A CORRELATIONAL-COMPARATIVE STUDY OF GRADES 9, 10, 11 AND 12 STUDENTS' MOTIVATION FOR LEARNING BIOLOGY AND THEIR BIOLOGY ACHIEVEMENT AT PAN-ASIA INTERNATIONAL SCHOOL, THAILAND

Martyn Carthy

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of MASTER OF EDUCATION in Curriculum and Instruction
Graduate School of Human Sciences
ASSUMPTION UNIVERSITY OF THAILAND
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Thesis Advisor: ASST. PROF. DR. RICHARD LYNCH

This study investigated student motivation for learning biology, with student biology achievement at Pan-Asia International School (PAIS) in Thailand. The study separated Grades 9 and 10 students, and Grades 11 and 12 students according to their academic program. The study examined the motivation of 64 Grades 9 and 10 students (“Pre-IB” Program), and 43 Grades 11 and 12 students (International Baccalaureate Diploma Program). The researcher used the Motivated Strategies for Learning Science Questionnaire (MSLSQ) to identify the student motivation level for learning biology of these 107 students in the high school department at PAIS. Student motivation level for learning biology was determined from five components of motivation for learning: intrinsic goal orientation, extrinsic goal orientation, task
determined from five components of motivation for learning: intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs and self-efficacy for learning and performance. Student achievement in biology was examined using two achievement placement tests (for Pre-IB and IBDP), created from past International Baccalaureate Diploma Program exam questions. The data collected was analyzed using means, standard deviations, Pearson product moment correlation coefficients and an independent samples t-test. The findings showed that the level of students' motivation for learning biology in both Grades 9 and 10 (Pre-IB students), and Grades 11 and 12 (IBDP students) was high. A significant relationship was determined between students' motivation level for learning biology and student biology achievement for both Grades 9 and 10 (Pre-IB students), and Grades 11 and 12 (IBDP students). Grade 12 students at PAIS were determined as having a lower level of motivation for learning biology, in comparison with the other grade levels studied. Recommendations for schools, teachers and future researchers were identified.

Field of Study: Curriculum and Instruction  
Student's signature

Graduate School of Graduate School of Human Sciences

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Advisor's signature
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CHAPTER I

INTRODUCTION

In this chapter the researcher will discuss the aim and importance of the study. The chapter comprises the background of the study, statement of the problem, the research questions, objectives and hypotheses, the scope of the study, definition of terms and the significance of the study.

Background of the Study

Science, incorporating the major subdivisions of biology, chemistry and physics, is still regarded internationally as a subject of renewed importance in modern times. For example, in the opinion poll Bryner (2013) carried out in the US, three times as many respondents considered science to be the most valuable school subject, compared to studies 10 years ago. Studies in the UK show that young people generally believe that science is important, and should remain a compulsory education subject (National Foundation for Educational Research, 2011). Improving science students' achievement is a significant area of research in education, with studies on factors such as improving teaching strategies, learning theories, pedagogy and student motivation (e.g., Hipkins et al., 2002).

Internationally science education is regarded as being in a time of reform, with research and studies focused upon altering the traditional teaching methods to find alternative methods of instruction (Pea & Collins, 2008). Ever-continuing mandated changes to science teaching and curricula have been identified as both harmful and beneficial forces (Ryder, Banner & Homer, 2014). The development of the constructivist learning approach in particular, has been one of the largest changes to
spur reform to science education (Garbett, 2011). As with other subjects however, the substantial focus has been upon improving teacher instruction methods (Ryder et al., 2014). An integration of a variety of instructional approaches is still widely regarded as the most successful and comprehensive method to improve science achievement (Garbett, 2011).

Within Thailand, science education is regarded as being in a time of regression. For example, typically around 120 minutes per week is devoted to science at the lower secondary level. This compares to typically around 240 minutes per week in other countries (Corcoran, 2009). Benchmarks such as the annual O-Net university entrance examinations show a sustained decrease in achievement in many subject areas (including science) in recent years (Maierbrugger, 2013). Thailand’s education sector is undergoing a time of uncertainty, as neighbouring countries with smaller economies are regarded as surpassing the comparatively well-resourced Thai education system (Maierbrugger, 2013).

Focusing upon science education, science has been shown to be a particularly weak area for Thailand. International benchmark testing shows Thailand’s science achievement scores to be both low, and declining. To illustrate, the TIMSS (Trends in Mathematics and Science Study) benchmark testing shows science achievement in Thailand has decreased significantly since the first testing in 1995 to the most recent testing in 2015 (see Table 1).
Table 1

**Science Results at TIMSS, 8th Grade Students (Thailand)**

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<tr>
<td>Score</td>
<td>525</td>
<td>482</td>
<td>471</td>
<td>451</td>
<td>431</td>
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*Note. From Factfish, 2015.*

The Program for International Student Assessment (PISA) is a survey conducted by the Office for Economic Co-operation and Development (OECD). PISA compares the math, science, and reading achievement of nations and territories. In 2012 Thailand scored 48th out of 65 countries during the PISA testing in science, with 444 points (Fry, 2013). In 2015 Thailand placed 55th out of the 72 entering countries in the most recent PISA testing in science, with 421 points (Dumrongkiat, 2016).

Thailand is now the bottom category of respondents to PISA, and benchmark testing shows that Thailand is among the lowest scoring respondents in Asia showing decreasing achievement in all subjects (Frederickson, 2016). According to Dilaka, Lathapipat, and Sondergaard (2015) the average Thai student is now 1.5 years academically behind the average Vietnamese student. It is clear that currently it is a time of declining performance for science education in Thailand, and studies are required to identify the reasons for this trend.

**Statement of the Problem**

Pan-Asia International School (PAIS) utilized a modified form of the Massachusetts State curriculum until 2013, when it transitioned to a Common Core based curriculum. In 2010, PAIS introduced the prestigious International Baccalaureate qualification, to provide greater opportunities for students to attend
universities internationally. PAIS currently offers the Common Core curriculum of the United States in primary and middle school (Grades 1-8), and then offers the International Baccalaureate Diploma Program (IBDP) in Grades 11 and 12.

This situation created a curriculum misalignment for PAIS students entering Grade 11 as the Common Core curriculum is not aligned with the IBDP curriculum requirements. Simply put, the content and skills the students learned in Grades 9 and 10 at PAIS did not prepare them sufficiently to take the IB Diploma. To resolve this situation PAIS introduced a “Pre-IB” program to improve learning in Grades 9 and 10. To more adequately prepare students for the IB Diploma Program, the objectives for IBDP students are taught to Grades 9 and 10 students, but the content is reduced and taught in a simplified manner. PAIS is currently (as of April 2017) an IB Middle Years Program (MYP) candidate school, attempting to implement a long term solution in the form of the IB Middle Years Program.

Comparing the Pre-IB program of Grades 9 and 10 to the IBDP program of Grades 11 and 12, broadly the same content and skills are taught, but with a number of differences. Pre-IB students learn a greater number of subjects, but study each subject for less hours each week. For example, the Pre-IB students study all of chemistry, physics and biology for 2 hours per week each, whereas IBDP program students will typically study a single science subject for four hours per week. Pre-IB assessments are generally simpler as the content is taught to less depth, and Pre-IB students are expected for perform less independent study as part of their course.

The current problem at PAIS is a discrepancy regarding students’ levels of science achievement between the Pre-IB students (Grades 9 and 10), and that of the IBDP students (Grades 11 and 12). On the whole, achievement in the science subjects is regarded as poor in the high school department at PAIS, and this observation is
particularly pronounced amongst the IBDP students (Grades 11 and 12). This issue requires study to identify the reasons for this situation, and thus possible solutions.

High school science at PAIS is taught as three distinct subjects (biology, chemistry and physics), so it is strange to observe the same decrease across three different subjects with three different teachers. As the researcher is the biology teacher, the study will be examine the students taught by this researcher in biology classes only, eliminating the factor of different science subjects and teachers.

The International Baccalaureate Diploma Program requires PAIS high school students to choose one course for each of the six subject groups for the IB Diploma Program. IBDP Group 4 incorporating biology and physics is the only subject group where PAIS students must study a science subject. Chemistry at PAIS is studied in Group 6, to allow chemistry to be studied concurrently with either biology or physics.

If there is was a misalignment between the middle and high school curricula at PAIS, the same trend of decreasing achievement should be observed in all six subject groups. However the phenomenon of decreasing achievement has been observed by teachers at PAIS to be greatly pronounced in science compared with the other subject groups.

Poor motivation is a possible cause for poor achievement in high school science at PAIS. There has been no previous study carried out upon student motivation for learning science at PAIS. A large number of PAIS students view that science does not hold much personal relevance to them and choose the science courses because they have no alternative not to. Many high school students at PAIS study science subjects only because they are required to choose something in Group 4 (Experimental Science) to complete the IB Diploma. Furthermore, many students do
not feel that the teachers at PAIS teach science in such a way that makes science relevant enough to motivate them further.

Science teachers at PAIS do not currently have enough information available to identify the nature of the problem and determine any changes required to rectify this issue. It is therefore hopeful that this study will identify a relationship between students’ motivation level for learning science and the students’ achievement in science, to allow teachers and administrators a more informed understanding of this situation. As this study is conducted by a biology teacher, the researcher will focus this study upon students studying biology at PAIS, and to minimise the effect of comparing different science teachers and subjects upon this study.

Research Questions

The following are the research questions for this study.

1. What are the levels of the students’ motivation for learning biology in Grades 9 and 10, at Pan-Asia International School?

2. What are the levels of the students’ motivation for learning biology in Grades 11 and 12, at Pan-Asia International School?

3. Is there a significant relationship between student motivation for learning biology and student biology achievement in Grades 9 and 10, at Pan-Asia International School?

4. Is there a significant relationship between student motivation for learning biology and student biology achievement in Grades 11 and 12, at Pan-Asia International School?
5. Is there any significant difference between student motivation for learning biology between Grades 9 and 10, and Grades 11 and 12 at Pan-Asia International School?

**Research Objectives**

The following are the research objectives for this study.

1. To determine the levels of the students' motivation for learning biology for Grades 9 and 10 students, at Pan-Asia International School.

2. To determine the levels of the students' motivation for learning biology for Grades 11 and 12 students, at Pan-Asia International School.

3. To determine if there is a significant relationship between students' motivation for learning biology and student biology achievement amongst Grades 9 and 10 students, at Pan-Asia International School.

4. To determine if there is a significant relationship between students' motivation for learning biology and student biology achievement amongst Grades 11 and 12 students, at Pan-Asia International School.

5. To determine if there is a significant difference in student motivation for learning biology between Grades 9 and 10 students, and Grades 11 and 12 students at Pan-Asia International School.

**Research Hypotheses**

The following are the research hypotheses for this study.

1. There is a significant relationship between student motivation for learning biology and student biology achievement amongst Grades 9 and 10 students, at Pan-Asia International School at the .05 level.
2. There is a significant relationship between student motivation for learning biology and student biology achievement amongst Grades 11 and 12 students, at Pan-Asia International School at the .05 level.

3. There is a significant difference for student motivation for learning biology between Grades 9 and 10 students, and Grades 11 and 12 students at Pan-Asia International School at the .05 level.

Theoretical Framework

The principal learning theory that this work is based upon is social cognitive theory by Bandura (1988). Social cognitive theory identifies human learning as a social interactive experience, and social experiences are shaped by personal characteristics. Essentially, people learn by observing others and modelling their behaviour. Social cognitive theory identifies learning as a relationship between a person's environment (situation), their personal factors (such as knowledge, attitude and expectations) (Bandura, 1988) and the person's behaviour (such as their performance in class).

Social cognitive theory identifies that people with high self-discipline and self-regulation will achieve highly, as they view learning scenarios as possibilities for potential success. On the other hand, individuals with lower self-discipline will achieve less, due to their focus on any potential negative outcomes (Bandura, 1991). Social cognitive theory also discusses the idea of self-efficacy and how self-efficacy is an effector of student motivation. Students with a high self-efficacy will be aware of, and better able to direct their own learning. Self-efficacy is created by past success, and can be reinforced by encouraging words and successful peer models.
(Bandura, 1993; Zimmerman, 2000; Zimmerman & Martinez-Pons, 1990). This model is known as Bandura’s model of reciprocal determinism.

In this study’s model of reciprocal determinism, the personal factors in this study are represented by the motivation level of the student for learning biology. The student’s motivation level will have an effect upon measurable student behaviours, which in this study is student achievement in biology classes. The constructs used for assessing students’ motivation level will be intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs and self-efficacy for learning and performance. Intrinsic goal orientation is the perception that their motivation to learn science is orientated towards sources within the individual. Extrinsic goal orientation is the perception that their motivation to learn science that is orientated towards sources outside of the individual. Task value is whether a task has a relevance to the personal goals of the student. Control of learning beliefs is whether students believe that they have control over their own studies and outcomes. Self-efficacy for learning and performance is the students’ confidence of their own abilities and their resulting expectancy for success (all from Pintrich, Smith, Garcia, & McKeachie, 1991). Bandura’s model for reciprocal determinism in this study can be represented as Figure 1 below.
Figure 1. Bandura's model of reciprocal determinism.

**Conceptual Framework**

This study was intended to determine the students' level of motivation for learning biology amongst Grades 9, 10, 11 and 12 students at Pan-Asia International School. The levels of student motivation for learning biology were identified using the MSLSQ, or Motivated Strategies for Learning Science Questionnaire. The MSLSQ was adapted from the Motivated Strategies for Learning Questionnaire (MSLQ) by Pintrich et al. (1991). Student's motivation levels were assessed using the constructs of the students' intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, and self-efficacy for learning and performance. To determine the level of student achievement for biology, the student's took an assessment created from a previous year's International Baccalaureate biology examination.

The researcher then looked for a significant relationship between student motivation for learning biology and student biology achievement for Grades 9, 10, 11 and 12 students at Pan-Asia International School. The motivation level for learning biology was compared for Grades 9 and 10 (pre-IB students) and Grades 11 and 12.
(IBDP students) to ascertain if there was a significant difference between these two groups. See Figure 2 for a summary of the conceptual framework of this study.

Figure 2. Conceptual framework.

**Scope of the Study**

The researcher will target this study at students in the high school department of PAIS, studying biology in the 2016/2017 academic year. As PAIS is an international school in Thailand, the student demographic makeup at PAIS should not be regarded as representative of a typical school within the Thai education system.
This study will assess the students’ motivation for learning biology as defined below, using the dimensions of intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs and self-efficacy for learning and performance. However there are other potential areas of motivation that are not measured by this study. There are also other alternate theories of motivation, for example self-determination theory (Deci & Ryan, 2002), with alternative methods of identifying and measuring motivation. This study will focus upon motivation as discussed by Bandura’s social cognitive theory (Bandura, 1991).

Definitions of Terms

**Biology** in this study refers to the subject of biology, taught in the high school department of Pan-Asia International School.

**Biology Achievement** in this study refers high school students’ final biology assessment scores at Pan-Asia International School.

**High School** in this study refers to the High School Department at Pan-Asia International School comprising Grades 9, 10, 11 and 12.

**IB** is International Baccalaureate, an international curriculum taught at Pan-Asia International School at the Diploma (High School) level.

**IBDP** is International Baccalaureate Diploma Program, which refers to the program of study undertaken by students in Grades 11 and 12 at Pan-Asia International School.

**Pre-IB** in this study is the preparatory (for IBDP) program of study, undertaken by students in Grades 9 and 10 at Pan-Asia International School.
Motivation in this study refers to the reasons for stimulating energy and desire in people to undertake and complete learning activities and behaviours. In this study motivation is measured by the following five subscales.

Control of Learning Beliefs in this study refers to whether students believe that they have control over their own studies, leading to positive outcomes. It concerns the idea that the students’ own actions determine their own success. In this study it will be measured by items 2, 7, 15 and 21.

Extrinsic Goal Orientation in this study refers to students’ perceptions that their motivation to learn science is orientated towards sources outside of the individual. It concerns the idea whether the motivation to complete a task is external, such as in the form of a reward or punishment. In this study it will be measured by items

Intrinsic Goal Orientation refers to the students’ perception that their motivation to learn science is orientated towards sources within the individual. It concerns the idea that participation in science learning is the aim in itself, motivation is derived from the pleasure of learning for its own reward. In this study it will be measured by items 1, 13, 18 and 20.

Self-Efficacy for Learning and Performance in this study is the students’ confidence of their own abilities and their resulting expectancy for success. It concerns the idea that motivation can come from internal judgement of one’s ability to successfully complete a task. In this study it will be measured by items 4, 5, 10, 12, 16, 17, 24 and 26.

Task Value is this study refers to whether a task has a relevance to the personal goals of the student. It concerns whether the learner feels the task is relevant,
important, interesting or useful to their aims. In this study it will be measured by items 3, 8, 14, 19, 22 and 23.

**MSLQ** is the motivated strategies for learning questionnaire created by Pintrich et al (1991), a research instrument adapted by this study.

**MSLSQ** is the motivated strategies for learning science questionnaire, an adapted form of the MSLQ by the researcher, used as an instrument for this study.

**PAIS** is Pan-Asia International School, an International School of around 350 (K-12) students in the Pravet area of Bangkok, Thailand.

**Students** in this study are high school students currently studying biology subjects in the high school department of Pan-Asia International School.

### Significance of the Study

The significance of this study is multi-fold, as it allows an insight into motivation for learning science and achievement in science, for multiple purposes. As part of this study, science teachers at PAIS could be able to identify some areas that damage student achievement in science, and whether motivation is a significant aspect of this. In the wider context, it allows this same insight into student motivation and achievement as similar institutions, such as other international schools that use the IB curriculum in Thailand.

This study should help the administrators at PAIS and other similar international schools to evaluate their science programs, and take into account the weighting of the motivation factors studied, and their resultant effects upon student achievement. This should aid the administrators to form more informed conclusions and work accordingly with the knowledge gathered.
This study should also be useful to future researchers in the same field, who aim to conduct similar research. The findings of this study could be assimilated into their own research, and serve as one source of literature regarding motivation relating to achievement. From the recommendations of this study, opportunities for further research topics might arise for future researchers.
CHAPTER II

REVIEW OF RELATED LITERATURE

In the previous chapter, the researcher briefly analysed the background and purpose of this study. In this second chapter, the researcher will examine these surrounding issues for the study, beginning firstly with the idea of motivation and some of the major concepts and theories that underlie it. Secondly the researcher will look at motivation in relation to education and the science classroom. Thirdly, the researcher will look at the wide context of current science education, both in the world and in Thailand specifically. Finally the researcher will look at the specific institutions and programs involved in this study, namely Pan-Asia International School and International Baccalaureate.

Motivation

According to Schunk, Pintrich and Meece (2008) the term motivation is derived from the Latin verb movere (to move), and the word motivation itself means having a desire to do something. Motivation is what allows individuals to achieve, such a desire to achieve a set goal. Whether being motivated from a personal goal, or motivated by some reward such as a wage increase, there are types and levels of motivation. A person who feels no source of desire, whether from an internal impetus or an external impetus is regarded as being unmotivated (Ryan & Deci, 2000). In the context of this educational study, unmotivated students are unlikely to be good learners.
Motivation refers to both the subject's behaviour and internal cognition, and is regarded as one of the critical factors for success in learning (Guay et al., 2010). Wiseman and Hunt (2001) hold the view that motivation is required for the basic development of meta-cognitive skills, which are required for all learning and achievement. Gardner (2005) also stressed the importance of motivation, which despite being important for educators, is an enormous and broader topic than merely that of the point of view of an educator. For example, Gardner (2005) stated that even a simple definition of motivation itself is not possible, motivation being such a complex concept. While this literature review began with one definition of motivation, it can be noted for example that Kleinginna and Kleinginna (1981) succeeded in determining 102 different statements that can define the meaning of motivation. It is clear the plethora of models and constructs to answer the question “What motivates students?” can confuse matters and sometimes limit progress (Pintrich, 2003).

Social Cognitive Theory

Social cognitive theory (SCT) developed from the work of noted psychologist Albert Bandura. Bandura's original work targeted the foundations of human behavior, particularly children, and how they model observed behaviors in their environment. Bandura's work led to the creation of social learning theory, examining how people learn through observing other people's behavior and the results of their actions. Bandura (1977) determined that most human behavior is created by modelling the behavior of others. Cognition resulted from observation of others' behavior, and acted as a guide for the future actions of the observer. In 1986, Bandura renamed social learning theory to social cognitive theory to create a better description
of how learning comes from social experiences and cognition that resulted (Bandura, 1986).

SCT is a model used to explain the developmental changes a person goes through during their life (Bandura, 1989). A feature of SCT is the idea of reciprocal determinism, that interactions between the environment, the behavior of the person, and their internal cognition are related in a bi-directional method. Basically, these factors can affect each other in a reciprocal fashion (Bandura 1986; Bandura 1989).

SCT broadly relates how people learn by observing others in social environments. Learning creates social behaviors, which can become an individual’s personality. Modelling is an important feature of SCT, whereby social behaviors observed in others, create cognition and future behaviors in the observer. Eventually, observing a new behavior can change an individual’s cognition, which thusly changes the individual’s own behavior (Bandura 1989).

Instrumentation and the MSLSQ

The instrument for this will be the Motivated Strategies for Learning Science Questionnaire (MSLSQ). The MSLSQ is adapted from the Motivated Strategies for Learning Questionnaire (MSLQ) by Pintrich et al. (1991). The MSLQ was developed to measure college age student’s motivational orientations, and their learning strategies they employed (Artino, 2005; Pintrich et al., 1991). The MSLQ arose from a desire by Bill McKeachie and Paul Pintrich to assess their students’ motivation and learning strategies, both McKeachie and Pintrich being professors at the University of Michigan in the 1980s (Artino, 2005). McKeachie and Pintrich used the MSLQ instrument to create and validate a model of college age student motivation and learning strategies that is still used currently by educational psychologists (Artino,
2005; Duncan & McKeachie, 2005). The MSLQ was developed using the social
cognitive view of motivation and student learning strategies (Artino, 2005; Pintrich,
2003).

Intrinsic Goal Orientation

The first subscale of the MSLQ is intrinsic goal orientation, which is a
reference to the reasons why a student will attempt to complete a task. Intrinsic goal
orientation is that student’s orientation towards completing a task for internal, self-
motivating reasons such as the challenge or curiosity (Pintrich et al., 1991).

Intrinsic motivation requires some inherent satisfaction to be present in
performing a task or activity itself, not related to any external reward (Deci & Ryan,
1985). Intrinsic motivation is a construct linked to personal interest and personal
desire, factors that are normally regarded as superior motivators that to the other
would still class intrinsic motivation as external however, because the reward is
present in the form of the personal pleasure created by this activity.

Intrinsic motivation can either be increased or decreased as a result of teacher
interactions, so lesson design should logically work maximizing the motivation that
results from the intrinsic pleasure of any activities (Ryan, 2009). Oudeyer and Kaplan
(2008) noted that there is no single unified accepted definition of “intrinsic
motivation” and that intrinsic motivation is frequently confused with internal
motivation, and further that no working framework exists to relate different intrinsic
motivations towards each other. Malone (1981) noted that while there has been much
study on the social and cognitive processes and their effects upon learning, at that
point intrinsic motivation had seen relatively little research and importance attached.
Anderson (2003) observed that science students are more likely to be extrinsically motivated, making intrinsically motivated science students atypical of the student body.

**Extrinsic Goal Orientation**

Extrinsic goal orientation again refers to the reasons for completing a task, and complements intrinsic goal orientation. Extrinsic goal orientation is a student orientated towards completing a task for an external reason, such as grades, competition or career purposes (Pintrich et al., 1991).

Extrinsic motivation is motivation identified as coming from potential external rewards, rather than from the reward of performing a task itself (Deci & Ryan, 1985; Ryan & Deci, 2000). Extrinsic motivators are typically applied as solutions to create motivation where none may previously exist, or to increase motivation when intrinsic motivation is too low for achievement.

External motivators can have both positive and negative effects upon learning. Where intrinsic motivation pre-exists, if extrinsic motivation is introduced then removed, then intrinsic motivation subsequently suffers. For example, in the study by Lepper, Green and Nisbett (1971), children who received extrinsic motivators often exhibited significantly reduced intrinsic motivation. There is caution around the application of external motivation, from the work of educational cognitivists such as Piaget (1952) as cited by Malone (1981). Piaget argued that intrinsic motivation is the essential form of motivation required for cognitive development. It was argued that intrinsically and not extrinsically, motivated activities are required for learning, which provide play-like learning for children to spur their initial development.
Extrinsic motivation is present for most school-age children in the forms of grade motivation and later career motivation. Grade motivation is a form of extrinsic motivation that comes from the award of a scholastic grade. Career motivation is a form of extrinsic motivation where students perform scholastically, thinking of their potential future in the form of their eventual career. For example, the study by Locano (2015) related the use of a career-based activity to increased self-efficacy and achievement.

According to Anderson (2007) highly performing extrinsically motivated students can exist, and for these individuals, career and grade motivation can serve as powerful factors in their cases. Some extrinsically motivated students however will simply perform the minimum amount of effort that is required for their desired grade, thus decreasing the overall value of the aforementioned forms of motivation (Anderson, 2007).

**Task Value**

Task value is a measure of a student’s opinion about the task they are attempting to complete. Task value is the student’s evaluation of their assigned work, and its importance and utility to this individual (Pintrich et al., 1991).

Task value represents the personal relevance to complete a task that an individual finds. (Agnesia, 2010). A task with high perceived personal relevance to the learner results in a higher level of motivation. For example, creating career motivation is one example where personal relevance is important. However, a task with a low level of personal relevance will often result in a lower level of performance from the individual.
Agnesia (2010) states that when a task is personally relevant to an individual’s goals, then consequently the learner’s motivation is increased. The student’s personal perception of the importance of a task has large consequences for student motivation. According to Wiseman and Hunt (2001) the setting of goals by teachers for students can have specific impacts of the motivation level of students. Teachers will identify goals for students that students would not identify themselves and do not view as being realistic. Teachers must empathize and create goals that students will view as important and achievable.

Control of Learning Beliefs

Control of learning beliefs is another subscale on the MSLQ, which represent a studied construct of motivation. Control of learning belief is the relationship the student feels between their academic performance and the outcome (Pintrich et al., 1991). Control of learning beliefs refers to the individual’s belief in the causes of their success and failure. It is related how much control the individual has to create the desired behavior and achieve desired outcomes (Bandura, 1997; Pintrich, 2003).

Students who believe they are in control of their learning and can create the outcomes they desire are more motivated and more likely to achieve than those who do not (Pintrich & Schunk, 2002). A student who believes achievement is outside their control (e.g., because of poor teacher performance), is unlikely to be motivated to perform highly. Conversely a student who believes success in their own hands is likely to be motivated to make these outcomes occur (Pintrich 2003).
Self-Efficacy for Learning and Performance

Self-efficacy is a subscale related to an individual’s ability to master and perform an assigned task (Pintrich et al., 1991). Students with a high self-efficacy will monitor their learning, and have a high self-expectancy for success.

Self-efficacy is an individual’s self-belief in their ability to execute activities and achieve (Bandura, 1991, 1997). Self-efficacy has been defined to be a sense of confidence of the individual’s ability to perform certain tasks (Lorsbach & Jinks, 1999). Self-efficacy is an important construct of motivation, because some students will not engage with an activity if they feel that it is beyond their self-perceived abilities. For example, Schunk (1991) found that children with a high self-efficacy were more likely to continue working and were generally more successful when completing difficult tasks, compared to students who exhibited low levels of self-efficacy. When individuals possess high self-efficacy, self-imposed strategies and approaches are implemented by the individual to improve their own performance (Schunk, 1995).

Bandura and Schunk (1981) pointed out that self-efficacy is closely linked to learning success. Success and fluency calibrates learner expectations, and a higher self-efficacy results in improved performance (Lee & Mao, 2016). Perception of impending success creates a perception of self-efficacy. Lack of perception of potential success will lower self-efficacy in this scenario. However an occasional failure will not greatly lower self-efficacy in a person with existing high self-efficacy (Bandura & Schunk, 1981).

Schunk (1989) viewed peer modelling as one important potential road to self-efficacy. The teacher can be a poor model for learners, as the learners typically do not view the teacher’s high efficacy as something that can be emulated by themselves.
But learning in an environment where other learners have a high level of self-efficacy can be very important, as learners then can view this behavior as something that can be emulated (Schunk, 1989).

Zimmerman (2000) has the view that self-efficacy should be viewed as something more than just the personal innate qualities of the individual, but as a performance capability. The distinction must be made between learner’s view about themselves and their own qualities, and their ability to perform a task in a specific field. Self-efficacy is therefore multi-dimensional, as self-efficacy can varies by subject, context or even by a specific learning environment (Zimmerman, 2000).

Previous Related Research

There have been a number of other studies comparing student motivation and student achievement, both science achievement and scholastic achievement in general. Focusing upon studies in science achievement, a number of other studies have previously occurred. The work by Potvin and Hasni (2014) is a reference to these studies, which attempted to categorise studies of science motivation, interest and achievement from the previous 12 years by location, character and constructs. The study targeted peer-reviewed science articles published in the largest popular resource for educational research, the education resources information centre (ERIC) database. Table 2 below shows the summary of their categorizations of studies in ERIC according to their major construct, from Potvin and Hasni (2014).
Table 2

*Major Studied Constructs for Science and Technology*

<table>
<thead>
<tr>
<th>Construct</th>
<th>Number of published papers</th>
<th>Approximate proportion of papers in database (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest</td>
<td>63</td>
<td>27</td>
</tr>
<tr>
<td>Motivation</td>
<td>49</td>
<td>21</td>
</tr>
<tr>
<td>Attitude</td>
<td>121</td>
<td>52</td>
</tr>
</tbody>
</table>

It can be seen from Table 2 that motivation was the least studied major construct in relation to student achievement, when compared with student interest and attitudes. Of the 49 studies on motivation above, 20 did not even explicitly attempt to define the term motivation (Potvin & Hasni, 2014). Most previous science-targeted research upon motivation has focused upon intrinsic motivation, with extrinsic motivation being more infrequently addressed (Potvin & Hasni, 2014).

In some respects it can be regarded as normal that student motivation decreases as they get older, with negative correlations observed between progression through grade level and student motivation (Gillet, Valler & Lafreniere, 2011). For example, in the study by Corpus, McClintic-Gilbert and Hayenga (2006), levels of intrinsic motivation in two K-8 schools in the US were determined to decrease significantly between Grades 3-8. This was echoed by French-Canadian high school students in the study by Otis, Grouzet and Pelletier (2005), a three-year longitudinal study which determined a decrease in student intrinsic and extrinsic motivation in Grades 8-10. It is considered that students progressing high school will have decreasing motivation in some subjects, while may maintain motivation in others. For example, the longitudinal study by Gottfried, Fleming and Gottfried (2001) examined intrinsic student motivation of Californian students from ages 9-17 for a number of
subjects, and determined a decrease in student intrinsic motivation for math, science and reading, but not social studies. It seems that subjects and curricula can have differing effects upon student motivation.

In the study by Jen and Yong (2013) located in Brunei, a study occurred of high school students’ motivation and achievement for combined science, using the similar (to this study) dimensions of intrinsic motivation, extrinsic motivation, personal relevance, self-efficacy, self-determination and assessment anxiety. According to Jen and Yong (2013) their study identified students who were placed into the “art stream” in Brunei schools, which represents students who are failed the requirement to enter the science stream. These students were forced to take science as a single combined compulsory subject, which usually has a lower achievement score than the science stream (Jen & Yong, 2013). This study interestingly found that student’s highest motivational orientations were extrinsic motivation and assessment anxiety, confirming lower intrinsic motivational orientations.

Reiss (2009) created the Reiss School Motivation Profile (RSMP) as an instrument to detail student motivation types and their ramifications for future performance. Using the RSMP, Reiss identified six reasons as to why high school may not be motivated and may be at their weakest point in the academic motivation. Examples of negative effectors upon student motivation in high school included fear of failure (causing a lack of motivation to engage with study), incuriosity, lack of ambition, lack of responsibility and combativeness (Reiss, 2009).

According to the study of Malaysian science students by Talib, Wong, Azhar and Abdullah (2009), proficiency and talent, language ability and attitude were all significant predictors of student achievement. Al-Zoubi and Younes (2015) examined possible reasons for poor student achievement. Examples of factors related with
poorly achieving students were lack of planning, psychological and medical reasons, parental and educational reasons, and exam anxiety. The final factor related was lack of motivation for success, and how motivation can be driven by lack of efficacy or lack of control of learning belief (due to poor teacher performance).

Clearly motivation is one of the factors which affects student achievement. For example, in the study of Thai high school students by Lwin & Eamoraphan (2015), student motivation was related with science achievement for two different academic programs. There was determined to be a positive correlation between student motivation and achievement at both programs. A further relevant study was that of Cai & Lynch (2016), which examined motivation for learning languages at an International School in Thailand, and found a significant relationship between motivation and achievement. In the study by Adams (1996) focusing upon motivation amongst female students, career motivation and task value were identified as more significant in higher ability students than in lower ability students. This echoes the study of 242 US high school students by Debacker and Nelson (2000) which identified higher ability students to have greater academic goals and task value for science, than those students with lower levels of ability.

There have been studies identifying motivation as a fluid dimension, measuring variables than increases or decreases in motivation. The study in Finland by Salmi (2003) identified a significant increase in student’s intrinsic motivation to learn science, after a field visit to a science education centre. In studies by Knox, Moynihan and Markowitz (2003) and Markowitz (2004) at a university in St Louis (USA), extra-curricular science activities were soon to have a positive effect upon science students’ attitudes and interest levels. The review of studies by Zoldosova
and Prokop (2006) emphasized a need for experiential learning as an effector of student motivation.

There have been studies on gender differences for learning science between boys and girls. For example, studies by Cavallo, Potter and Rozman (2004), Britner and Pajares (2006) and Taasoobshirazi (2007) have all identified male students as having higher self-efficacy for learning science than female students. Meece and Jones (1996) studied fifth and sixth grade science students and determined that boys have a higher level of self-determination than girls, though conversely Glynn, Taasoobshirazi and Brickman (2009) of university science students identified that girls have a greater control of learning believes than boys. In some studies it was determined there was no significant difference in personal relevance between the sexes (e.g., Glynn et al., 2009).

There have been studies to identify the differences in motivation between difference science subjects, namely between biology, chemistry and physics. An interesting review of studies by Steinkamp and Maehr (1984) identified that girls have more positive viewpoints of biology and chemistry than boys, while boys are more likely to have a positive orientation towards physics. This was echoed by the previously mentioned study by Debacker and Nelson (2000), which identified girls as having the more positive motivational orientation when learning biology.

**Factors Affecting Science Student Achievement**

Science is a vital subject for the future of humanity, as the tools and concepts developed from science overlap into all other fields (Atkinson, 2011). All aspects of society have been affected by the development of the scientific method, and the
resulting technologies that have become accessible to our species, from discovering how to make fire to the discovery of the genome (Sciencelearn, 2011)

As a science educators, the role of the teacher in science is not merely to impart scientific content. Students must be scientifically literate to understand scientific contents and identify pseudo-science (Shafer, 2015). In the 21st century, it must be understood that issues of scientific literacy are becoming global issues, for example scientific studies of climate change are resulting in a mainstream debates. Science educators should reach beyond the idea of merely teaching students to aim for science carriers, but to aim that students in all fields (and by extension the greater public) have an understanding of scientific literacy (Marincola, 2006).

Teacher Behaviours

The teacher’s effectiveness is still regarded as being the most important single factor for student achievement (Hattie, 2003; Rivkin, Hanushek, & Kain, 2005). The difference between a highly effective teacher and an ineffective teacher can be up to the difference of nine months of study, or an entire academic year (Rowan, Correnti, & Miller, 2002). There are a number of areas where teacher behaviour is a significant factor in classroom learning in science, though this can often be applied to other subjects in education. For example it has been identified there can be a relationship between primary teacher behaviour (from their own competence) and student attitudes towards science and technology (Denessen, Nienke, Hasselman, & Louwse, 2015)

One area in teacher behaviour affecting achievement is lesson clarity, where lessons have a clearly stated goal and the teacher is able to communicate it clearly and effectively to their students. According to Borich (2004), behaviours such as; talking at levels above student comprehension, wandering into irrelevant topics away from
the stated goal, or using speech patterns that retard student understanding, all result in poor lesson clarity (as cited in Ajaja & Urhievwjire, 2013).

Another teacher behaviour that can affect student achievement is differentiated instruction. Differentiated instruction is changing the traditional teacher-centred classroom environment to one that incorporates a variety of activities, learner styles and interests (Subban, 2006). Differentiated instruction allows the inclusion of many instructional styles, to appeal to different types of learners and to enhance their motivation for a subject. The preferred teacher behaviour would be to identify different student needs and profiles, and to create different instruction techniques to fulfil their individual requirements (Subban, 2006).

It seems a lack of teacher variation and differentiation in instruction is usually the problem, rather than too much variation (Ajaja & Urhievwjire, 2013; Tanner & Allen, 2004). The effective science teacher must be aware of a variety of delivery methods and be prepared to use multiple methods of instruction. Inflexibility about methods of instruction is a factor that will typically reduce levels of student achievement (Ajaja & Urhievwjire, 2013; Tanner & Allen, 2004).

A fundamental area of teaching identified is teacher enthusiasm level, which can affect both student motivation and therefore student achievement. Enthusiasm comes from self-confidence and competence, and this enthusiasm is transmittable to students (Garbett, 2011). Successful teachers of science need to be competent in several areas, both understanding science content required, understanding effective teaching practices, and know how to combine these two factors (Garbett, 2011). This viewpoint was echoed by Anderson (2007), who stated that good science teachers need to be able to motivate their students, and these teachers naturally increase their students’ understanding of science. Best and Addison (2000) determined that
expressive characteristics, such as warmth, enthusiasm and extroversion were marked as the characteristics of effective teachers.

Another area of research when considering teacher effectiveness is teacher task orientation, or how much time teachers allocate to each task. It has been determined that this can have an effect upon resultant student achievement. It has been shown that teachers who target more intellectual tasks for the majority of the teaching and aim for higher level understandings typically show greater levels of student achievement (Brophy, 2002).

A further area recognised to impact upon science achievement is student success rate. Teachers should design activities that students can work with effectively and comprehend to succeed. Karweit and Slavin (1981) examined students in a district in Maryland (USA), and determined that student success can be related to the amount of time that learners spend engaged in thinking about and completing tasks, which are related with the content they are learning. Teachers creating well-designed tasks which require students to think creatively to complete them, resulted in higher student achievement.

Trowbridge and Bybee (1996) determined the following characteristics for effective science teachers.

1. Teaching effectiveness is positively related to training and experience as evidenced by the number of educational courses, student-teaching grade, and teaching experience.

2. Teachers with more positive attitudes toward the curriculum that they are teaching tend to be those with a higher grade-point average and more teaching experience.
3. Better classroom discipline is associated with teacher characteristics of restraint and reflectivity.

4. Higher level, more complex questions are employed more often by teachers with greater knowledge and experience in teaching.

**Pedagogy and Constructivism**

Pedagogy relates to the instructional strategies used by teachers, and relate a choice of underlying learning theory such as behaviourism, constructivism, cognitivism, humanism and others (Loughran, Berry & Muhall, 2012). Pedagogy is more than just a content delivery method and chosen learning theory however, but can include the whole method of teaching, the skills required, the background of the instructor and the attendant discourse entailed for learning (Loughran et al., 2012).

Requirements for effective pedagogy when teaching sciences and the nature of science (the scientific method) are neatly summarised by Hipkins et al. (2002) and Ryan (2009). The pedagogy should include the eliciting of pre-existing ideas from learners, and linking them to the subject content being examined. Science should also be taught and learned in context, to allow learners to make wider links to the very nature of science as a whole. The purpose for which science is carried out should be explicit, and potential applications should be made clear (particularly vocationally). The students’ knowledge of content, knowledge of procedure and knowledge of scientific practice should be developed holistically. Teachers should model linkages between evidence and theory, with discussion and argumentation designed to examine the relationships presented by these outcomes (Hipkins et al., 2002; Ryan, 2009).

Today the constructivist learning theory is regarded as the theory most closely linked to science education (Solomon, 1987). Broadly, there are two recognised
fathers of constructivism, that conceptualised by Piaget and that conceptualised by Vygotsky. According to Piaget, cognitivist schemes are formed, modified and accommodated as new information arrives to the individuals. According to this interpretation, learning is done by individuals and requires the assimilation of information and the creation of new schemes.

According to Vygotsky, social constructivism is slightly different. Social constructivism focused upon the social context of learning, and views learning as an event that does not happen in isolation. Social constructivism instead identifies learning as an activity that occurs between individuals and is modified by the social environment in which it occurs (all from Malone, 2012).

From the constructivist perspective, teachers must look at science in a slightly different, less absolute form. Scientific knowledge in this context are schemes or constructs, created as tentative knowledge that is currently accepted, but must be viewed within the ever changing nature of scientific knowledge (Ryan, 2009). For example, scientific knowledge is really the latest iteration of a changing convention, accepted scientific knowledge such as the model of the atom, has actually been changed multiple times as newer explanations arose (Rosen, 2012).

Scientific knowledge should therefore be taught to be questioned and not merely delivered as content. This is counter to current practices, where science teaching is actually heavily focused on content delivery (Ryan, 2009). For science teachers, the focus should be upon the scientific method, critical thinking and science for its social applications, rather than attempting to make students memorise content for examinations. Constructivism is a methodology that should be focused upon science education, as a method where students actively pursue and make meanings of science through their own social interactions (Driver et al., 1994).
A feature of science education, though necessarily a unique one, should be the experiences and experiments carried out to construct knowledge. One famous example comes from John Dewey, who advocated the idea of experiential education. In the system advocated by Dewey, a school’s education should be constructing knowledge related to its real life intended purpose (as cited in Vanderstraeten, 2002). Learning should not merely be learning for the sake of learning. Dewey proposed to remove the separation between “real life” and “classroom” and attempt to model the classroom on real experiences. This concept folds in nicely the ideas we now think of as constructivism.

A related concept is experiential learning, as espoused by Kolb (as cited in Smith, 2010). Experiential learning is a theory of learning which ties in learning as a cyclical process or sequence. The sequence of experiential learning is first to have a concrete experience, then secondly to observe and reflect about this activity. Thirdly the student needs to think hard and form abstract concepts about the activity and finally to actively experiment using these abstract concepts in other situations. When this cycle is completed, another cycle can begin from the results of the experimentation (Smith, 2010).

Experiential learning in Kolb’s concept requires both concrete activities and then the opportunity to reflect after the activity is complete. In experiential learning, the process of learning (and the experiences themselves) are required for true learning to occur (Smith, 2010). This has important ramifications for science, as without the learning experiences, textbook learning is of significantly inferior value. Experiential learning requires planned reflection upon completed activities, and the opportunities to apply learned experiences in new experimental applications (Weinberg, Basile &
The study by Weinberg et al. (2011) for example linked experiential learning to career motivation for study.

The Learning Environment

The learning environment can be another important factor to consider when examining achievement in science. The learning environment does not literally mean the physical environment of the classroom, but also encompasses the whole surrounding context that any learning occurs in (Guney & Selda, 2012). Learning environments are typically related to the particular learning theory being applied in the classroom (e.g., behaviourism), and for example whether the students feel comfortable and have opportunity to interact with their peers, or the environment allows only for direct instruction (Guney & Selda, 2012).

The learning environment should be ideally be designed in a way to allow students to operate in a student-centered manner, communicate peer to peer. By allowing students to operate autonomously and regulate their own learning, empowered students find greater motivation and higher levels of achievement (Halpern, 2011).

Uses of Technology

The use of technology can also be a factor when considering education and science. The use of technology has been increasing in all aspects of education, and science is no exception to this (Kozma, 2003). Technology has been integrated into the classroom, as instructional technology to change classroom teaching and for other more indirect areas of impact. For example, students are now working collaboratively using technology and using technology to search for information, publish their results
and create products. Teachers are now changing their role, from being “all-knowing” and providing all information personally, to becoming facilitators to students’ own learning, checking their progress and assessing their achievement (Kozma, 2003).

However, the directly measurable and assessable impact of ICT in the classroom has been mixed. Some examples show a definite trend of increased student achievement with ICT, and there is enormous pressure to integrate ICT into the classroom. For example, the study in Turkey by Delen and Bulut (2011) identified that student exposure to ICT at home and at school was a strong predictor of achievement in math and science. However not all studies have confirmed this trend. Alsafran and Brown (2011) for example compared the use of ICT in the classroom in Singapore and the US. In Singapore the use of ICT was found to have a clear positive relationship between technology and achievement, while in the US there was no relationship between the use of technology and achievement (Alsafran & Brown, 2011). Alsafran and Brown (2011) decided that the significant factor was the proper use of technology in education settings.

Science Education in Thailand

As mentioned in the background to this study, education in Thailand is currently facing a time of concern. Despite higher education spending and resources than many neighbouring countries, education achievement is decreasing, and decreasing below the values of some neighbouring countries (Maierbrugger, 2013).

International benchmark testing has examined science education in Thailand, and confirmed this as a cause for concern. In 2012, most current Thai science and math subject teachers (79-86%) had graduated with at least a bachelor’s degree in their subject, significantly above the international average (57-63%) (Khaopa, 2012).
However when the TIMSS (Trends in Mathematics and Science Study) scores are examined for Thailand, science grades are lower than their peers in other countries and decreasing. Reasons have been expounded for this lack of achievement, that even though Thai teachers may be more qualified and have more degrees than some other countries their teaching ability is variable, most can not write lesson plans effectively (less than 38%) and are not confident in their teaching ability (Khaopa, 2012).

Other reasons identified for lack of achievement in science were time distribution, with Thai students spending more hours per day learning that other countries, but spending less time spent studying overall over the academic year (Maxwell, 2015). Another reason examined was a lack of experiments or experiential learning, as the Thai school system is far too focused on delivery of content and not upon the nature of science (The Nation, 2012). A wider problem with the Thai education system is poor assessment methods, with widely acknowledged poor standardised testing systems and a heavily criticised examination board, the National Institute of Educational Testing Service or NIETS (Prachathai, 2012).

These failures in the Thai education system are not specific to just science, but have an impact upon science education amongst the other subjects. It has been observed from Thailand’s PISA scores that Thai 15 year olds are performing at comparably poor levels internationally. Using the concept that 40 points on PISA testing translates to 1 year of study, means that the average 100+ point difference shows that Thai 15 year olds are 2.5 years behind their peers in Shanghai, South Korea and Hong Kong (Kaewmala, 2012b).

Therefore any treatment of science education in Thailand must be looked at holistically, and can not merely focus upon science. The Thai system for university entrance or O-Net exam exhibits wild fluctuations in science scores that call into
question the whole validity and reliability of O-Net testing (Kaewmala, 2012). The Thai universities are increasingly concerned about the ability of the O-Net system to identify suitable university candidates, to the extent they are circumventing the O-Net system wherever they can (Kaewmala, 2012).

**International Baccalaureate**

International Baccalaureate or IB is an organisation, curriculum and series of qualifications recognised internationally and taught in international schools. The framework for the International Baccalaureate system was laid down in 1948 with a paper by Marie-Thérèse Maurette with the title “Educational Techniques for peace. Do they exist?” (Maurette, 1948). In the 1960s, a group of teachers from the International School of Geneva created the International Schools Examinations Syndicate (ISES) based upon these recommendations, which would eventually become the International Baccalaureate (Fox, 2001). Up to this point, International Baccalaureate existed only in the form of the International Baccalaureate Diploma Program (IBDP), which was taught at the high school level to 17 and 18 year old students.

Over time additional programs were added to the International Baccalaureate for other age groups. IB now provides a Primary Years Program (PYP) for primary schools, a Middle Years Program (MYP) for middle schools, and a Career-related Program (CP) for high school learners who desire to learn vocationally in addition to the original Diploma Program, which is still available and increasingly popular (International Baccalaureate Organisation, 2015). At Pan-Asia International School, the IB Diploma Program is currently the only program from International
Baccalaureate available to PAIS students, though the school is attending to implement the MYP program.

Students completing Grade 10 at PAIS are required to choose their study program in Grades 11 and 12, and if they choose to take IB (and are deemed academically capable), they can select subjects from one of six areas (1. Language and Literature, 2. Language Acquisition, 3. Individuals & Societies, 4. Experimental Science, 5. Mathematics, 6. The Arts). This is in addition to the three core requirements of Extended Essay, Theory of Knowledge and Community Action Service (International Baccalaureate Organisation, 2015b) which all students must complete. See Table 3 for a summary of the IBDP subject groups, and the options available at PAIS.
Table 3

*IBDP Groups and Available Subjects at PAIS in 2016/2017*

<table>
<thead>
<tr>
<th>IB Diploma Program group</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Language and Literature</td>
<td>English A</td>
</tr>
<tr>
<td></td>
<td>Arabic A</td>
</tr>
<tr>
<td></td>
<td>Turkish A</td>
</tr>
<tr>
<td>2 Language Acquisition</td>
<td>English B</td>
</tr>
<tr>
<td></td>
<td>Arabic B</td>
</tr>
<tr>
<td></td>
<td>Arabic Ab Initio</td>
</tr>
<tr>
<td></td>
<td>Mandarin Ab Initio</td>
</tr>
<tr>
<td>3 Individuals and Societies</td>
<td>History</td>
</tr>
<tr>
<td></td>
<td>Business Studies</td>
</tr>
<tr>
<td></td>
<td>Economics</td>
</tr>
<tr>
<td></td>
<td>Physics</td>
</tr>
<tr>
<td></td>
<td>Biology</td>
</tr>
<tr>
<td>4 Experimental Science</td>
<td>Mathematics</td>
</tr>
<tr>
<td></td>
<td>Math Studies</td>
</tr>
<tr>
<td>5 Mathematics</td>
<td>Visual Arts</td>
</tr>
<tr>
<td></td>
<td>Chemistry</td>
</tr>
</tbody>
</table>

*Note.* IBDP students must additionally complete the Extended Essay, a Community Action Service (CAS) project, and a Theory of Knowledge (TOK) requirement.

The International Baccalaureate Diploma Program requires that all students must study science, this is mandatory even though the choice of which science subject
to take is an elective. Students may choose to take more than one science, but the fact that PAIS only offers physics and biology in Group 4 (Experimental Science) means that students are forced to take physics or biology to complete the International Baccalaureate. Taking the UK’s A-Level qualification for comparison, there is no requirement to study any subject science for 17 and 18 year olds.

IB is internally regarded as a prestigious externally assessed qualification. The acceptance rate for IBDP students into university is typically high, for example in the United Kingdom it is higher than all other qualifications, including the native equivalent A-Levels (Ricks, 2013). Universities often treat IB candidates preferentially, due to the demanding nature of IB and the supposedly superior nature of the candidates which IB produces (International Baccalaureate Organisation, 2013). The IBDP is explicitly constructivist in nature, and deliberately articulates the very nature of science, as part of its curriculum. According to the International Baccalaureate Organisation (2008):

“The pedagogical approaches described here are based on a constructivist understanding of how children learn. Constructivism is a theory of cognition, now widely used and accepted, that asserts that knowledge is not passively learned but actively built and refers to approaches that recognize the importance of engaging and challenging existing mental models in learners in order to improve understanding and performance. In the light of a constructivist understanding of teaching and learning, IB programmes are designed to stimulate young people to be intellectually curious and equip them with the knowledge, conceptual understanding, skills, reflective practices and attitudes needed to become autonomous lifelong learners”. (p. 12)
Pan-Asia International School

PAIS or Pan-Asia International School is an international school in the Prawet district of Bangkok, the capital city Thailand. An international school is defined as a school where the medium of instruction is different from that of the host country (Hayden & Thompson, 2008). At Pan-Asia International School the medium of instruction is English, except in the cases of lessons in second and third languages. Pan-Asia International School was established in 2004 to provide American standards in education in Thailand. Currently Pan-Asia International School has students from more than 41 countries of origin (Pan-Asia, 2015).

The stated goal of PAIS is a combination of western curriculum and eastern culture, and the ISAT listing of Pan-Asia International School states that the school follows an American curriculum (International Schools Association of Thailand, 2015). In the case of PAIS, previously this was the Massachusetts state curriculum of the USA. In 2010 Massachusetts transitioned to the US common core curriculum, subsequently PAIS commenced the transition to the US common core curriculum too. Where benchmarks for standards are not available from the common core curriculum, benchmarks are retained from the previous Massachusetts state curriculum (Pan-Asia 2015). This adapted form of the common core curriculum is followed until Grade 11, when students have the option to take the International Baccalaureate Diploma Program.

Pan-Asia International School is a large, modern facility, the oldest parts being only around 12 years old (as of 2017). Pan-Asia International School grew rapidly from a single building into its current form, with two buildings, two football pitches, two covered gymnasium courts, and two swimming pools (Pan-Asia, 2015). These
facilities enable a wide range of extra-curricular activities, such as football, futsal, volleyball, basketball, cricket, swimming, tennis, badminton and athletics.

The educational philosophy according to PAIS (2015, para. 7) is:

“Our educational philosophy aims at shaping the hearts and minds of our students by promoting a congenial school environment that instils in our students high morals, confidence and a pride in their identity. PAIS strives to present a new outlook in education by providing a nurturing, compassionate and loving environment”.

Pan-Asia is accredited by the International School of Thailand (ISAT) organization, the Thai Ministry of Education and the Western Association of Schools and Colleges (WASC), an American accreditation agency (Pan-Asia, 2015). Pan-Asia has also been accredited by the International Baccalaureate Organisation to run an IB Diploma Program (International Baccalaureate Organisation, 2015a) since 2010. Pan-Asia International School is currently operated by the Marmara Company of Turkey. The Marmara Company began investing in education in Thailand in 1996, and since has expanded to operate four schools in the Kingdom of Thailand (Marmara, 2015).

As identified in the statement of the problem, the achievement of students in science subjects notably decreases as they enter the high school department of PAIS. While some students have high prior achievement in science subjects, and maintain this level of achievement until graduation, these students are sadly regarded as atypical of the student mass. There has been observed to be a decrease in student science achievement in PAIS at the high school level. This observation can appear pronounced from a single grade level to the next, with the resulting phenomenon that many students seem to have decreasing achievement in science, simply in moving up to the next grade level.
One possible explanation is the discrepancy in instructional strategies between the middle and high school science teachers at PAIS. However, high school science at PAIS is taught as three distinct subjects (biology, chemistry, and physics), and it is strange to see the same decrease across three high school science subjects, with three different teachers. Another explanation is that this phenomenon is created by increased difficulties experienced by PAIS students moving from middle school to high school. At PAIS, students can currently study the International Baccalaureate Diploma Program at high school level. The International Baccalaureate requires the study of six subject areas, of which science is one compulsory subject. All PAIS high school students are required to choose one elective course in each of the six subject groups from the IB Diploma Program.

There is currently a disconnect between the high school and middle school at PAIS, as the middle school curriculum is based upon the common core curriculum of the USA. This means that the middle school curriculum at PAIS is aligned with common core students in the US, but not with the needs of preparing students for the International Baccalaureate Diploma Program in high school. The misalignment from a common core based curriculum to an IB-based curriculum makes the transition in Grade 11 a difficult one.

As of 2017, PAIS is a candidate school for the Middle Years Program (MYP) of International Baccalaureate. However, the candidacy stage of MYP lasts at least 2 years, subject to approval by International Baccalaureate. This means that the full MYP program can not be implemented at PAIS for at least two years, starting in the academic year 2019-2020 at the earliest. As a response to this problem, PAIS has implemented a “Pre-IB” program in Grades 9 and 10. The Pre-IB program was an ad-
hoc creation at PAIS, attempting to introduce the IBDP content and requirements at
an earlier stage to improve student performance.

For example, in biology classes the students’ ability to work independently on
experimental design and complete laboratory reports was hampered by lack of
practice of these skills. IBDP required the development of experimental skills in
biology that were not adequately addressed by the Common Core based curriculum.
By teaching the IBDP content and skills in Grades 9 and 10, it is hoped that students
will be better prepared for the rigorous requirements of IBDP. For a summary of the
curricula currently in place at PAIS (as of academic year 2016-2017), see Table 4
below.
Table 4

*The Curricula Used at Each Grade Level at PAIS (2016-2017)*

<table>
<thead>
<tr>
<th>Grade level</th>
<th>Curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Common Core</td>
</tr>
<tr>
<td>2</td>
<td>Common Core</td>
</tr>
<tr>
<td>3</td>
<td>Common Core</td>
</tr>
<tr>
<td>4</td>
<td>Common Core</td>
</tr>
<tr>
<td>5</td>
<td>Common Core</td>
</tr>
<tr>
<td>6</td>
<td>Common Core (to be replaced by MYP)</td>
</tr>
<tr>
<td>7</td>
<td>Common Core (to be replaced by MYP)</td>
</tr>
<tr>
<td>8</td>
<td>Common Core (to be replaced by MYP)</td>
</tr>
<tr>
<td>9</td>
<td>Pre-IB (to be replaced by MYP)</td>
</tr>
<tr>
<td>10</td>
<td>Pre-IB (to be replaced by MYP)</td>
</tr>
<tr>
<td>11</td>
<td>IBDP</td>
</tr>
<tr>
<td>12</td>
<td>IBDP</td>
</tr>
</tbody>
</table>

*Note.* The Pre-IB Program is a program created locally at PAIS until the IB Middle Years Program candidacy phase is completed. The MYP program will be implemented by 2019-2020 at the earliest.

Currently, the Grades 11 and 12 students learn similar content to Grades 9 and 10 students, due to the Pre-IB objectives being aligned with the requirements of IBDP. For an example of the content taught, find the units presented in Table 5 below.
Table 5

*Topics Taught in High School Biology Classes at PAIS*

<table>
<thead>
<tr>
<th>Topic</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Standard Level Topic) Cells</td>
</tr>
<tr>
<td>2</td>
<td>(Standard Level Topic) Molecular Biology</td>
</tr>
<tr>
<td>3</td>
<td>(Standard Level Topic) Genetics</td>
</tr>
<tr>
<td>4</td>
<td>(Standard Level Topic) Ecology</td>
</tr>
<tr>
<td>5</td>
<td>(Standard Level Topic) Evolution and Biodiversity</td>
</tr>
<tr>
<td>6</td>
<td>(Standard Level Topic) Human Physiology</td>
</tr>
<tr>
<td>7</td>
<td>(Higher Level Topic) Nucleic Acids</td>
</tr>
<tr>
<td>8</td>
<td>(Higher Level Topic) Metabolism, Respiration &amp; Photosynthesis</td>
</tr>
<tr>
<td>9</td>
<td>(Higher Level Topic) Plant Biology</td>
</tr>
<tr>
<td>10</td>
<td>(Higher Level Topic) Genetics &amp; Evolution</td>
</tr>
<tr>
<td>11</td>
<td>(Higher Level Topic) Animal Physiology</td>
</tr>
<tr>
<td>Optional</td>
<td>(Standard Level and Advanced Human Physiology</td>
</tr>
<tr>
<td>Topic D</td>
<td>Higher Level Topic)</td>
</tr>
</tbody>
</table>

For example, all biology students in high school at PAIS study topic 1 (cells) using the same content objectives at both Pre-IB and IBDP level. However, the instructional methods used will be different, and the depth to which the content is taught change between Pre-IB and IBDP students. For example, Pre-IB students might be taught by completing exercises in class, with the more advanced objectives simplified. The number of teaching hours would be less, so the topic would be merely introduced and perhaps an activity completed. Conversely the IBDP students would be expected to explore the same topic fully and independently in their own time. A
research assignment might be set, and the students might be expected to present their findings to the class.

Summary

This chapter examined areas that can affect science achievement in students. Motivation can affect learning in science in a number of dimensions, such as through intrinsic motivation, extrinsic motivation, self-efficacy, task value and control of learning beliefs. Student achievement in science can be affected by a number of additional factors, such as teaching practices, learning environment, instructional methods and pedagogy. Pan-Asia teaches science using the progressive International Baccalaureate Diploma Program, which is internationally regarded as being highly achieving and explicitly constructivist in nature.
CHAPTER III

RESEARCH METHODOLOGY

For this chapter, the researcher will describe the methodology intended to be used for this study; including the research design, the population, the sample, the research instrument, the collection of the data and the data analysis.

**Research Design**

The research design was a quantitative, a correlational-comparative study between motivation for learning biology and biology achievement. The design of this research was focused upon identifying students’ motivation levels for learning biology and students’ biology achievement for Grades 9, 10, 11 and 12 at Pan-Asia International School.

The first and second objectives required simple descriptive statistics, intended to determine the motivation level for learning biology amongst the Grades 9 and 10, and Grades 11 and 12 students. The third and fourth objectives required the use of inferential statistics, intended to test the correlation between motivation for learning biology and biology achievement. The third objective also required the use of inferential statistics, as it will compare the motivation for learning biology levels of the Grades 9 and 10, and Grades 11 and 12 students.
Population

There are 107 high school students studying biology in Grades 9, 10, 11 and 12 at Pan-Asia International School. The students are all taught by the researcher and are studying in the 2016-2017 academic year.

The population of students at each level is variable, especially after Grade 11, as students can make elective choices about their study. At Grade 11 and afterwards, the population size of students choosing biology as an elective typically decreases as some students “dropped out” of biology.

Sample

For this study, the sample was all of the 107 high school students currently studying biology by the researcher at Grades 9, 10, 11 and 12, in the 2016-2017 academic year at Pan-Asia International School. See Table 6 for the sample used in this study.

Table 6

Students Sampled per Grade Level

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td>10</td>
<td>28</td>
</tr>
<tr>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>12</td>
<td>23</td>
</tr>
<tr>
<td>Total Pre-IB (Grades 9 and 10)</td>
<td>64</td>
</tr>
<tr>
<td>Total IBDP (Grades 11 and 12)</td>
<td>43</td>
</tr>
<tr>
<td>Total</td>
<td>107</td>
</tr>
</tbody>
</table>
Research Instruments

There were two research instruments used in this study. The first was the Motivated Strategies for Learning Science Questionnaire (MSLSQ), which examined student motivation level for learning biology. The second was a biology placement examination, which assessed student biology achievement.

MSLSQ

The Motivated Strategies for Learning Science Questionnaire (MSLSQ), is an adaptation of the Motivated Strategies for Learning Questionnaire (MSLQ), developed by Pintrich et al. (1991). The MSLSQ uses a 7-point Likert-type scale, where students state their agreement or disagreement with offered statements. There are 26 items on this instrument, and possible responses range from one (not at all true of me) to seven (very true of me), giving a minimum possible response of 26 and a maximum possible response of 182 (see Appendix A).

The original MSLQ identified the levels of six subscales of motivation. The adapted MSLSQ utilised five of these six subscales, each examining a component of motivation. The five utilised subscales were intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs and self-efficacy for learning and performance (see Students Sampled per Grade Level).
Table 7

**MSLSQ Items and Relevant Subscales**

<table>
<thead>
<tr>
<th>Items</th>
<th>Subscale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 13, 18, 20</td>
<td>Intrinsic goal orientation</td>
</tr>
<tr>
<td>6, 9, 11, 25</td>
<td>Extrinsic goal orientation</td>
</tr>
<tr>
<td>3, 8, 14, 19, 22, 23</td>
<td>Task value</td>
</tr>
<tr>
<td>2, 7, 15, 21</td>
<td>Control of learning beliefs</td>
</tr>
<tr>
<td>4, 5, 10, 12, 16, 17, 24, 26</td>
<td>Self-efficacy for learning and performance</td>
</tr>
</tbody>
</table>

As per research objective one, the researcher identified the students’ motivation level for learning biology. The MSLQ matches the mean value to an interpretation, ranging from a very high level of motivation (scores 5.81-7.00) to a very low level of motivation (scores 1.20-2.00). The interpretation for motivation level from the MSLSQ results can be found in Table 8.

Table 8

**Interpretation of the MSLSQ**

<table>
<thead>
<tr>
<th>Mean value</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.81-7.00</td>
<td>Very high motivation level</td>
</tr>
<tr>
<td>4.61-5.80</td>
<td>High motivation level</td>
</tr>
<tr>
<td>3.41-4.60</td>
<td>Moderate motivation level</td>
</tr>
<tr>
<td>2.21-3.40</td>
<td>Low motivation level</td>
</tr>
<tr>
<td>1.00-2.20</td>
<td>Very low motivation level</td>
</tr>
</tbody>
</table>
Validity and Reliability of the MSLSQ

The MSLSQ is based upon the MSLQ by Pintrich et al. (1991). The MSLQ with 15 subscales is intended as a modular instrument, with the subscales to be used collectively or individually as the researcher required. As such a Cronbach’s alpha can be identified for the whole study or for the individual subscales.

According to Pintrich, Smith, Garcia, and McKeachie (1993), the internal consistency estimates of reliability (Cronbach’s alpha) were calculated in a robust manner, demonstrating a high internal consistency. Reliability data was obtained from three rounds of data collection; 1986 (326 students), 1987 (687 students) and 1988 (758 students). The predictive validity has also been examined, and the subscales for this study (intrinsic goal orientation, extrinsic goal orientation, task value, control of learning belief and self-efficacy for learning and performance) were all positively correlated with academic achievement (Pintrich et al., 1993).

The validity and reliability of the MSLQ have been confirmed in other studies. For example, Taylor (2012) noted that the MSLQ has high predictive validity for both intended and actual (alternate) uses of this instrument. A study by Ilker, Arslan and Demirhan conducted a study using the MSLQ on Turkish high school students, and indicated sufficient levels of validity and reliability (Cronbach’s alpha values were between 0.7 and 0.77). A study by Feiz, Hooman, and Kooshki (2013) with Iranian high school students examined the construct validity and reliability of the MSLQ, confirming it as a useful tool for assessing motivational strategies for learning. The specifications of the MSLSQ with the alpha value for reliability are presented below as Table 9.
Table 9

**Specifications of the MSLSQ**

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Item numbers</th>
<th>Number of items for each component</th>
<th>Cronbach’s alpha value by Pintrich et al. (1991)</th>
<th>Cronbach’s alpha value in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrinsic Goal Orientation</td>
<td>1, 13, 18, 20</td>
<td>4</td>
<td>.74</td>
<td>.53</td>
</tr>
<tr>
<td>Extrinsic Goal Orientation</td>
<td>6, 9, 11, 25</td>
<td>4</td>
<td>.62</td>
<td>.69</td>
</tr>
<tr>
<td>Task Value</td>
<td>3, 8, 14, 19, 22, 23</td>
<td>6</td>
<td>.90</td>
<td>.82</td>
</tr>
<tr>
<td>Control of Learning Beliefs</td>
<td>2, 7, 15, 21</td>
<td>4</td>
<td>.68</td>
<td>.65</td>
</tr>
<tr>
<td>Self-efficacy for Learning and Performance</td>
<td>4, 5, 10, 12, 16, 17, 24, 26</td>
<td>8</td>
<td>.93</td>
<td>.86</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>26</td>
<td>.77</td>
<td>.71</td>
</tr>
</tbody>
</table>

**Biology Placement Examination**

The second instrument in this study was a biology placement examination, a test of student understanding of content. Two placement examinations were used, one with common questions for Grades 9 and 10 (Pre-IB students) and one with common questions for Grades 11 and 12 (IBDP students). These instruments can be found under appendix A and B respectively. These biology placement examinations each contain 20 multiple choice questions, giving the students a biology achievement score of 1-20.

The placement questions were taken from previous International Baccalaureate Diploma Program biology exam papers from the previous 10 years, using a record of past papers, and the IBO past paper exam question bank CD. As the International Baccalaureate
Diploma Program uses an external assessment aimed at International Schools all over the world, this should ensure a high level of validity and reliability.

Collection of Data

The collection of the data was carried out by the researcher personally. No research assistant was required. The researcher requested permission from PAIS to conduct the study, then collected the required data using the MSLSQ and the biology achievement placement tests (see Table 10). The MSLSQ was distributed to students during biology class time. Approximately a week later, students took a simple examination of their knowledge of biology content.

Table 10

<table>
<thead>
<tr>
<th>Activity</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Obtain permission from PAIS administrators to conduct the study.</td>
<td>April 3rd 2017</td>
</tr>
<tr>
<td>2. Distribute the MSLSQ instrument to students during biology classes.</td>
<td>April 17th - 21st 2017</td>
</tr>
<tr>
<td>3. Collect data on student biology achievement from using the biology placement examinations.</td>
<td>April 24th - 28th 2017</td>
</tr>
</tbody>
</table>
Data Analysis

The following methods were used for data analysis in this study.

**Objective 1** determined the level of the students’ motivation for learning biology for Grades 9 and 10 students, at Pan-Asia International School. Means and standard deviation were calculated to find the level of student motivation for learning biology.

**Objective 2** determined the level of the students’ motivation for learning biology for Grades 11 and 12 students, at Pan-Asia International School. Means and standard deviation were calculated to find the level of student motivation for learning biology.

**Objective 3** identified a correlation between students’ motivation for learning biology and student biology achievement amongst Grades 9 and 10 students, at Pan-Asia International School. A Pearson product moment correlation coefficient was used to determine the correlation between student motivation for learning biology and student biology achievement.

**Objective 4** will identify a correlation between students’ motivation for learning biology and student biology achievement amongst Grades 11 and 12 students, at Pan-Asia International School. A Pearson product moment correlation coefficient was used to determine the correlation between student motivation for learning biology and student biology achievement.

**Objective 5** compared student motivation level for learning biology between Grades 9 and 10 students, and Grades 11 and 12 students at Pan-Asia International School. The independent samples’ $t$-test was computed for a comparison of student motivation level for learning biology.
### Summary of the Research Process

#### Table 11

<table>
<thead>
<tr>
<th>Research objective</th>
<th>Source of data</th>
<th>Data collection method or research instrument</th>
<th>Data analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Determine the students’ motivation level for learning biology for IBDP students at PAIS.</td>
<td>Grades 9 and 10</td>
<td>Motivated Strategies for Learning Science</td>
<td>Means and standard deviations</td>
</tr>
<tr>
<td>2. Determine the students’ motivation level for learning biology for IBDP students at PAIS.</td>
<td>Grades 11 and 12</td>
<td>Motivated Strategies for Learning Science</td>
<td>Means and standard deviations</td>
</tr>
<tr>
<td>3. Determine the relationship between student motivation level for learning biology and achievement in biology for pre-IB students at PAIS.</td>
<td>Grades 9 and 10</td>
<td>Motivated Strategies for Learning Science</td>
<td>Pearson product moment correlation coefficient</td>
</tr>
<tr>
<td>4. Determine the relationship between student motivation level for learning biology and achievement in biology for pre-IB students at PAIS.</td>
<td>Grades 11 and 12</td>
<td>Motivated Strategies for Learning Science</td>
<td>Pearson product moment correlation coefficient</td>
</tr>
</tbody>
</table>

(continued)
(continued)

<table>
<thead>
<tr>
<th>Research objective</th>
<th>Source of data</th>
<th>Data collection method or research instrument</th>
<th>Data analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Compare the student motivation for learning biology between Grades 9 and 10,</td>
<td>Grades 9, 10, 11 and 12</td>
<td>Motivated Strategies for Learning Science</td>
<td>Independent samples t-test</td>
</tr>
<tr>
<td>Grades 9 and 10 students, and Grades 11 and 12 students at Pan-Asia International School</td>
<td>biology</td>
<td>Questionnaire</td>
<td>(MSLSQ)</td>
</tr>
<tr>
<td></td>
<td>students at PAIS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER IV

RESEARCH FINDINGS

This chapter presents the research findings from the data collected with the Grades 9, 10, 11 and 12 students (N = 107) at Pan-Asia International School for the five research objectives that guided this study. The first two objectives involved identifying the students’ level of motivation. The second two objectives involved identifying the significance of the relationship between the students’ level of motivation and achievement scores in biology. The fifth objective was related to identifying any significant difference between the two student groups in this study. The presentation of the findings will be given objective by objective.

Research Objective One

The first research objective was to determine the level of the students’ motivation for learning biology for Grades 9 and 10 (Pre-IB) students, at Pan-Asia International School. This was performed by calculating the means and standard deviations of the students’ motivation scores.

The data for this objective was collected with using the Motivated Strategies for Learning Science Questionnaire or MSLSQ (see Appendix A). The MSLSQ is a 7-point Likert-type scale, with responses ranging from 1 (completely false) to 7 (completely true). There were 26 items in this instrument related to the students’ motivation levels for learning biology. The 5 interpretation values for the level of motivation ranged from a very low level of motivation to very high level of motivation (see Table 8 in Chapter III). The findings of each item of the MSLSQ are listed below (see Table 12).
Table 12

Means, Standard Deviations and Interpretation of MSLSQ Items for Grades 9 and 10 Students

<table>
<thead>
<tr>
<th>Item</th>
<th>Interpretation (motivation level)</th>
<th>Item</th>
<th>Interpretation (motivation level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High</td>
<td>2</td>
<td>High</td>
</tr>
<tr>
<td>3</td>
<td>Moderate</td>
<td>4</td>
<td>Moderate</td>
</tr>
<tr>
<td>5</td>
<td>Moderate</td>
<td>6</td>
<td>High</td>
</tr>
<tr>
<td>7</td>
<td>High</td>
<td>8</td>
<td>High</td>
</tr>
<tr>
<td>9</td>
<td>High</td>
<td>10</td>
<td>High</td>
</tr>
<tr>
<td>11</td>
<td>High</td>
<td>12</td>
<td>Moderate</td>
</tr>
<tr>
<td>13</td>
<td>High</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Item</th>
<th>Interpretation (motivation level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>I am very interested in the content of biology classes</td>
</tr>
<tr>
<td>15</td>
<td>If I try hard enough, then I will understand the content of biology class.</td>
</tr>
<tr>
<td>16</td>
<td>I'm confident I can do an excellent job on any assignments and tests in biology class.</td>
</tr>
<tr>
<td>17</td>
<td>I expect to do well in biology class.</td>
</tr>
<tr>
<td>18</td>
<td>The most satisfying thing for me in biology class is trying to understand the content as thoroughly as possible.</td>
</tr>
<tr>
<td>19</td>
<td>I think the content in biology class is useful for me to learn.</td>
</tr>
<tr>
<td>20</td>
<td>If I have the opportunity in biology, I will choose assignments that I can learn from even if they don't guarantee a good grade.</td>
</tr>
<tr>
<td>21</td>
<td>If I don't understand the biology content, it is because I didn't try hard enough.</td>
</tr>
<tr>
<td>22</td>
<td>I like the subject of biology.</td>
</tr>
<tr>
<td>23</td>
<td>Understanding the subject of biology is very important to me.</td>
</tr>
<tr>
<td>24</td>
<td>I'm certain I can master the skills being taught in biology.</td>
</tr>
<tr>
<td>25</td>
<td>I want to do well in biology class because it is important to show my ability to my family, friends, or others.</td>
</tr>
<tr>
<td>26</td>
<td>Considering the difficulty of this class, the teacher, and my skills, I think I will do well in biology class.</td>
</tr>
<tr>
<td>Overall Motivation</td>
<td>5.054</td>
</tr>
</tbody>
</table>
In this study motivation level for learning biology was determined from 5 different components of motivation. The MSLSQ has 5 subscales for motivation, which were used to determine a level of motivation for each component. The means and standard deviations were calculated to determine the level of intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs and self-efficacy for learning and performance when learning biology. In the case of Grades 9 and 10 (Pre-IB students) they were determined to have a high level of motivation for all 5 components of motivation (see Table 13).

Table 13

Means and Standard Deviations and Interpretation of MSLSQ Components for Grades 9 and 10 Students

<table>
<thead>
<tr>
<th>Item Numbers</th>
<th>Component</th>
<th>M</th>
<th>SD</th>
<th>Interpretation (motivation level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 13, 18, 20</td>
<td>Intrinsic Goal Orientation</td>
<td>5.268</td>
<td>1.420</td>
<td>High</td>
</tr>
<tr>
<td>6, 9, 11, 25</td>
<td>Extrinsic Goal Orientation</td>
<td>5.094</td>
<td>1.788</td>
<td>High</td>
</tr>
<tr>
<td>3, 8, 13, 19, 22, 23</td>
<td>Task Value</td>
<td>5.110</td>
<td>1.550</td>
<td>High</td>
</tr>
<tr>
<td>2, 7, 15, 21</td>
<td>Control of Learning Beliefs</td>
<td>5.683</td>
<td>1.409</td>
<td>High</td>
</tr>
<tr>
<td>4, 5, 10, 12, 16, 17, 24, 26</td>
<td>Self-Efficacy for Learning and Performance</td>
<td>4.650</td>
<td>1.427</td>
<td>High</td>
</tr>
</tbody>
</table>

Overall Motivation | 5.054 | 1.441 | High  |
According to Table 13, the overall level of motivation for Grades 9 and 10 (Pre-IB students) was 5.054. According to the interpretation table shows a high level of motivation for learning biology. The range of values recorded was from 4.357 (moderate) to 5.964 (very high). Overall it can be stated that the level of motivation for learning biology for Grades 9 and 10 students ranged from 4.357 - 5.964, with a mean value of 5.054.

**Research Objective Two**

The second objective was to determine the level of the students’ motivation for learning biology for Grades 11 and 12 (IBDP) students, at Pan-Asia International School. This was performed by calculating the means and standard deviations of the students’ motivation scores.

The data for this objective was collected using the Motivated Strategies for Learning Science Questionnaire or MSLSQ (see Appendix A). The MSLSQ is a 7-point Likert-type scale, with responses ranging from 1 (completely false) to 7 (completely true). There were 26 items in this instrument related to the students’ motivation levels for learning biology. The 5 interpretation values for level of motivation ranged from a very low level of motivation to very high (for the interpretation of results, see Table 8 in Chapter 3). The findings of each item of the MSLSQ are listed below (see Table 14).
Table 14

**Means, Standard Deviations and Interpretation of MSLSQ Items for Grades 11 and 12**

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>In biology class, I prefer content that really challenges me so I can learn new things.</td>
</tr>
<tr>
<td>2</td>
<td>If I study in appropriate ways, then I will be able to learn the content in biology class.</td>
</tr>
<tr>
<td>3</td>
<td>I think I will be able to use what I learn in biology in other classes.</td>
</tr>
<tr>
<td>4</td>
<td>I believe I will receive a high grade in biology.</td>
</tr>
<tr>
<td>5</td>
<td>I'm sure I can understand the most difficult content presented in reading for biology class.</td>
</tr>
<tr>
<td>6</td>
<td>Getting a good grade is the most satisfying thing for me in biology class right now.</td>
</tr>
<tr>
<td>7</td>
<td>It is my own fault if I don't learn the content in biology class.</td>
</tr>
<tr>
<td>8</td>
<td>It is important for me to learn the content in biology class.</td>
</tr>
<tr>
<td>9</td>
<td>The most important thing for me right now is my overall grade, so my main concern in biology class is getting a good grade.</td>
</tr>
<tr>
<td>10</td>
<td>I'm confident I can understand basic concepts taught in biology class.</td>
</tr>
<tr>
<td>11</td>
<td>If I can, I want to get better grades in biology class than most of the other students.</td>
</tr>
<tr>
<td>12</td>
<td>I'm confident I can understand the most complex content presented by the teacher in biology class.</td>
</tr>
<tr>
<td>13</td>
<td>In biology class, I prefer content that arouses my curiosity, even if it is difficult to learn.</td>
</tr>
</tbody>
</table>

Interpretation ( motivation level )

<table>
<thead>
<tr>
<th>Item</th>
<th>M</th>
<th>SD</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.450</td>
<td>1.535</td>
<td>Moderate</td>
</tr>
<tr>
<td>2</td>
<td>5.475</td>
<td>1.396</td>
<td>High</td>
</tr>
<tr>
<td>3</td>
<td>4.500</td>
<td>1.617</td>
<td>Moderate</td>
</tr>
<tr>
<td>4</td>
<td>4.000</td>
<td>1.281</td>
<td>Moderate</td>
</tr>
<tr>
<td>5</td>
<td>3.275</td>
<td>1.633</td>
<td>Low</td>
</tr>
<tr>
<td>6</td>
<td>4.750</td>
<td>1.808</td>
<td>High</td>
</tr>
<tr>
<td>7</td>
<td>5.025</td>
<td>1.915</td>
<td>High</td>
</tr>
<tr>
<td>8</td>
<td>5.400</td>
<td>1.499</td>
<td>High</td>
</tr>
<tr>
<td>9</td>
<td>4.225</td>
<td>1.833</td>
<td>Moderate</td>
</tr>
<tr>
<td>10</td>
<td>4.825</td>
<td>1.599</td>
<td>High</td>
</tr>
<tr>
<td>11</td>
<td>4.600</td>
<td>1.751</td>
<td>Moderate</td>
</tr>
<tr>
<td>12</td>
<td>4.300</td>
<td>1.454</td>
<td>Moderate</td>
</tr>
<tr>
<td>13</td>
<td>4.625</td>
<td>1.675</td>
<td>High</td>
</tr>
<tr>
<td>Item</td>
<td>Item Description</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>14</td>
<td>I am very interested in the content of biology classes</td>
<td>4.625</td>
<td>1.652</td>
</tr>
<tr>
<td>15</td>
<td>If I try hard enough, then I will understand the content of biology class.</td>
<td>5.700</td>
<td>1.018</td>
</tr>
<tr>
<td>16</td>
<td>I'm confident I can do an excellent job on any assignments and tests in biology class.</td>
<td>3.850</td>
<td>1.477</td>
</tr>
<tr>
<td>17</td>
<td>I expect to do well in biology class.</td>
<td>4.600</td>
<td>1.317</td>
</tr>
<tr>
<td>18</td>
<td>The most satisfying thing for me in biology class is trying to understand the content as thoroughly as possible.</td>
<td>5.400</td>
<td>1.533</td>
</tr>
<tr>
<td>19</td>
<td>I think the content in biology class is useful for me to learn.</td>
<td>5.450</td>
<td>1.431</td>
</tr>
<tr>
<td>20</td>
<td>If I have the opportunity in biology, I will choose assignments that I can learn from even if they don't guarantee a good grade.</td>
<td>4.775</td>
<td>1.330</td>
</tr>
<tr>
<td>21</td>
<td>If I don't understand the biology content, it is because I didn't try hard enough.</td>
<td>4.975</td>
<td>1.493</td>
</tr>
<tr>
<td>22</td>
<td>I like the subject of biology.</td>
<td>4.925</td>
<td>1.655</td>
</tr>
<tr>
<td>23</td>
<td>Understanding the subject of biology is very important to me.</td>
<td>4.825</td>
<td>1.781</td>
</tr>
<tr>
<td>24</td>
<td>I'm certain I can master the skills being taught in biology.</td>
<td>4.100</td>
<td>1.482</td>
</tr>
<tr>
<td>25</td>
<td>I want to do well in biology class because it is important to show my ability to my family, friends, or others.</td>
<td>3.475</td>
<td>1.961</td>
</tr>
<tr>
<td>26</td>
<td>Considering the difficulty of this class, the teacher, and my skills, I think I will do well in biology class.</td>
<td>4.175</td>
<td>1.448</td>
</tr>
</tbody>
</table>

Overall Motivation Level for Learning Biology | 4.628 | 1.560 | High
In this study motivation level for learning biology was determined from five different components of motivation. The MSLSQ has five subscales for motivation, which were used to determine a level of motivation for each component. The means and standard deviations were calculated to determine the level of intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs and self-efficacy for learning and performance when learning biology. In the case of Grades 11 and 12 students, they were determined to have a high level of motivation for intrinsic goal orientation, task value and control of learning beliefs when learning biology. However Grades 11 and 12 (IBDP students) were determined to have a moderate level of extrinsic goal orientation and self-efficacy for learning and performance (see Table 15).
Table 15

Means and Standard Deviations of MSLSQ Components for Grades 11 and 12 Students

<table>
<thead>
<tr>
<th>Item Numbers</th>
<th>Component</th>
<th>M</th>
<th>SD</th>
<th>Interpretation (motivation level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 13, 18, 20</td>
<td>Intrinsic Goal Orientation</td>
<td>4.865</td>
<td>1.524</td>
<td>High</td>
</tr>
<tr>
<td>6, 9, 11, 25</td>
<td>Extrinsic Goal Orientation</td>
<td>4.365</td>
<td>1.872</td>
<td>Moderate</td>
</tr>
<tr>
<td>3, 8, 13, 19, 22, 23</td>
<td>Task Value</td>
<td>5.095</td>
<td>1.615</td>
<td>High</td>
</tr>
<tr>
<td>2, 7, 15, 21</td>
<td>Control of Learning Beliefs</td>
<td>5.345</td>
<td>1.450</td>
<td>High</td>
</tr>
<tr>
<td>4, 5, 10, 12, 16, 17, 24, 26</td>
<td>Self-Efficacy for Learning and Performance</td>
<td>4.196</td>
<td>1.511</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Overall Motivation</td>
<td>4.628</td>
<td>1.560</td>
<td>High</td>
</tr>
</tbody>
</table>

According to Table 15, the overall level of motivation for Grades 11 and 12 (IBDP students) was 4.628. According to the interpretation table, this shows a high level of motivation for learning biology. The range of values recorded was from 3.275 (low) to 5.700 (high). In summary it can be stated that the level of motivation for learning biology for Grades 11 and 12 students ranged from 3.275 - 5.700, with a mean value of 4.628.
Research Objective Three

Research objective three was to determine if there was a significant relationship between students’ motivation for learning biology and student biology achievement amongst Grades 9 and 10 students, at Pan-Asia International School. This was determined using a Pearson product moment correlation coefficient calculated by entering data into statistical analysis software.

Data for this objective was collected using a combination of the MSLSQ (see Appendix A) and the students’ Pre-IB biology achievement exam scores (see Appendix B) and presented in Table 16. The Pearson correlation coefficient or $r$ value can be interpreted according to Table 17.

Table 16

<p>| Pearson Product Moment Correlation Coefficient Between Grades 9 and 10 Students’ Motivation Level for Learning Biology and Grades 9 and 10 Students’ Biology Achievement. |
|---------------------------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Motivation level for learning biology</th>
<th>Biology achievement</th>
<th>Pearson correlation</th>
<th>Sig (2-tailed)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology achievement</td>
<td>Pearson correlation</td>
<td>.277**</td>
<td>.039</td>
<td>There is a significant relationship</td>
</tr>
<tr>
<td></td>
<td>Sig (2-tailed)</td>
<td>.039</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. ** Correlation is significant at the .05 level (2-tailed).
Table 17

*Interpretation of Pearson r Values*

<table>
<thead>
<tr>
<th>Strength of Association</th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weak</td>
<td>.1 to .3</td>
<td>-0.1 to -0.3</td>
</tr>
<tr>
<td>Moderate</td>
<td>.3 to .5</td>
<td>-0.3 to -0.5</td>
</tr>
<tr>
<td>Strong</td>
<td>.5 to 1.0</td>
<td>-0.5 to -1.0</td>
</tr>
</tbody>
</table>

*Note. Adapted from Lund Research Ltd, 2013*

According to Table 17, the $r$ value of .277 indicates that there was a weak positive relationship between students’ motivation for learning biology and the student’s biology achievement amongst Grades 9 and 10 students, at Pan-Asia International School. The significance of .039 shows that this relationship was significant at the .05 level. Therefore, the researcher accepted research hypothesis one: *There is a significant relationship between student motivation for learning biology and student biology achievement amongst Grades 9 and 10 students, at Pan-Asia International School at the .05 level.*

**Research Objective Four**

Research objective four was to determine if there was a significant relationship between students’ motivation for learning biology and student biology achievement amongst Grades 11 and 12 students, at Pan-Asia International School. This was determined using a Pearson product moment correlation coefficient calculated by entering data into statistical analysis software.
Data for this objective was collected using a combination of the MSLSQ (see Appendix A) and the students’ IBDP biology achievement exam scores (see Appendix C) and recorded in Table 18.

Table 18

_Pearson Product Moment Correlation Coefficient between Grades 11 and 12 Students’ Motivation Level for Learning Biology and Grades 11 and 12 Student’s Biology Achievement._

<table>
<thead>
<tr>
<th>Motivation level for learning biology</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology achievement</td>
<td>Pearson correlation .366**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.027</td>
</tr>
</tbody>
</table>

*Note.** *Correlation is significant at the .05 level (2-tailed).*

The $r$ value of .366 indicates that there was a moderate positive relationship between students’ motivation for learning biology and student biology achievement amongst Grades 11 and 12 students, at Pan-Asia International School. The significance value of .027 shows that this relationship was significant at the .05 level. Therefore, the researcher accepted research hypothesis two: There is a significant relationship between student motivation for learning biology and student biology achievement amongst Grades 11 and 12 students, at Pan-Asia International School at the .05 level.

**Research Objective Five**

Research objective five was to determine if there was a significant difference in student motivation for learning biology between Grades 9 and 10 students, and Grades 11 and 12 students at Pan-Asia International School. An independent-samples
A t-test was conducted to compare student motivation for learning biology between Grades 9 and 10 (Pre-IB students) and Grades 11 and 12 (IBDP students). The results are presented in Table 19 below.

Table 19

<table>
<thead>
<tr>
<th>Grade level</th>
<th>M</th>
<th>SD</th>
<th>t</th>
<th>Df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 and 10</td>
<td>5.054</td>
<td>1.441</td>
<td>2.259</td>
<td>89</td>
<td>0.026</td>
</tr>
<tr>
<td>11 and 12</td>
<td>4.628</td>
<td>1.560</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to Table 19, the p value of this t-test was .026, which was significant at the .05 level. There was a significant difference in student motivation level for learning biology between Pre-IB students (M=5.054, SD=1.441) and IBDP students (M=4.628, SD=1.560). Therefore the researcher has accepted research hypothesis three: There is a significant difference for student motivation for learning biology between Grades 9 and 10 students, and Grades 11 and 12 students at Pan-Asia International School at the .05 level.

Additional Findings

In this section the researcher will present the four additional findings of this study. These additional findings are not for the five stated research objectives, but are additional discoveries made as part of this study. These additional findings examined the four high school grade levels separately and determined their motivation level for
The original intention of this study was to compare two study groups at PAIS, namely the Pre-IB and IBDP students. However, it was considered informative by the researcher to identify which of the grade levels studied was positive or negatively impact the mean value for the grouped score. For example Grades 11 and 12 are grouped as IBDP students. Examining them separately allowed the researcher to determine how each grade level affected the grouped student motivation level, and thus determine if the original understanding of the problem was correct. The motivation levels for each separate grade level (Grades 9, 10, 11 and 12) are presented as Tables 20-23 respectively.

### Table 20

*Means, Standard Deviations and Interpretation for the Components of the MSLSQ for Grade 9 Students*

<table>
<thead>
<tr>
<th>Component</th>
<th>M</th>
<th>SD</th>
<th>Interpretation (motivation level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrinsic Goal Orientation</td>
<td>5.114</td>
<td>1.368</td>
<td>High</td>
</tr>
<tr>
<td>Extrinsic Goal Orientation</td>
<td>5.212</td>
<td>1.756</td>
<td>High</td>
</tr>
<tr>
<td>Task Value</td>
<td>5.131</td>
<td>1.521</td>
<td>High</td>
</tr>
<tr>
<td>Control of Learning Beliefs</td>
<td>5.727</td>
<td>1.348</td>
<td>High</td>
</tr>
<tr>
<td>Self-Efficacy for Learning and Performance</td>
<td>4.568</td>
<td>1.415</td>
<td>Moderate</td>
</tr>
<tr>
<td>Overall</td>
<td>5.059</td>
<td>1.527</td>
<td>High</td>
</tr>
</tbody>
</table>
The mean student response score for learning biology in Grade 9 was identified to be 5.059, which corresponds to a high motivation level (see Table 8). Therefore it was determined that Grade 9 students at PAIS have a high level of motivation for learning biology.

Table 21

*Means, Standard Deviations and Interpretation for the Components of the MSLSQ for Grade 10 Students*

<table>
<thead>
<tr>
<th>Component</th>
<th>M</th>
<th>SD</th>
<th>Interpretation (motivation level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrinsic Goal Orientation</td>
<td>5.098</td>
<td>1.512</td>
<td>High</td>
</tr>
<tr>
<td>Extrinsic Goal Orientation</td>
<td>4.924</td>
<td>1.829</td>
<td>High</td>
</tr>
<tr>
<td>Task Value</td>
<td>4.703</td>
<td>1.641</td>
<td>High</td>
</tr>
<tr>
<td>Control of Learning Beliefs</td>
<td>5.620</td>
<td>1.488</td>
<td>High</td>
</tr>
<tr>
<td>Self-Efficacy for Learning and Performance</td>
<td>4.766</td>
<td>1.439</td>
<td>High</td>
</tr>
<tr>
<td>Overall</td>
<td>5.045</td>
<td>1.580</td>
<td>High</td>
</tr>
</tbody>
</table>

The mean student response score for learning biology in Grade 10 was identified to be 5.045, which corresponds to a high motivation level (see Table 8). Therefore it was determined that Grade 10 students at PAIS have a high level of motivation for learning biology.
Table 22

*Means, Standard Deviations and Interpretation for the Components of the MSLSQ for Grade 11 Students*

<table>
<thead>
<tr>
<th>Component</th>
<th>M</th>
<th>SD</th>
<th>Interpretation (motivation level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrinsic Goal Orientation</td>
<td>5.927</td>
<td>1.230</td>
<td>Very High</td>
</tr>
<tr>
<td>Extrinsic Goal Orientation</td>
<td>4.828</td>
<td>1.674</td>
<td>High</td>
</tr>
<tr>
<td>Task Value</td>
<td>5.688</td>
<td>1.108</td>
<td>High</td>
</tr>
<tr>
<td>Control of Learning Beliefs</td>
<td>5.703</td>
<td>1.049</td>
<td>High</td>
</tr>
<tr>
<td>Self-Efficacy for Learning and Performance</td>
<td>4.594</td>
<td>1.264</td>
<td>Moderate</td>
</tr>
<tr>
<td>Overall</td>
<td>5.146</td>
<td>1.361</td>
<td>High</td>
</tr>
</tbody>
</table>

The mean student response score for learning biology in Grade 11 was identified to be 5.146, which corresponds to a high motivation level (see Table 8). Therefore it was determined that Grade 11 students at PAIS have a high level of motivation for learning biology.
Table 23

*Means, Standard Deviations and Interpretation for the Components of the MSLSQ for Grade 12 Students*

<table>
<thead>
<tr>
<th>Component</th>
<th>M</th>
<th>SD</th>
<th>Interpretation (motivation level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrinsic Goal Orientation</td>
<td>4.461</td>
<td>1.685</td>
<td>Moderate</td>
</tr>
<tr>
<td>Extrinsic Goal Orientation</td>
<td>3.763</td>
<td>1.832</td>
<td>Moderate</td>
</tr>
<tr>
<td>Task Value</td>
<td>4.333</td>
<td>1.698</td>
<td>Moderate</td>
</tr>
<tr>
<td>Control of Learning Beliefs</td>
<td>4.921</td>
<td>1.647</td>
<td>High</td>
</tr>
<tr>
<td>Self-Efficacy for Learning and Performance</td>
<td>3.724</td>
<td>1.256</td>
<td>Moderate</td>
</tr>
<tr>
<td>Overall</td>
<td>4.346</td>
<td>1.729</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

The mean student response score for learning biology in Grade 12 was identified to be 4.346, which corresponds to a moderate motivation level (see Table 8). Therefore it was determined that Grade 12 students at PAIS have a moderate level of motivation for learning biology.

A summary of these additional findings can be found below as Table 24. It can be observed that the motivation level for learning biology was high for students at all grade levels, except for Grade 12. The Grade 12 students were determined to have a moderate level of motivation for learning biology.
Table 24

Means, Standard Deviations and Interpretation of the Motivation Level in Learning Biology, for Each Grade Level at PAIS.

<table>
<thead>
<tr>
<th>Grade level</th>
<th>M</th>
<th>SD</th>
<th>Interpretation (motivation level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 9</td>
<td>5.059</td>
<td>1.527</td>
<td>High</td>
</tr>
<tr>
<td>Grade 10</td>
<td>5.045</td>
<td>1.580</td>
<td>High</td>
</tr>
<tr>
<td>Grade 11</td>
<td>5.146</td>
<td>1.361</td>
<td>High</td>
</tr>
<tr>
<td>Grade 12</td>
<td>4.346</td>
<td>1.729</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

Focusing on the Grade 12 students’ motivation levels for learning biology (see Table 23), the Grade 12 students exhibited the lowest overall level of motivation for learning biology. To compare the five different components of motivation between the grade levels, the findings are visually presented in graphical form below (Figures 3-7).
Figure 3. Students' mean response score of intrinsic goal orientation when learning biology, according to their grade level at Pan-Asia International School in this study.

This study also observed a trend of decrease in students' level of intrinsic goal orientation for learning biology for Grade 12 students at PAIS. The Grade 12 students had the lowest level of intrinsic goal orientation of the four grade levels studied.

Figure 4. Students' mean response score of extrinsic goal orientation when learning biology, according to their grade level at Pan-Asia International School in this study.
There was also a trend of decrease in students’ level of extrinsic goal orientation for learning biology for Grade 12 students at PAIS. The Grade 12 students had the lowest level of extrinsic goal orientation of the four grade levels studied.

![Figure 5. Students’ mean response score of task value when learning biology, according to their grade level at Pan-Asia International School in this study.](image)

Another trend observed was of decrease in the students’ level of task value for learning biology, for Grade 12 students at PAIS. The Grade 12 students had the lowest level of task value of the four grade levels studied.
This study demonstrated a trend of decrease in students' level of control of learning beliefs for learning biology, for Grade 12 students at PAIS. The Grade 12 students had the lowest level of control of learning beliefs of the four grade levels studied.
Figure 7. Students' level of self-efficacy for learning and performance when learning biology, according to their grade level at Pan-Asia International School in this study.

The final trend was of decrease in students' level of self-efficacy for learning and performance when learning biology for Grade 12 students at PAIS. The Grade 12 students had the lowest level of self-efficacy for learning and performance of the four grade levels studied.

This chapter presented the research findings from the data collected with the Grades 9, 10, 11 and 12 biology students in this study. The results were presented in order of the research objective addressed and then any additional findings. The following chapter will present a summary of the study and its findings, the conclusions from the findings and discussion in relation to the research objectives and hypothesis, and makes recommendations for how teachers can improve achievement in biology classes.
CHAPTER V

CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS

This chapter will present a summary of this study and the findings. The summary will include the research objectives and hypotheses and the methodology used to investigate them. Then the findings of the study will be presented and the main conclusions that can be drawn, with discussion of the implications of these findings. Finally recommendations will be made from these implications for both teaching practice and future research.

Summary of the Study

This research studied the levels of motivation for learning biology and biology achievement of Grades 9, 10, 11 and 12 students at Pan-Asia International School, Thailand. This study broadly sought to identify the level of motivation for two groups of students (Pre-IB and IBDP), to determine the significance of this relationship with their achievement, and finally to determine if there was a significant difference between these two student groups. Two research instruments were used in this study, the Motivated Strategies for Learning Science Questionnaire (MSLSQ) and an achievement placement examination in biology.

The MSLSQ and the biology achievement placement examination were completed by 107 high school students at Pan-Asia International School in the 2016-2017 school year. For the student’s motivation level for learning biology, this data was collected during April 17th to 21st 2017. The MSLSQ is a 7-point Likert-type instrument containing 26 items to determine the students’ level of motivation for
learning biology. The students' biology achievement was measured using two placement tests created from International Baccalaureate Diploma Program past biology exam questions. These examinations were 20 multiple choice items, with a common examination given to Grades 9 and 10 (64 Pre-IB students) and a second common examination given to Grades 11 and 12 (43 IBDP students) For the students' achievement score in biology, data was collected from April 24th to 28th 2017.

This study sought to address the following five research objectives and three research hypotheses.

1. To determine the level of the students' motivation for learning biology for Grades 9 and 10 students, at Pan-Asia International School.
2. To determine the level of the students' motivation for learning biology for Grades 11 and 12 students, at Pan-Asia International School.
3. To determine if there is a significant relationship between students' motivation for learning biology and student biology achievement amongst Grades 9 and 10 students, at Pan-Asia International School.
4. To determine if there is a significant relationship between students' motivation for learning biology and student biology achievement amongst Grades 11 and 12 students, at Pan-Asia International School.
5. To determine if there is a significant difference in student motivation for learning biology between Grades 9 and 10 students, and Grades 11 and 12 students at Pan-Asia International School.

The following three research hypotheses relate to research objectives three, four and five respectively.
1. There is a significant relationship between student motivation for learning biology and student biology achievement amongst Grades 9 and 10 students, at Pan-Asia International School at .05 level.

2. There is a significant relationship between student motivation for learning biology and student biology achievement amongst Grades 11 and 12 students, at Pan-Asia International School at .05 level.

3. There is a significant difference for student motivation for learning biology between Grades 9 and 10 students, and Grades 11 and 12 students at Pan-Asia International School at .05 level.

Summary of the Findings

Main Findings

The following findings are listed in order of research objective addressed.

**Research objective one.** The level of the students’ motivation for learning biology for Grades 9 and 10 (Pre-IB students) at Pan-Asia International School was determined to be high.

**Research objective two.** The level of the students’ motivation for learning biology for Grades 11 and 12 (IBDP students) at Pan-Asia International School was determined to be high.

**Research objective three.** A Pearson product moment correlation coefficient was calculated to determine the significance of the relationship between motivation for learning biology and achievement in biology for Grades 9 and 10 students. The significance level in this study determined there was a significant weak positive
relationship between motivation for learning biology and achievement in biology for
Grades 9 and 10 students at Pan-Asia International School.

**Research objective four.** A Pearson product moment correlation coefficient
was calculated to determine the significance of the relationship between motivation
for learning biology and achievement in biology for Grades 11 and 12 students. The
significance level in this study determined there was a significant weak positive
relationship between motivation for learning biology and achievement in biology for
Grades 11 and 12 students at Pan-Asia International School.

**Research objective five.** An independent samples t-test was used to determine
if there was a significant difference between the level of motivation for learning
biology for Grades 9 and 10 students, and for Grades 11 and 12 students. The
significance level in this study was determined to indicate there is a significant
difference in motivation level for learning biology between Grades 9 and 10 (Pre-IB
students), and Grades 11 and 12 (IBDP students) at Pan-Asia International School.

**Additional Findings**

There were four additional findings in this study. The original intention of the
research was to examine the motivation level for students in two different study
programs in PAIS, namely the Pre-IB and IBDP programs. The researcher felt that
examining the motivation of each grade level separately, it might be possible to better
identify the year groups that are contributing towards the overall findings.

1. It was determined that the level of students' motivation for learning biology
   for Grade 9 students at Pan-Asia International School was high.

2. It was determined that the level of students' motivation for learning biology
   for Grade 10 students at Pan-Asia International School was high.
3. It was determined that the level of students’ motivation for learning biology for Grade 11 students at Pan-Asia International School was high.

4. It was determined that the level of students’ motivation for learning biology for Grade 12 students at Pan-Asia International School was moderate.

Conclusions

This study was an examination of the effect of motivation upon students’ achievement when learning biology. The study looked at the difference in motivation between two groupings of students and tried to examine the relationship of motivation to their biology achievement score.

The initial findings indicated that there was not a considerable difference in motivation level between the two student groupings, both Pre-IB and IBDP students had the same level of motivation for learning biology (high). It was expected that there would be a decrease in student motivation level for learning biology as grade level increased. However, it can be observed that the IBDP students were only marginally within the boundary for a high level for motivation when learning biology.

The following conclusions were drawn from the findings of this study. For both Grades 9 and 10 students (Pre-IB students) and Grades 11 and 12 students (IBDP students), there was found to be a significant relationship between the students’ motivation level for learning biology and their biology achievement. There was determined to be a significant difference in the students’ motivation level for learning biology between Grades 9 and 10 (Pre-IB students) and Grades 11 and 12 (IBDP students) at Pan-Asia International School. This difference was demonstrated by a lower level of extrinsic goal orientation and a lower level self-efficacy for learning and performance when learning biology, amongst the Grades 11 and 12 students.
As detailed in the additional findings, the greatest difference in motivation between the two groupings (Pre-IB and IBDP) comes from the Grade 12 students. The Grade 11 students had retained a high level of motivation for learning biology, while Grade 12 students declined to a moderate level of motivation for learning biology. Research objective five indicated there to be a significant difference in motivation level for learning biology, between Grades 9 and 10 (Pre-IB students) and Grades 11 and 12 (IBDP students). It follows that the focus of this study, and any follow on work, focus upon the abnormality of these Grade 12 biology students at PAIS.

**Discussion**

Student motivation has been studied previously and determined to have a possible relationship with student achievement (e.g., Cai & Lynch, 2016; Jen & Yong, 2012; Li & Lynch, 2016; Lwin & Eamoraphan, 2015; Schunk 1989). Returning to the statement of the problem, it was the impression of the researcher and other science teachers of decreasing academic performance in science classes, within the high school department of Pan-Asia International School. The results of this study indicated a significant relationship between student motivation level for biology and student biology achievement. This study indicated a decrease in student motivation for learning biology as students progress through grade levels at PAIS. However, the decline did not occur at the boundary between the Pre-IB and IBDP programs, as was originally expected.

The original expectation of this study was of a possible disconnect between the Pre-IB and IBDP students at PAIS. However, the findings of this study suggest there is relatively little difference between the Grade 9, 10 and 11 students at PAIS, and thus the transition between the Pre-IB and IBDP programs need not be regarded as
damaging students' motivation level for learning biology. It seems student motivation for learning biology remains high throughout the Pre-IB program, and is maintained into the first year of the IBDP program.

It should therefore be discussed to why the motivation level for learning biology of Grade 12 students at Pan-Asia International School is anomalous compared to other grade levels examined? Prima facie, it can be considered normal for student motivation to decrease as students get older and progress through grade levels at a school (Corpus et al., 2006; Gillet et al., 2012). High school students, can be expected in some respects to be at their lowest ebb in terms of intrinsic motivation (Otis et al., 2005). However, this is not true of all subjects, as some high school students can sustain high levels of intrinsic motivation in subjects they are engaged in (Gottfried et al., 2001).

This study indicated that the decline between Pre-IB to IBDP students was when students entered into Grade 12, and not into Grade 11 as was previously expected. The Grade 11 students maintained a high level of motivation in most areas, and in some components increased their motivation from Grade 10. However in Grade 12 a decrease was observed in the levels of student intrinsic goal orientation, extrinsic goal orientation, task value and self-efficacy for learning and performance, together with their overall level of motivation.

As was stated earlier, it is normal to see a decrease in motivation levels as students get older, except with self-efficacy unless interested and task value have declined (Bandura & Schunk, 1981). It is interesting to note that every grade level examined showed a high level of control of learning beliefs. This was also unexpected, as self-efficacy for learning and the other components are related, a decrease would be expected in all the studied components of motivation (Lee & Mao,
Completing Grade 12 is the culmination of at least 12 years of study for students, and poorly achieving students can become demotivated when they feel that their academic progress is failing (Reiss, 2009). In the researcher’s opinion, many of the students in this Grade 12 group had poor levels of motivation for learning biology, due to their perception of a lack of progress meeting the demands of the difficult International Baccalaureate Diploma Program.

One particular result that should be discussed is the motivation level recorded for item number 5 (see Table 15) amongst IBDP students. This was the only item in the MSLSQ that determined a low level of motivation. The item was “I'm sure I can understand the most difficult content presented in reading for biology class.” A clue may come from the reference to reading in this item. There may be a specific issue with Grade 12 students at PAIS in terms to reading ability, and this possibility should be further examined in any follow on study.

Another finding which contravened expectations was regarding the students’ level of self-efficacy for learning and performance when learning biology. It was expected from previous research that student self-efficacy increases with grade level, when students experience success they should experience increased expectations for success (Pintrich et al., 1991). The decrease in student self-efficacy seems anomalous compared to the other motivation components measured. However, it can be reconciled that self-efficacy is expected to increase with repeated success (Bandura & Schunk, 1981). Lack of success can cause a decrease in student self-efficacy, as instead they have an increased expectancy for failure.

An additional possible factor could be the biology teacher for high school classes at PAIS. In the case of some grade levels, biology was taught for two or three years by the current biology teacher (the researcher). In the case of Grade 12 students, this
was their first full academic year of instruction in biology by the researcher (previously they had been taught by another teacher). The teacher is still regarded as the greatest single variable in student achievement (Hattie, 2003; Rivkin et al., 2005) and a decrease in student success and self-efficacy must consider the role of the teacher as a factor.

It should also be observed that these Grade 12 students were surveyed close to the final examinations for the International Baccalaureate Diploma Program. These students were nearing the completion of their studies, and thus were preparing for high stakes assessments at this stage in the academic calendar. The Grade 12 students were unique in that they were preparing for future university courses or employment, and so their motivation for study (at their current school) was examined at a difficult time in the school year.

Overall, it can be observed there is a decrease in the level of motivation for learning biology amongst the Grade 12 students, when compared to other high school grades at PAIS. It is highly possible that decreasing student motivation is a causal factor in the decrease in student achievement, as students progress through the high school of PAIS (e.g., Otis et al., 2005). The opportunity remains to more precisely identify the nature of this problem, through a more targeted study (see recommendations for future research).

Recommendations

Recommendations for School Administrators

School administrators should clearly be aware of the importance of student motivation level, amongst the many factors that affect student achievement. School administrators should make sure that student motivation is considered in school
policies, and teachers are addressing motivation when designing their subject course. While teachers can plan to address motivation individually, any solution performs best when treated holistically. Administrators should attempt to standardize solutions amongst teachers, and training provided where possible. Teacher In-Service Education of Teachers (INSET) training should logically address factors that affect student achievement, and some time should be specifically spent on ways to address poor student motivation. Teachers should be provided with opportunities to work together, and experienced teachers encouraged to provide peer feedback on their preferred ways to increase students’ motivation levels.

Administrators can also assist teachers by creating policies that provide teachers with options to deal with student motivation. Examples would be creating protocols that allow teachers to report students with poor achievement. This would allow school counsellors to assess an underachieving student’s motivation level and to investigate the reasons behind their poor motivation level. Policies can also be created to allow teachers to reward high achieving students and increase extrinsic motivation. Teachers should have a range of options to reward highly achieving students, from small rewards on a day to day basis, to rewarding school trips, to end of year student awards.

At high school level, administrators should increase student motivation through providing opportunities to demonstrate task value. Students who have explored their university options and planned career options are likely to have a higher level of task value to their study than students who have not decided upon their options after school. Providing students with clear targets to aim for is an important aspect of instilling motivation. Students who have no plan for after their studies are unlikely to have a high level of grade or career motivation.
Recommendations for Teachers

The findings of this study reinforce the importance of considering motivation when teaching science subjects. Clearly it is important for all teachers to be aware of the factors that affect student achievement, and to consider whether they are being considered in their classroom. This study has highlighted the importance of one of those factors, and the relationship between motivation and achievement.

Teachers should consider the factors that affect student achievement independently, and holistically to aid student progress. Teachers should attempt to design tasks that aid the students’ task value and where possible control of learning belief. Teachers increase task value by designing study programs that are relevant to student needs, and highlighting the importance of their course. Control of learning beliefs can be improved by allowing students choices about how they complete an activity, or which activities they choose to complete. Self-efficacy can be improved through allowing students the opportunity to demonstrate their success, and designing a course of study where students experience a climate where they expect to succeed. Finally extrinsic motivators can be applied, simple rewards such as extra activities and field trips, or smaller everyday items can provide students with a simple and demonstrable value to their achievements.

Teachers should focus upon high school students, particularly Grade 12 students who are nearing the completion of their study. Students in high school can particularly can suffer in terms of poor motivation, especially as they are nearing the end of their study. Teachers must be aware of the stressful nature of high stakes assessment, and plan fun activities despite the intensive time demand of revision for high stakes examination.
Recommendations for Future Research

This study determined a significant relationship between motivation level for learning biology, and biology achievement in high school classes at Pan-Asia International School. It also determined there was a difference between Pre-IB (Grades 9 and 10 students) and IBDP (Grades 11 and 12 students), in particular a decrease in motivation level for learning biology amongst the IBDP (principally Grade 12) students at Pan-Asia International School. There are a number of avenues to extend this study to increase the useful findings.

A follow-up study is recommended with an opportunity to identify the reasons behind decreased motivation for Grade 12 students in biology. The researcher would recommend a qualitative study, where a number of respondents are selected for interview. This would allow for a researcher to examine a number of the study respondents as to why they do or do not feel motivated when studying biology. A mixed qualitative and quantitative follow-up study would allow a more comprehensive examination of the issues.

This study was limited in scope, with only the high school biology students at Pan-Asia International School as the population. A recommendation for future research would be to conduct the study using a larger population and sample. A future study should include at least one other international school using the International Baccalaureate Diploma Program, or more. It would be an ideal future practice to extend this study with as many different IBDP international schools as possible.

A future study recommendation would be to try to include students from all of the science subjects from the International Baccalaureate Diploma Program, namely chemistry, physics, environmental systems and societies, and sport, exercise and health science. This study could also be extended in terms of including students from
other grade levels, such as middle school (Grades 6-8). However this study should be extended to include other international schools with the same curriculum, so ideally after PAIS implements the International Baccalaureate Middle Years Program (MYP) program.
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APPENDIX A

Motivated Strategies for Learning Science Questionnaire
Motivated Strategies for Learning Science Questionnaire

One of your teachers is participating in a study of high school student motivation for learning science. We would like to kindly ask for your participation in this study.

In this study, we would like you to complete the following questionnaire, which is related to your motivation for learning in biology classes. Your participation in this questionnaire is voluntary, it will not in any way affect your grade and is only related to learning about your motivation for biology.

There are no right or wrong answers, please read the statements and mark whether you agree or disagree with them using the directions below. We thank you for taking the time to consider your responses and answer honestly.

Student Name: __________________________________________ (please print in CAPITALS)

Student Class: __________________________________________

Directions

The following questions ask about your feelings when learning biology.

Remember there is no right or wrong answer, just try to think about whether you agree or disagree with the statements. Use the scale below to answer the questions.

Completely False  1  2  3  4  5  6  7  Completely True

If you feel a statement is completely false when describing you, circle number 1.

If you feel a statement is completely true when describing you, circle number 7.

If you feel somewhere the truth is in somewhere in between, tick the box that you feel most closely matches your feelings.
1. In biology class, I prefer content that really challenges me so I can learn new things.
   Completely False  [1 2 3 4 5 6 7]  Completely True

2. If I study in appropriate ways, then I will be able to learn the content in biology class.
   Completely False  [1 2 3 4 5 6 7]  Completely True

3. I think I will be able to use what I learn in biology in other classes.
   Completely False  [1 2 3 4 5 6 7]  Completely True

4. I believe I will receive a high grade in biology.
   Completely False  [1 2 3 4 5 6 7]  Completely True

5. I'm sure I can understand the most difficult content presented in reading for biology class.
   Completely False  [1 2 3 4 5 6 7]  Completely True

6. Getting a good grade is the most satisfying thing for me in biology class right now.
   Completely False  [1 2 3 4 5 6 7]  Completely True

7. It is my own fault if I don't learn the content in biology class.
   Completely False  [1 2 3 4 5 6 7]  Completely True

8. It is important for me to learn the content in biology class.
   Completely False  [1 2 3 4 5 6 7]  Completely True

9. The most important thing for me right now is my overall grade, so my main concern in biology class is getting a good grade.
   Completely False  [1 2 3 4 5 6 7]  Completely True
10. I'm confident I can understand basic concepts taught in biology class.
   Completely False  1  2  3  4  5  6  7  Completely True

11. If I can, I want to get better grades in biology class than most of the other students.
   Completely False  1  2  3  4  5  6  7  Completely True

12. I'm confident I can understand the most complex content presented by the teacher in biology class.
   Completely False  1  2  3  4  5  6  7  Completely True

13. In biology class, I prefer content that arouses my curiosity, even if it is difficult to learn.
   Completely False  1  2  3  4  5  6  7  Completely True

14. I am very interested in the content of biology classes.
   Completely False  1  2  3  4  5  6  7  Completely True

15. If I try hard enough, then I will understand the content of biology class.
   Completely False  1  2  3  4  5  6  7  Completely True

16. I'm confident I can do an excellent job on any assignments and tests in biology class.
   Completely False  1  2  3  4  5  6  7  Completely True

17. I expect to do well in biology class.
   Completely False  1  2  3  4  5  6  7  Completely True
18. The most satisfying thing for me in biology class is trying to understand the content as thoroughly as possible.

Completely False  1  2  3  4  5  6  7  Completely True

19. I think the content in biology class is useful for me to learn.

Completely False  1  2  3  4  5  6  7  Completely True

20. If I have the opportunity in biology, I will choose assignments that I can learn from even if they don't guarantee a good grade.

Completely False  1  2  3  4  5  6  7  Completely True

21. If I don't understand the biology content, it is because I didn't try hard enough.

Completely False  1  2  3  4  5  6  7  Completely True

22. I like the subject of biology.

Completely False  1  2  3  4  5  6  7  Completely True

23. Understanding the subject of biology is very important to me.

Completely False  1  2  3  4  5  6  7  Completely True

24. I'm certain I can master the skills being taught in biology.

Completely False  1  2  3  4  5  6  7  Completely True

25. I want to do well in biology class because it is important to show my ability to my family, friends, or others.

Completely False  1  2  3  4  5  6  7  Completely True

26. Considering the difficulty of this class, the teacher, and my skills, I think I will do well in biology class.

Completely False  1  2  3  4  5  6  7  Completely True
APPENDIX B

Pre-IB Biology Achievement Placement Test
Pre-IB Biology Achievement Placement Test

The following paper contains 20 multiple choice questions from previous IB Biology exam papers. For each question please circle the correct answer (A-D).

1. Which of the following structures are found in all cells?
   - A. Mitochondria
   - B. Cell walls
   - C. Chloroplasts
   - D. Ribosomes

2. What is a difference between the structure of all prokaryotes and all eukaryotes?
   - A. Prokaryote
     - cell wall
     - chloroplasts
     - flagellum
     - nucleoid
   - B. Eukaryote
     - no cell wall
     - no chloroplasts
     - no flagellum
     - nuclear membrane

3. The diagram is a model of one type of movement across a membrane.

What is this type of movement?
   - A. Simple diffusion
   - B. Facilitated diffusion
   - C. Osmosis
   - D. Active transport
4. The statement relates to Pasteur’s experiments.

In his experiments, Louis Pasteur demonstrated that:

If broth was boiled to kill all organisms and was then kept in swan-necked flasks, preventing the entry of organisms, no organisms grew in the broth.

If the swan-necked flask was broken, mold soon started to grow in the broth.

What did this statement suggest?

A. Mold evolved by endosymbiosis.
B. Oxygen is required for anaerobic respiration.
C. Cells can only be formed by division of pre-existing cells.
D. Nutrients are a requirement for mold growth.

5. Why is stem cell research considered unethical by some groups?

A. Stem cells are living organisms.
B. New organisms could be produced from stem cells.
C. Use of stem cells could involve the culture of pluripotent cells.
D. Use of embryonic cells involves the death of early-stage embryos.

6. Which of the following structures are present in both plant and animal cells?

I. Cell wall
II. Chloroplast
III. Mitochondrion

A. I only
B. I and II only
C. I and III only
D. III only
7. Which statement is part of the cell theory?

A. All cells have a cell wall.
B. Every cell shows emergent properties.
C. All cells come from pre-existing cells
D. Every cell carries out all the functions of life.

8. Which characteristic of stem cells makes them useful for treating Stargardt’s disease?

A. They can differentiate into retinal cells.
B. They are readily available from especially created embryos.
C. They transport white blood cells to the eyes.
D. They divide by binary fission so provide sufficient cells.

9. What do diffusion and osmosis have in common?

A. They only happen in living cells.
B. They require transport proteins in the membrane.
C. They are passive transport mechanisms.
D. Net movement of substances is against the concentration gradient.

10. Which functions of life are found in all unicellular organisms?

A. Growth, response and nutrition
B. Differentiation, response and nutrition
C. Metabolism, meiosis and homeostasis
D. Growth, metabolism and differentiation

11. Which of the following characteristics found in a structure necessarily indicates that it is alive?

A. The presence of genetic material
B. The presence of a lipid bilayer
C. Metabolism
D. Movement
12. Which of the following are features of prokaryotes and eukaryotes?

<table>
<thead>
<tr>
<th></th>
<th>70S ribosomes</th>
<th>80S ribosomes</th>
<th>Naked DNA</th>
<th>DNA associated with proteins</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>prokaryote</td>
<td>eukaryote</td>
<td>prokaryote</td>
<td>eukaryote</td>
</tr>
<tr>
<td>B.</td>
<td>eukaryote</td>
<td>prokaryote</td>
<td>eukaryote</td>
<td>prokaryote</td>
</tr>
<tr>
<td>C.</td>
<td>eukaryote</td>
<td>prokaryote</td>
<td>prokaryote</td>
<td>eukaryote</td>
</tr>
<tr>
<td>D.</td>
<td>prokaryote</td>
<td>eukaryote</td>
<td>eukaryote</td>
<td>prokaryote</td>
</tr>
</tbody>
</table>

13. By which process do most bacteria divide?

A. Mitosis  
B. Meiosis  
C. Conjugation  
D. Binary fission

14. Below is a micrograph of an *E. coli* bacterium undergoing reproduction.

In the diagram what does label X identify?

A. Nucleoid region  
B. Chromatin  
C. Histones  
D. Endoplasmic reticulum
15. Which of the following will contribute to the cell theory?

I. Living organisms are composed of cells.
II. All cells come from mitosis.
III. Cells are the smallest units of life.

A. I only  
B. II only  
C. I and III only  
D. I, II and III

16. Which of the following structures are found in all cells?

A. Nucleus  
B. Golgi Body  
C. Cell Membrane  
D. Endoplasmic Reticulum

17. How does surface area to volume ratio change with an increase in cell size?

A.  
B.  
C.  
D.
18. Which of the following structures does *Escherichia coli* have?

I. 70S Ribosomes  
II. Pili  
III. Nucleus

A. I only  
B. I and II only  
C. II and III only  
D. I, II and III

19. In viewing an electron micrograph of a cell, ribosomes, pili and a single circular chromosome are observed. What other structure is likely to be present?

A. The rough endoplasmic reticulum  
B. Mitochondria  
C. A nuclear membrane  
D. A plasmid

20. What is the function of the cytoplasmic (plasma) membrane of this bacterium?

A. To produce ADP  
B. To form the only protective layer preventing damage from outside  
C. To control entry and exit of substances  
D. To synthesize proteins
APPENDIX C

IBDP Biology Achievement Placement Test
IBDP Biology Achievement Placement Test

The following paper contains 20 multiple choice questions from previous IB Biology exam papers. For each question please circle the correct answer (A-D).

1. Capillaries surround the alveoli in the lungs. Which pair of statements correctly describes the concentrations of oxygen and carbon dioxide in the lungs?

<table>
<thead>
<tr>
<th>Oxygen</th>
<th>Carbon dioxide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher in the capillaries</td>
<td>Higher in the alveoli</td>
</tr>
<tr>
<td>Lower in the capillaries</td>
<td>Higher in the alveoli</td>
</tr>
<tr>
<td>Lower in the alveoli</td>
<td>Higher in the capillaries</td>
</tr>
<tr>
<td>Higher in the alveoli</td>
<td>Higher in the capillaries</td>
</tr>
</tbody>
</table>

2. What causes a resting potential to develop in a neuron?

A. Diffusion of sodium and potassium ions
B. Active transport of sodium and potassium ions
C. Active transport of sodium and diffusion of chloride ions
D. Active transport of potassium and diffusion of chloride ions

3. Which statement is true for the antibiotic penicillin?

A. Watson and Crick developed the usage of penicillin.
B. Penicillin blocks processes unique to eukaryotic cells.
C. Viruses lack metabolism and penicillin has no effect on them.
D. Florey and Chain sequenced the genome of Penicillium notatum.
4. What is the position of heart valves when blood pressure is highest in the aorta?

<table>
<thead>
<tr>
<th>Atrio-ventricular Valves</th>
<th>Semi-lunar Valves</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. open</td>
<td>closed</td>
</tr>
<tr>
<td>B. closed</td>
<td>open</td>
</tr>
<tr>
<td>C. closed</td>
<td>closed</td>
</tr>
<tr>
<td>D. open</td>
<td>open</td>
</tr>
</tbody>
</table>

5. Why is penicillin not used in the treatment of human immunodeficiency virus (HIV)?

A. HIV patients may be allergic to penicillin.
B. Penicillin does not affect viruses.
C. Penicillin affects helper T-cell metabolism.
D. Penicillin causes antibiotic resistance.

6. What is the purpose of pulmonary surfactant?

A. Promotes capillary growth
B. Decreases surface tension
C. Adheres alveoli and capillaries
D. Stretches the inside surface of the alveoli

7. Celiac disease causes the destruction of the villi cells. Which of the following is most likely to happen to people with celiac disease?

A. Incomplete digestion of fats
B. Poor absorption of calcium
C. Increased levels of glucose in blood
D. Damage in the oesophagus caused by an increase in acid content of the stomach
8. Which vessel directly supplies the heart muscle with blood?
   A. The aorta
   B. The pulmonary artery
   C. The coronary artery
   D. The pulmonary vein

9. What is the main function of the large intestine?
   A. Absorption of water
   B. Digestion of fats and proteins
   C. Absorption of nutrients
   D. Recycling of digestive enzymes

10. Which chamber of the heart has the thickest walls?
    A. Left atrium
    B. Right atrium
    C. Left ventricle
    D. Right ventricle

11. Which vessel carries deoxygenated blood?
    A. The coronary artery
    B. The pulmonary artery
    C. The aorta
    D. The pulmonary vein

12. William Harvey discovered that blood flows away from the heart in arteries and back to the heart in veins. What hypothesis could be developed from this discovery?
    A. The human body contains both arteries and veins.
    B. Blood vessels link up arteries to veins.
    C. How blood moves from arteries into veins.
    D. Veins are connected to the left side of the heart and arteries to the right side.
13. The graph below shows changes in membrane potential in an axon during the passage of an action potential. What is causing the decrease in membrane potential at point X?

A. Sodium ions entering the axon
B. Potassium ions entering the axon
C. Sodium ions leaving the axon
D. Potassium ions leaving the axon

14. Which part of the brain has a role in the control of the heartbeat and how are messages passed from this part of the brain to the heart?

<table>
<thead>
<tr>
<th>Part of the brain</th>
<th>Type of message</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. hypothalamus</td>
<td>hormone</td>
</tr>
<tr>
<td>B. hypothalamus</td>
<td>nerve</td>
</tr>
<tr>
<td>C. medulla</td>
<td>hormone</td>
</tr>
<tr>
<td>D. medulla</td>
<td>nerve</td>
</tr>
</tbody>
</table>

15. Is the blood in the aorta, left ventricle and pulmonary artery oxygenated or deoxygenated?

<table>
<thead>
<tr>
<th></th>
<th>Aorta</th>
<th>Left ventricle</th>
<th>Pulmonary artery</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>oxygenated</td>
<td>deoxygenated</td>
<td>deoxygenated</td>
</tr>
<tr>
<td>B.</td>
<td>deoxygenated</td>
<td>oxygenated</td>
<td>oxygenated</td>
</tr>
<tr>
<td>C.</td>
<td>oxygenated</td>
<td>oxygenated</td>
<td>deoxygenated</td>
</tr>
<tr>
<td>D.</td>
<td>oxygenated</td>
<td>oxygenated</td>
<td>oxygenated</td>
</tr>
</tbody>
</table>
16. Between which structures do sensory neurons carry nerve impulses?

A. From receptors to muscles  
B. From effectors to the central nervous system (CNS)  
C. From the central nervous system (CNS) to receptors  
D. From receptors to the central nervous system (CNS)

17. What is a characteristic of intestinal villi?

A. They contain few capillaries.  
B. They increase the surface area of the small intestine.  
C. They have a smooth surface.  
D. They are projections from the plasma membranes of the intestinal cells.

18. Which words from the table below complete the sentence correctly?

*In the pancreas, ____ secret glucagon, which ____ blood glucose levels.*

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>II</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>a cells</td>
<td>raises</td>
</tr>
<tr>
<td>B</td>
<td>β cells</td>
<td>raises</td>
</tr>
<tr>
<td>C</td>
<td>a cells</td>
<td>lowers</td>
</tr>
<tr>
<td>D</td>
<td>β cells</td>
<td>lowers</td>
</tr>
</tbody>
</table>

19. What causes the formation of a nerve impulse on the post-synaptic membrane?

A. Ca2+ binding with a receptor site  
B. K+ leaking into the post-synaptic membrane  
C. Neurotransmitter binding with receptor sites  
D. Neurotransmitter being removed from the synapse

20. What will be happening in a person after eight hours of sleep?

A. β cells in the pancreas will be producing insulin.  
B. Glucose will be converted into glucagon.  
C. A cells in the pancreas will be producing glucagon.  
D. Glycogen is being produced and stored in the liver and muscle cells.
BIOGRAPHY

Martyn Carthy is currently a student in the Master’s Degree in Education; Curriculum and Instruction (M.Ed.) program in the Graduate School of Human Sciences at Assumption University of Thailand. The author was born in 1984 in Liverpool, UK and attended Halewood Community Comprehensive School, in the Merseyside area. For his undergraduate work, Martyn studied biology sciences at the University of Wales at Bangor, Wales. Martyn graduated in 2006 as a Bachelor of Science (B.Sc.) in Zoology. After working in the transport department of Merseyside’s local government, the author eventually found his calling as a secondary level biology teacher. The author has been teaching now for six years, and is currently the Head of the Science Department at Pan-Asia International School in Bangkok, Thailand. Martyn specializes in teaching Biology for the International Baccalaureate Diploma Program and is extremely passionate about teaching the importance of following the scientific method.