogy during her training. This teacher is the only one who used the term "self-efficacy" in her interview, stating: Many students approach their work with very low self-efficacy, feeling they won't be able to do it before they even try.

Student surveys revealed that ELLs' preferred means of presenting work was through "oral presentations". When teachers were asked as to why this might be the case they offered different possible reasons:

It could be laziness, they don't want to do the write up. Especially ESL students, some of them…you know the cases we get aren't the hardest workers of the school. But also, they have this misconception that oral work is easier, which it isn't, but they think there's less to do. (Teacher C)

If they didn't do their homework, they should feel like they can come and get help from you. Instead of being a hard-liner…When this element is missing, they just get a block

and think ‘I can’t do it’. They’re not lazy! There’s this misconception, but actually they find homework very difficult. (Teacher A)

It appears therefore that for all except Teacher A, the presence of ELLs in exam courses made their work more difficult, and they would rather not have them there. Teacher A was the only one who seemed more in support of inclusion, suggesting that proficiency is a spectrum that all non-native speakers, including seemingly “fluent” ones, lie on: Many non-ESL teachers say ‘I’m not an ESL teacher’, but actually all teachers teaching non-natives are ESL teachers.

She was also the only one who picked up on the profound observation that language difficulties often mask learning difficulties, adding yet another layer to the complexities of ELL classroom experiences. While learning difficulties are not exclusive to ELLs, a lack of proficiency in English makes it difficult to identify whether the difficulty is language or learning based. Going back to the role of native language, it was suggested that students with a Latin-based native language struggles less than those with non-Latin-based native languages. But language is only one component of the learning experience. As Teacher A suggests, language difficulties often mask underlying learning difficulties. Considering both points together it becomes even more evident that the ELL learning experience is far more diverse than teachers may initially think, and necessitates a closer and more individualized approach in order to guarantee that students’ unique learning needs are met.

When asked what she attributed her different perspectives on ELLs and their academic abilities to, Teacher A said her training opened her eyes to the role of language in science education:

It used to really annoy me when they all spoke Russian, I was like ‘this is an English-only zone!’, but I understand why it’s important for them to incorporate their language. It was

the training that opened my eyes to the fact that in science it's not just the concepts, but it's also the words, and it helps them with their own language.

Culture. The final theme that falls under the "emotional" category is culture, and how it affects students' behavior and classroom interactions. While all teachers agreed that ELLs are on average, more shy than their native peers, Teacher D said the degree of shyness varied depending on culture, while Teacher B said it varied according to personality. While shyness is certainly a personality trait, culture definitely plays a role in students' conception of "appropriate" classroom behavior. When asked whether ELLs are more of less inclined to speak up in class, Teacher D said it depends on where they come from. She noted that her German students were generally at ease asking questions, while the Asian ones generally remained silent. When asked why, she said: The girl I'm talking about, she comes from a place where she was told it's bad to ask questions, and the teacher is always right. Given that they struggle as it is among their native peers, ELLs reluctance to ask questions for whichever reasons, presents yet another roadblock to their learning, and is something that must be addressed carefully by teachers.

Findings and Implications

Collectively, the student surveys and teacher interviews yielded a large body of rich and descriptive data on how non-native speakers integrate language and content within mainstream biology classes of international schools. An attempt to simplify or summarize this large body of data would not only be impossible, but would do the study a great injustice. Instead however, this chapter presents the main findings of the study, and explores their implications to teaching practice. For purposes of organization, the findings have been divided into five headings as follows: 1) The role of language as a mediator in science learning. 2) The importance of native language to both additional language acquisition and science learning. 3) Communicative competence and expression in science classes. 4) Time,

pace and differentiation within international exam curricula. 5) Student self-efficacy and teacher training.

Language as a Mediator in Science Learning

The role of language as a mediator in learning has been widely documented. In science, it is used, as previously discussed as a discourse of reasoning used to observe, hypothesize, test, and subsequently justify or reject claims. In Biology in particular, language is used to describe living things at all levels of organization, from biochemical reactions to large-scale ecological processes. It makes sense therefore, that the term that recurred with the highest frequency in both the surveys and the interviews was "vocabulary". Students used it when describing what found the most difficult about science classes, saying there was "too much new vocabulary", a claim that supports the importance of literacy in science in order to engage meaningfully with content (Leki, 1995; Sutton, 1992). Teachers used to express what they believed to be English Language Learners' (ELLs) biggest challenge within science classes, saying that the sheer volume of new information and complex vocabulary put ELLs at a serious disadvantage compared to their native peers. This emphasis on the *volume* of information involved in learning Biology, reinforces the notion that scientific terminology extends beyond simple labeling, and instead encompasses a broader collection of semiotic representations that collectively define abstract ideas or concepts (Amin et al., 2009; Hasan, 2002; Lemke, 1998). Scientific terms, as previously discussed, cannot be fully understood in isolation, and must be interpreted using not only words, but also signs and symbols. All of these semiotic representations are rooted in language, which adds a layer of complexity to the learning experience of students like ELLs who exhibit limited proficiency.

Vocabulary was found to be a limiting factor at each level of learning, be it the input, processing, or expression of content. In terms of input, students struggled with the complexity of academic writing found in textbooks. During the processing phase, a large

volume of vocabulary in a new language, meant slower processing times and heavier cognitive loads as students needed to translate words into their native tongues, before storing their definitions within their memory registers. In terms of output, students struggled to express themselves in the accurate and precise way that scientific discourse requires, reducing the quality of their output and making it difficult to differentiate between perceived and actual understanding.

An interesting finding was that, ELLs do not all face the same degree of difficulty with regards to language in science. As noted by one teacher, students who come from native languages that are Latin-based, tend to be more familiar with scientific terms that are also rooted in Latin. Their linguistic backgrounds help them understand words that share similar roots even if the terms themselves are new to them. Contrastingly, ELLs from non-Latin language bases, do not have this advantage, and take longer to understand scientific vocabulary. Scientific terms are indeed often rooted in Latin, and frequently composed of morphemes, which are easier to comprehend for students whose native languages are also rooted in Latin and may therefore recognize the various components of the word (Jaipal, 2002). For those In addition, students who's native languages have entirely different alphabets, such as Arabic or Mandarin, tend to struggle even more, because they must first learn an entirely new alphabet, before learning to string letters together into coherent words, and words into sentences.

The Role of Native Language

A second finding is the role of students' native language as an instructional aid when learning science in a new language. During the input phase, students cited the use of electronic translators as a means of quickly and efficiently translating words into their own language. One teacher reported that students annotate worksheets in their own language to facilitate revision before exams and yet another said her student actually audiotapes lessons

and subsequently transcribes and translates them at home. If a teacher is explaining a biological process such as photosynthesis for example, and uses an important keyword that an ELL might not know, the use of a translator during lesson time allows them to "unlock" it's meaning immediately. The implication of translation in "real-time" therefore, is that students are less likely to fall behind, or miss out on essential parts of explanations simply due to a limited vocabulary repertoire.

The role of native language is perhaps most important during the information processing phase. When new content is received, it must be processed or "assimilated" by the brain, in order to be stored within long-term memory (Schunk, 2012). In lay terms, processing means that the brain must find a way to "make sense" of new information, which involves connecting it to prior knowledge. The challenge is for ELLs to connect new information coded in English, with prior knowledge coded in another language, a process that actually includes two distinct components: linguistic and scientific. Many aspects of language acquisition such as phonological, orthographical and semantic involve multiple brain structures operating simultaneously, as coordinated by synaptic networks (Schunk, 2012). In addition, according to Information Processing theory, new information is itself assimilated by building neural connections to existing information stored in long-term memory (Schunk, 2012). What these two observations imply, is that learning content in a new language is more cognitively taxing than doing so in one's own native language. In order to facilitate this process of "meaning making", research suggests that ELLs rely to some extent on their native language, to translate prior knowledge into English, or to translate new information into their own language (Micic, 2008), a claim supported by this study's findings on the use of electronic translators during lesson time. On a multiple choice question, asking what language they think in when revising for science tests, the majority of students replied "mostly in English, but also my language", reiterating the role of native language as a support

tool when assimilating new information (Clark et al., 2012; Micic, 2008). The data also showed, interestingly enough, that linguistic resources can be shared amongst learners of the same ethnic background, as a means of filling in knowledge gaps. Part of an explanation that one student may struggle to comprehend, may be understood by another. In fact, two teachers shared anecdotes about how the more motivated and keen ELLs preferred to work in groups with other peers who speak the same native language, in an effort to join linguistic resources and arrive at a collective understanding of the material. They both said that, even if the students were all speaking their own language instead of English, allowing them to work in groups actually helped them understand the material better, which in turn improved their understanding of scientific terms and processes in English. This finding was a new perspective, not previously considered by the P.I. However, exploration of the phenomenon of group work among ELLs uncovered research that supports group work among ELLs of the same native tongue, as a means of enhancing additional language acquisition (Long & Porter, 1985; McGroarty, 1989).

During the third step of learning, which involves the expression of scientific content, native language was found, yet again, to play a key role in ways that may be less obvious. Native language support helps ELLs express what they know to teachers, and allows them to show teachers what they may already have studied in their own language. As evidenced by teachers' anecdotes, lack of access to native language resources, coupled with limited communicative proficiency, often leads to frustration and anger on behalf of students who may understand the material but cannot express this understanding to their teachers. In contrast, when students do manage to use translators for support, they take pride in their understanding and feel become more motivated.

Collectively, the abovementioned examples have two implications. First of all, they support the claim that native language increases the volume of new information ELLs take in,

facilitates the connection of this new information to prior knowledge, and scaffolds the student's expression of scientific thoughts, thereby allowing for a more accurate portrayal of what the student has actually understood. The corollary to this therefore, is that traditional instructional strategies that insist on ELLs using only English in class, actually prevent students from accessing valuable scientific resources stored in their native language. Preventing students from accessing this information impedes effective assimilation of new material and lowers the overall quality of learning that takes place.

Although research on the integration of native language support in science education does exist, it remains limited to a small number of studies, and its impacts have not yet translated into widespread, tangible changes in teaching practice. Unfortunately, many teachers still use traditional methods that only incorporate the English language when teaching ELLs science, under that assumption that immersing them completely in English is the most effective way to increase their proficiency (Gersten & Baker, 2000). While relying too heavily on native language support is equally detrimental to building students' communicative competence, neglecting this resource is also ill advised. The following section further explores the concept of communicative competence and it's role in student expression.

The Importance of Communicative Competence

Communicative competence is a general term used to describe a student's ability to express thoughts and understanding in a coherent manner (Jaipal, 2002). The development of communicative competence as a skill is particularly important to biology, as it has been previously described as a "wordy" science (Chimbganda, 2000). One teacher interestingly noted that all students, even native speakers initially struggle to develop a communicative competence. Using Mikhael Bakhtin's (1986) notion of science, as a "social" rather than national language as a frame of reference, all students, regardless of their native language,

must learn to manipulate language to observe, describe, hypothesize and draw conclusions. This teacher's observation that even native speakers struggle to develop their communicative competence at first, reiterates the aforementioned difference between general proficiency and Cognitive Academic Language Proficiency, or CALP. While general proficiency refers to a broad ability to communicate and engage in meaningful social interactions, CALP refers to a more context-specific language proficiency that takes many years to develop. The result is a gap of several years between the acquisitions of spoken English versus academic English (Allen & Park, 2011; Carrier, 2005; Lemke, 1990).

The observation that even native speakers struggle to initially develop communicative competence may lead to the misconception that ELLs and native speakers face equal difficulties in expression. However, given that ELLs exhibit limited proficiency in even general English, they struggle even more than their native peers to develop CALP. This in turn falsifies the notion that ELLs and native speakers face equal challenges in learning science since the latter is a technical field in which communicative proficiency is often likened to "learning a new language all together". If anything, these findings draw attention to the multiple difficulties that ELLs face *in addition to* those they share with native speakers. Much like the adage *"sameness is not fairness",* instructional strategies that fail to take into consideration ELLs unique difficulties are not only detrimental to their learning, but not at all in line with the principles of inclusive teaching that govern most international schools.

Because CALP takes longer for ELLs to acquire than native speakers, ELLs often find themselves in situations where they understand a concept, but don't know how to express this understanding coherently (Chimbganda, 2000; Corder, 1967; Jaipal, 2002). The result, as previously discussed is a sense of frustration, which is channeled either positively or negatively. In some cases this frustration translates into feelings of hopelessness, but in others, it encourages students to use various coping strategies to communicate, despite the

barriers they face (Chimbganda, 2000). The problem with coping strategies is that, as their name suggests, they are used to "cope" with a problem, rather than solving it once and for all. In this case, the problem is difficulty in communication, and coping strategies are used to cover up this difficulty, often at the cost of the intended communicative goal. Efforts to make up for communicative incompetence by using coping strategies therefore inadvertently result in the masking of problem areas or gaps in content understanding. The following section explores this phenomenon further using examples of coping strategies uncovered from the data.

L2 strategies include paraphrasing, which involves repeating information in an effort to accurately convey it's intended meaning, and circumlocution, which means avoiding directly answering the question by elaborating instead on background information (Chimbganda, 2000). Another type of strategy is risk-avoidance, which as its name implies, involves efforts to mask communicative incompetence by avoiding direct engagement with the topic of the question, thus relinquishing the communicative goal entirely (Chimbganda, 2000). Semantic simplification is the use of a simplified repertoire of reasoning or hypotheses to facilitate communication (Chimbganda, 2000). Often used when students understand the content, but lack the linguistic tools to express this understanding. The result is a vast reduction in the intended message, which is arguably one of the most unfortunate consequences of this approach. Finally, risk-taking strategies, involve efforts to communicate despite limited linguistic tools, at the cost of correct grammar, spelling and syntax (Chimbganda, 2000) .

According the data, students typically used L2 strategies such as paraphrasing and circumlocution on tests or written assignments. Risk-avoidance was used by leaving test questions entirely blank, or refusing to participate in class discussions. Semantic simplification was one of the most common strategies identified within the data, resulting in

message reduction. The unfortunate implication of this particular coping strategy is that, it is ultimately the most detrimental to ELL learning, because it masks students' actual understanding, and instead perpetuates the incorrect perception that the student hasn't understood the topic well. Finally, risk-taking strategies were also commonly used according to the data. All teachers agreed that students used risk-taking strategies, at the cost of correct grammar, spelling and syntax. Although risk-taking remains a coping strategy, the fact that students used it often showed that they were willing to express, however rudimentarily, what they had understood. This is particularly noteworthy, because it led to a discussion on the extent to which teachers made accommodations when marking the work of students with limited proficiency.

Teachers were asked if they penalized ELLs in the same way as native speakers, or if any leniency was shown when the teacher "could see that the student understood the concept" but was obviously struggling to express themselves. For non-exam classes, teachers were more lenient with ELLs, and accepted answers that were less precise or accurate than desired. However, in exam classes, the same teachers were less lenient with ELLs. In order for points to be awarded, answers needed to adhere exactly to the mark scheme. The justification for doing so was that exam classes culminated in externally-assessed examinations, meaning that the principal role of the teacher was to prepare students for those external examinations. In such contexts, leniency may seem tempting, but in the long run, would give students a false impression of their progress. The fact that teachers the teachers interviewed recognized this is significant in light of research on the effect of teacher expectations of student performance. While teachers may be tempted towards leniency, it often results in the lowering of content goals and academic expectations of ELLs, which in turn gives students false impressions of their progress. Poor scores on standardized examinations subsequently come as a surprise, and lower student self-efficacy and motivation (Duran et al., 1998).

Interestingly, one strategy that recurred in the data, but that does not clearly fall into any of the abovementioned categories is dishonesty. When asked about common strategies used to "mask" their difficulties, all four teachers said that students lie when asked if they understand, adding that they often smile or nod to appear more convincing. One teacher added that they even resort to copying their friends' homework to avoid exposing that they didn't understand how to do it. In a particularly touching anecdote, one teacher recalled a student who came to her admitting he hadn't done his math homework, which was due in the next lesson. When she asked him why, he said he didn't understand how to do it, but made the teacher swear she wouldn't tell anyone his secret. The student was adamant about the last part, he didn't want his math teacher to know that he was struggling. This apprehension and unease related to students' language abilities has been appropriately called "language anxiety", and arises particularly when students are moved from ESL classes to mainstream ones (Papamihiel, 2002). In mainstream classes, in the absence of their familiar ESL environment, their confidence may be shaken, resulting in feelings of stress or trepidation (Papamihiel, 2002). Beyond empathizing with the abovementioned student's struggle, this anecdote gives an indication of just how far students are willing to go to hide their difficulties. It also raises the question as to why they want to hide them to begin with? With this question in mind, the following section discussed one of the most important findings of the study; the role of self-efficacy in learning, and its effect on student-teacher interactions.

Student Self Efficacy As a Performance Predictor

Self-efficacy was certainly a highly salient theme found in this study. Data analysis revealed the existence of a negative feedback loop, essentially fueled by low self-efficacy. Existing research supports the claim that self-efficacy correlates directly with student performance, meaning that a positive belief in one's own abilities, actually results in higher achievement (Schunk, 2012; Zimmerman et al, 1992). Unfortunately, the converse is also

true. Research also supports the fact that a teacher's belief in a student's capabilities also improves their performance, known informally as "positive-reinforcement". The negative feedback loop uncovered in the data, not only supports claims by research, but also suggests that the inverse is also valid, whereby replacing low self efficacy would logically convert the negative feedback loop into a positive one where student performance improves and teacher expectations are raised.

All four teachers agreed that ELLs exhibit low self-efficacy and motivation, and three out of the four teachers believed ELLs to be less academically driven than their native peers, a belief commonly held by educators of nonnative English speakers, especially those from immigrant backgrounds (Vollmer, 2010). When asked why ELL performance is generally lower than that of native students, one teacher cited laziness as a reason, adding that ELLs "are not known to be hard-workers", a stereotype that also recurs in other studies (Vollmer, 2010; Wright, 2004). Such perceptions suggest that, there may be some correlation between student self-efficacy, teacher perceptions and actual performance. Analysis of the data exposed a negative feedback loop whereby students enter mainstream classes already stigmatized and feeling less capable, a perception often perpetuated by three of the four teachers interviewed. This low confidence contributes to lower achievement than their native peers, which seemingly confirms both their own self-doubt, and reinforces the lower expectations teachers have of them. This in turn, feeds back into the cycle, further lowering their self-efficacy and motivation to continue working. A visual representation of this hypothetical negative feedback loop is provided below:

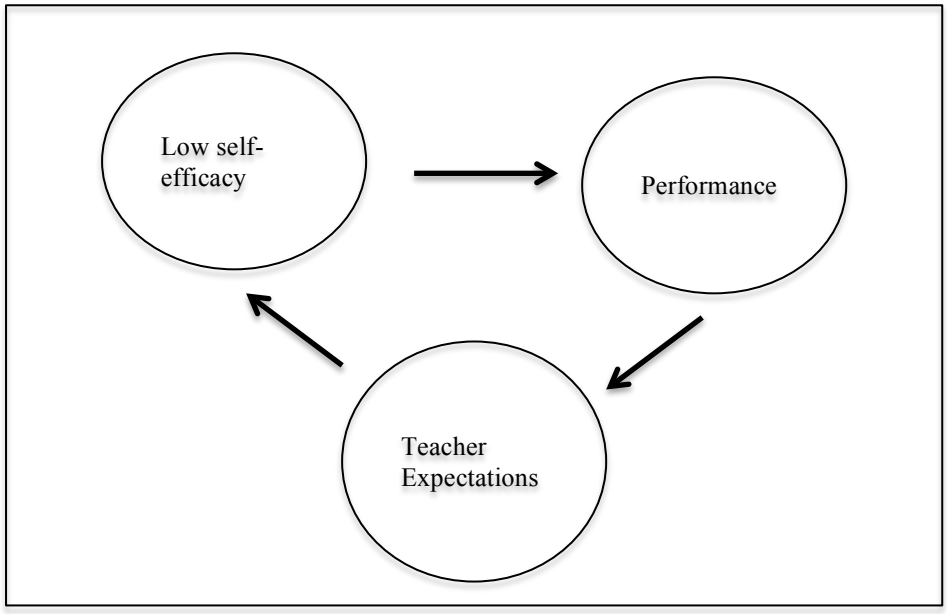

Figure 2. The cyclical relationship between low self – efficacy, performance, and teacher expectations.

The cyclical nature of the process depicted in Figure 2 suggests that there are no particular starting or ending points, it is therefore difficult to tell whether low teacher expectations before a student has the chance to "prove" him/herself are what leads to lower scores, or whether low self efficacy, leads to low scores, which in turn lower teacher expectations of ELLs. Regardless of whichever factor "came first", the significance of this cycle is that negative views students have of themselves seem to result in negative outcomes, which raises several important questions.

First of all, why do ELLs come into mainstream classes already doubting their capabilities, before even putting these to the test? The answer lies in the niche that these ELLs occupy, within the wider context of the student body. As discussed earlier, ELLs are not only a minority, but are somewhat marginalized by their peers and even by the faculty, who afford them less importance than the "high achieving" native speakers who exhibit high academic potential. However, their low self-efficacy is not the sole factor that determines their performance, and a second question that arises when analyzing the feedback loop is, what other factors set ELLs up to perform poorly when compared to their native peers?

Both existing research, and the data suggest that a lack of communicative competence leads to coping strategies such as message reduction that compromise the intended communicative goal, thereby lowering the overall "quality" of student responses (Chimbganda, 2000). This in turn reflects in poorer scores, which as previously mentioned, feeds the low self-efficacy that fuels the negative cycle (Zimmerman et al., 1992). The implications of this are that ELL performance is dictated by a complex array of factors that appear to still be poorly understood, falsifying the oversimplified assumptions that ELLs simply are not hard working.

Since self-efficacy is what fuels the cycle, the final question that arises from this negative feedback loop, is how to replace low self-efficacy with high self-efficacy as the driver of this process? During the interviews, one teacher made a particularly profound observation, which is that students took pride in succeeding in non-language-based tasks. Given that language is so central to learning in science, it seems natural that students who struggle with it, would feel overwhelmed by it's ubiquitous presence as a limiting factor in all aspects of their learning. Conversely, it makes sense that they would enjoy tasks in which their success didn't depend on this limiting factor. During practical activities such as laboratory investigations, this teacher reported that not only was the discrepancy in performance between ELL and native speakers far less evident, but students themselves thoroughly enjoyed the challenge of a hands-on task where their proficiency wasn't a limiting factor to achievement. She did add that they still took longer to perform tasks because instructions needed to be repeated to them slowly, and several times, but that overall, engaging in non-language based activities seemed to promote their self-efficacy.

The significance of this observation is that despite the centrality of language to learning in science, it is both possible, and essential to engage students in activities that are not language-based. Doing so "levels" the playing field, so to speak, albeit only to a certain

extent, between ELLs and native speakers by removing language as a measure of achievement. It also promotes higher self-efficacy, which is the factor that fuels the negative feedback loop mentioned above. Replacing negative self-efficacy with positive self-efficacy, converts the negative feedback loop into a positive one, resulting in higher student achievement, higher teacher expectations of ELLs, and most importantly a more rewarding learning experience for these students.

Inclusion in International Curricula

The final, finding of the study is the question of inclusion within international curricula. Programs like the International Baccalaureate Diploma Program (IBDP), the International General Certificate of Secondary Education (IGCSE) and Advanced Placement (AP) courses are world-renowned for their academic excellence, with many universities even offering university credit for successfully completed IB and AP courses. The IB in particular, is touted as a modern and interdisciplinary program, based on principles of global citizenship, diversity and open-mindedness (IBO Online). In fact, the "IB Learner Profile", which describes the characteristics and competencies that IB students should fulfill includes attributes such as: inquirers, knowledgeable, thinkers, communicators, principled, open-minded, caring, balanced and reflective (IBO Online, n.d).

Language proficiency isn't explicitly stated in the Learner Profile, but is clearly a requirement given the complexity and breadth of the program's content. Assessment questions all begin with "IB Command Terms", which represent skills students should have developed by the end of the program. These terms are roughly aligned with principles of Bloom's Taxonomy, and are designed to challenge students to go beyond simple recall during assessment. Examples of such terms are, "argue", "deduce", "explore", "formulate", "justify", "reflect", among many others. In terms of Bloom's Taxonomy, all of the abovementioned terms involve higher order thinking skills (Bloom & Krathwohl, 1956;

Forehand, 2010). But of what use are higher order thinking skills, if thoughts cannot be expressed due to limited language proficiency? This question is especially relevant since final examinations are externally assessed against mark schemes, meaning that examiners don't know the individual students' language levels, and award marks based on very narrowly defined criteria. Whether explicitly or implicitly therefore, the IB is a rigid and inflexible program tailored to native speakers, or at least to those who have mastered CALP. It would be a fair assumption therefore, that most students enrolled in such programs are in fact, native speakers.

Research however, shows the opposite. Native English speakers from North America or the United Kingdom generally attend public schools in their countries, and graduate with national high school certificates. The students who enroll in programs like the IGCSE and IB are generally international students who attend private international schools (Hayden & Wong, 1997; Hayden, Rancic & Thompson, 2000). That doesn't mean that all IB and IGCSE students are ELLs, in fact many are third culture kids who may have studied in English all their lives. But a fair number of ELLs do opt for IGCSE and IB courses in the hopes of securing spots at reputable universities. The problem therefore, is that while many IB and IGCSE students are not, in fact native English speakers, the programs appear to be tailored to such students. Looking at these exam boards as businesses therefore, it can be said that they discriminate against the very same students that form their "client base", so to speak.

There appear to be three possible resolutions to the abovementioned dilemma. The first possible change is at the program-level and consists of an overhaul of the IBDP and IGCSE curricula, which would involve changes to both content and assessment, to accommodate students with limited English proficiency. Textbooks would need to include support material, and assessment would also need to change to accommodate students with limited language proficiency. Given that the exam boards themselves are the entities that

would make these changes, such an overhaul is not something that is easily implemented. This leads to the second possible change, which is at the school-level and involves modifying instructional time and strategies to better support ELLs enrolled in such programs.

As the data reveals, time and pace severely limit the amount of differentiation teachers can provide for ELLs enrolled in their exam classes. Yet, the teachers who did attempt to differentiate instructional material and provide added scaffolding for students reported that ELLs benefited from such adjustments. The question therefore isn't whether differentiation is needed or not, but rather, how it can be afforded given such tight time constraints. In most international schools, the IB, IGCSE and AP programs run over a period of two years. Perhaps adding a foundational term to this two-year program would allow ELLs to acclimatize to the level of accuracy and precision required of students, and would help them cultivate the linguistic tools used to express this accuracy and precision. The foundational or preparatory course should include all of the language based study skills that ELLs would need to succeed in the actual course, and should address the challenges faced while taking in new information, processing it and subsequently expressing it. It should also familiarize students with scientific discourse as a "social language" and most importantly, allow students plenty of opportunities to practice and refine their communicative competence. The duration of such a course need not be very long, and could take place during summer holidays before the student enters the exam course the following school year. Once enrolled in the two year program, ELLs may be offered additional language-based support as a means of continuing the scaffolding provided during the foundational course. This could take place in the form small-group lessons, for example. This would not only alleviate pressure from the teacher as they struggle to meet the needs of all students, but would also give ELLs an added sense of support and security, which would increase their self-efficacy.

A final possibility, at the student-level, which some schools may opt for, but is arguably not the best option, is simply making the exam more exclusive, and requiring students to pass a language proficiency exam before enrolling. In contrast to English placement tests that most international schools require students to sit, this could be a science-specific proficiency test that assesses the extent to which students have acquired CALP. In this way, students who don't meet linguistic requirements would simply not be allowed to enroll in the course. This option obviously defies all attempts at inclusion and equal opportunity, making it a less than favorable solution.

Regardless of whichever option is preferable, the last finding of this study, that ties together all of the themes uncovered, is the relationship between teacher training and the quality of ELLs learning experience. Not only do many teachers lack the instructional know-how and resources to meet the needs of ELLs (Hayden, Thompson & Jeff, 2013), many are "blissfully ignorant" as reported by one of the interviewed teachers who noted many of her colleagues stance that, "I'm not an English Second Language (ESL) teacher, this isn't my problem". Understanding that language proficiency isn't divided into discrete levels on a graded scale, and is instead a continuum the term, broadens the definition of "ELL" to encompass far more students, especially in international schools. Therefore, as Teacher A said, all teachers of nonnative speakers are indeed ESL teachers.

Given the prevalence of ELLs in schools, and the role of language as a mediator of learning, teachers must be trained to meet not only the technical needs of these students, but also their emotional ones. Doing so will guarantee a more positive and inclusive learning environment where each student feels valued for their unique characteristics.

Conclusion

This research study was conducted in the aim of achieving three goals. The first was to examine how English Language Learners (ELLs) experience the integration of language

and content within mainstream Biology classes. The second was to articulate which, if any, aspects of their classroom experience hindered, and which helped their efforts to learn Biology in a foreign language. Finally, the third goal was to explore how teachers experience the immersion of ELLs within their mainstream Biology classes.

Through student surveys and semi-structured interviews with teachers, a rich and descriptive account of both the student and teacher perspectives on ELL science education was uncovered. Despite geographical barriers between the P.I and subjects, data was collected remotely using the Internet. Ideally, one-on-one interviews with students would have enriched the data set further, along with classroom observations. However, because neither were possible, the administering of the surveys first, their subsequent analysis, and use in the design of interview questions for teachers, provided for triangulation between sources and completed the overall picture. The main findings of the research are summarized in five main points. Firstly, the data reiterates the central role of language as a mediator for learning, in any discipline. Secondly, the importance of native language to both additional language acquisition and learning Biology is highlighted. Similarly, the importance of communicative competence, especially in scientific expression is supported by the data. Time, pace, and differentiation were also found to be fundamental aspects that require careful consideration in the design and delivery of international exam courses such as the International Baccalaureate Diploma Program (IBDP) or the Advanced Placement (AP). Finally, the importance of fostering a supportive learning environment that promotes high self efficacy among students is reiterated.

In the introductory section of this study, three vignettes were provided to contextualize the experiences of ELLs in international schools. As this is written, Anton continues on his academic journey in university, Fahd struggles to complete the academic year and move into Grade 12, and Xiao-Ren's future plans remain uncertain. At the same

time, additional students just like Anton, Fahd and Xiao-Ren are enrolling in international schools for the upcoming year. It is the hope of the P.I, that this study, not only raises awareness about such students, but also contributes towards research that ultimately seeks to improve the schooling of these underserved learners. After all, as Linda S. Wallace says, "inclusion is the umbrella that keeps us dry when the downpours of life occur".

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Appendix A

The American University in Cairo, Institutional Review Board Approval

To: Yasmeen Tawfik

Cc: Dena Riad & Salma Serry

From: Atta Gebril, Chair of the IRB

Date: Feb 4, 2015

Re: Approval of study

This is to inform you that I reviewed your revised research proposal entitled "Integrating Language and Content Within Mainstream Biology Classrooms - The Experiences of English Language Learners," and determined that it required consultation with the IRB under the "expedited" heading. As you are aware, the members of the IRB suggested certain revisions to the original proposal, but your new version addresses these concerns successfully. The revised proposal used appropriate procedures to minimize risks to human subjects and that adequate provision was made for confidentiality and data anonymity of participants in any published record. I believe you will also make adequate provision for obtaining informed consent of the participants.

This approval letter was issued under the assumption that you have not started data collection for your research project. Any data collected before receiving this letter could not be used since this is a violation of the IRB policy.

Please note that IRB approval does not automatically ensure approval by CAPMAS, an Egyptian government agency responsible for approving some types of off-campus research. CAPMAS issues are handled at AUC by the office of the University Counsellor, Dr. Amr Salama. The IRB is not in a position to offer any opinion on CAPMAS issues, and takes no responsibility for obtaining CAPMAS approval.

This approval is valid for only one year. In case you have not finished data collection within

a year, you need to apply for an extension.

Thank you and good luck.

Dr. Atta Gebril

IRB chair, The American University in Cairo

2046 HUSS Building

T: 02-26151919

Email: agebril@aucegypt.edu

Appendix B

Consent for Minors to Participate in Online Survey

Yasmeen Tawfik <tawfikyasmeen@aucegypt.edu>

Dear Mr. Usher,
My name is Yasmeen Tawfik, and until recently I worked CDL as a teacher. I'm currently doing my Master's in Education and, in cooperation with Elizabeth Durant, deputy head of the English department, am conducting educational research as part of my studies.

I would like to administer a survey to the ESL students, since I used to teach them and am interested in the way theylearn. As they are minors, but living away from their parents, I am requesting consent to do so from you, as the head of their pastoral care.

Here is the link to the survey, incase you want to look at what the ten questions are:

https://www.surveymonkey.com/s/JF7DGRV

I am also attaching a consent form that validates the ethics of the survey and ensures complete anonymity of the results. You don't actually have to sign it, a simple email reply giving me the green light to administer the survey should do.

Thank you for your cooperation on this, I look forward to your reply.

Documentation of Informed Consent for Participation in Research Study

Project Title: *Integrating Language and Content Within Mainstream Biology Classrooms - The Experiences of English Language Learners*

Principal Investigator:

Yasmeen Tawfik

Telephone: (+20)01094744424

Email: tawfikyasmeen@aucegypt.edu

*Your student is being asked to participate in a research study. The purpose of the research is to understand the way English Language Learners integrate language and content learning within a mainstream Science classes. The findings may be published and presented in the future, although no names or personal identifiers will ever be included.

*During regular lesson time, your student will complete a questionnaire using the internet-based research software SurveyMonkey. The expected duration of participation should be approximately 10 minutes.

*There are no risks or discomforts associated with this research. Recall that this study is an entirely independent undertaking with no impact whatsoever on your student's academic career.

*While there will not be any direct, material benefits or remuneration associated with participation, what your student will gain from participating in this study is adding his/her voice as a stakeholder, to the growing body of research in Science education.

*The information your student will provide for purposes of this research will be stored in a password-protected file. Student questionnaires will be anonymous.

* Any questions about the research are more than welcome and should be directed to the principal investigator (contact details at top of first page).

*Participation in this study is voluntary. Refusal to participate will involve no penalty or loss of benefits to which your student is otherwise entitled. Your student may discontinue participation at any time without penalty or the loss of benefits to which he/she is otherwise entitled.

Signature (Teacher) _____

Printed Name _____

Date _____

USHER Justin <justin.usher@cdl.ch>

Dear Yasmeen,

I hope you are well. I am happy to sign the form, but I wonder what the best way to get as many answers as possible is. I could send it in Houses, but Elizabeth might want to consider pushing it into the classes? Please let me know how you would like to proceed.

Best,

Justin

Justin Usher

Director of Boarding

Collège du Léman Sàrl

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justin.usher@cdl.ch : www.cdl.ch

Yasmeen Tawfik <tawfikyasmeen@aucegypt.edu>

Dear Mr. Usher,

Thank you for your prompt reply! As far as the survey itself goes, Lizzie's has very kindly agreed to cooperate with the ESL teachers to administer it directly in lesson time. So on your

side, all I need is an email acknowledgement (replying to this email for example), giving me permission to administer the survey.

Thanks again for your help, and cooperation!

Yasmeen

Sent from my iPad

USHER Justin <justin.usher@cdl.ch>

Hi Yasmeen,

I am happy to sign. Good Luck!

Yasmeen Tawfik <tawfikyasmeen@aucegypt.edu>

Thank you!

Appendix C

Student Survey Questions

Introduction Questions:

1. Date of birth:
2. Male/Female:
3. Number of years studied English:

Please rate how much you agree or disagree with the statements below: (scale of 1-5 from strongly agree, to strongly disagree):

4. In Biology class, it's easier to explain my thoughts in speaking than writing.
5. Learning new vocabulary in Biology class is as easy as learning new vocabulary in English class.
6. On a test, if I don't know a vocabulary word, I use a simpler one instead, even if it's not the exact one I want.
7. I don't care about my grammar and spelling, as long as my teacher understands what I am trying to say.
8. I find the vocabulary in the textbook difficult to understand.
9. I find the test questions difficult to understand.
10. I can easily connect what I learn in Biology class here with what I learned in Biology in my old school in _____ (insert language).

Multiple Choice Questions:

11. When the teacher says something that I don't understand, my reaction is to:

a. Stop him/her and ask for an explanation
b. Ask the teacher alone after class
c. Ask my friend to translate during class

d. Stay silent

e. Other *(please specify:)*

12. How would you describe the pace of the class?

a. The pace is too fast, I can't keep up with the new words and definitions

b. The pace is fine, I understand and follow along easily

c. The pace is too slow, I get bored easily

13. If I don't know how to express my thought in English during a test:

a. I use an electronic translator to help me translate the words I am looking for.

b. I ask my friend how to say the word in English.

c. I describe the word to my teacher so that he/she can help me find the name.

d. I draw a picture.

e. I leave the space blank.

f. Other *(please specify)*:

14. My grades in Biology now compared to my grades in Biology when I studied in my own language are:

a. Lower

b. Higher

c. Similar

15. If you had a project, how would you like to present it?

a. Written essay

b. Oral presentation

c. Drama (short film, role play, song etc)

d. Other *(specify)*:

16. When revising for Biology tests, my thinking is:

a. Only in English

b. Only in _____ (insert language)

c. Mostly in English but also a little in _____ (insert language)

d. Mostly in _____ (insert language) but also a little in English

e. An equal mix of English and _____ (insert language)

Open - Ended Questions:

17. What's the hardest thing about learning Biology in English?
18. What is the one thing your teacher does, that helps you the most to learn Biology?
19. If you had a chance to keep or drop Biology next year, what would you choose, and why?

Appendix D

Consent for Teachers to Participate in Semi-structured Interviews

Documentation of Informed Consent for Participation in Research Study

Project Title: *Integrating Language and Content Within Mainstream Biology Classrooms - The Experiences of English Language Learners*

Principal Investigator:

Yasmeen Tawfik

Telephone: (+20)01094744424

Email: tawfikyasmeen@aucegypt.edu

*You are being asked to participate in a research study. The purpose of the research is to understand the way English Language Learners integrate language and content learning within a mainstream Biology class. The findings may be published and presented in the future, although no names or personal identifiers will ever be included.

The procedures of the research will be as follows:

1. Anonymous Student Survey: Administered during class time and filled in online via Survey Monkey. *Please note that this survey intended for students to complete, not teachers.*
2. Confidential Semi-Structured Interviews: Following the student surveys, interview questions will be conducted with teachers in order to gain instructor perspectives on integrating language and Science in the classroom. Interviews will either take place in person or online via Skype, depending on teachers' conveniences. Interviews are expected to last around 45 minutes each. The interviews will be audiotaped to facilitate coding and data analysis.

*There are no risks or discomforts associated with this research. Recall that this study is an entirely independent undertaking with no impact whatsoever on your professional career.

*While there will not be any direct, material benefits or remuneration associated with participation, what you gain from participating in this study is adding your voice as stakeholders, to the growing body of research in Science education.

*The information you provide for purposes of this research will be stored in a password-protected file. Student questionnaires will be anonymous, and teacher interviews will be confidential.

* Any questions about the research are more than welcome and should be directed to the principal investigator (contact details at top of first page).

*Participation in this study is voluntary. Refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may discontinue participation at any time without penalty or the loss of benefits to which you are otherwise entitled.

Signature (teacher) _____

Printed Name _____

Date _____

Appendix E

Teacher Interview Questions

Audio/Visual Check: QuickTime and Skype working

Background/Introduction to Study:

- Title of study: *Integrating Language with Content in Mainstream Biology Classrooms - The experience of English Language Learners*
- Purpose: To understand the experiences of ELLs as they simultaneously learn Biology and English

"Agenda" of interview:

- Background questions
- Teacher perspectives on teaching ELL
- Comments on Student Survey responses (input, processing, output)

Interview Questions

1. Number of years teaching, how many of those were in an international school?
2. Number of years teaching ELLs?
3. Teaching qualification?
4. Do you see a connection between language and science, in your role as a teacher?
5. Have you identified any particular challenges associated with teaching ELLs versus native speakers?

"Input" - related questions:

1. What do you think ELLs struggle with, in terms of taking in new information?
2. Do you feel that your ELL students ask questions readily when they don't understand?
3. Do you ever feel that they mask their lack of understanding? (How?)

4. “The hardest thing is to know science in your languagw but you need to start knowing in english the same thing even is not ur language and is very hard even u kbow ib english u will not be able to understand like in your own language.” - your interpretation?

“Processing” - related questions:

1. Do you find students connect what they learn in your class, to prior knowledge in their own language?

“Output” - related questions:

1. Many students said they replaced words they didn’t know in English with simpler ones, even if their original meaning is diminished. What do you think of this?
2. Many students said they asked their peers, or used an electronic translator to find words they didn’t know in English. What do you think of this?
3. The majority of students said their preferred mode of expressing their work was through oral presentations. Any ideas as to why?
4. Once student said they remain quiet even if they don’t understand because “asking questions to teacher is hard”. Another one said “words teacher uses is hard”. How do you facilitate back and forth verbal interactions?
5. Among the strategies students said helped them learn, students mentioned:

a. Simplifying complex terms
b. Explaining concepts in different ways (diagrams, lab demonstrations, videos)
c. Providing support material (vocab lists, additional worksheets, revision sheets)
d. Speaking slowly, enunciating scientific vocabulary clearly, going over explanations after class again

Realistically, how much of this is possible, and if not all, what obstacles do you face trying to incorporate all of these?

AOB: Do you have any additional comments to add?

Thank you very much for your time.