A study of the effectiveness of inquiry-based learning and project-based learning of science and language subjects at high school level in the U.A.E.

دراسة لفعالية التعلم القائم علي التحقيق والتعلم القائم علي المشاريع للمواضيع العلمية واللغوية علي مستوي المدارس الثانوية في الامارات

By

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Abstract

The objective of this study was to investigate the suitability of inquiry-based learning and project-based learning approaches in the science and language at the high school level and their effectiveness. The researcher used a mixed qualitative and quantitative approach in order to accomplish this objective. A two-part survey questionnaire was used to examine the suitability of IBL and PBL to different subjects and the respondents' perceptions about their use. A comparison of pre and post-test scores of students was used to determine which among the two approaches were more effective. The results show that in terms of suitability, the research instrument focused mainly on IBL. It was found that IBL is most compatible with English, Science, and SPED subjects; and that it is grossly incompatible with Math subjects. It can be inferred based on that that PBL may be the more compatible approach with Math subjects. In terms of effectiveness using the test scores, IBL strategies were more effective. This was evidenced by the bigger impact that using IBL strategies had on the test scores of the respondents compared to when PBL strategies were used. The higher score differentials were observed when IBL was used; the differences between pre and post-test scores were smaller in the PBL group.

Keywords: Inquiry-based learning (IBL), project-based learning (PBL)

ملخص

الهدف من هذه الدراسة هو التحقيق في مدى ملاءمة التعلم القائم على الاستقصاء ونهج التعلم القائم على المشاريع في العلوم واللغة على مستوى المدرسة الثانوية وفعاليتها. استخدم الباحث منهجا نوعيا وكمي مختلط من أجل تحقيق هذا الهدف. تم استخدام استبيان من جزأين لدراسة مدى ملاءمة (IBL) و (PBL) لمختلف الموضوعات وتصورات المستفيدين حول استخدامها. واستخدمت مقارنة بين درجات ما قبل الاختبار وبعده من الطلاب لتحديد أي من النهجين كان أكثر فعالية. وتظهر النتائج أنه من حيث الملاءمة، ركزت أداة البحث بشكل رئيسي على (IBL). وقد تبين أن (IBL)هو الأكثر توافقا مع اللغة الإنجليزية، العلوم، وذوي الاحتياجات الخاصة ؛ وأنها تتعارض بشكل صارخ مع الرياضيات. ويمكن استدلال على أساس أن (PBL) قد يكون النهج أكثر توافقا مع الرياضيات. من حيث الفعالية باستخدام درجات الاختبار، كانت استراتيجيات (IBL) أكثر فعالية. وقد تجلى ذلك من خلال التأثير الأكبر الذي استخدمه إستراتيجيات (IBL) على درجات الاختبار لدى المستجيبين مقارنة باستخدام استراتيجيات (PBL). لوحظت الفروق في درجات أعلى عند استخدام (IBL). كانت الفروق بين درجات ما قبل الاختبار وبعده أصغر في مجموعة(PBL).

Acknowledgement

To say that the process of conducting a study about one of the most hotly debated topics in the field of education would be an understatement. There were a lot of challenges that came my way throughout the course of the process of writing the manuscript. I would like to take this opportunity to thank the Lord for giving me the wisdom, strength, passion, perseverance, and commitment to be able to finish an almost insurmountable feat. I also want to thank my family for their unwavering support throughout the process. The almost endless streak of sleepless nights would have been unbearable without the help and support of my family. To my friends who were always there to become my emotional outlets, thank you. You guys have taken a lot of load off my shoulders and a lot of pressure off my chest. I would have gone insane were it not for the emotional support that I got from those people. Lastly, to the members of the research committee and the stakeholders of the university (e.g. professors and members of the faculty), thank you, for the unwavering support throughout this process. The completion of this study was an important milestone for me, both personally and academically.

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1. INTRODUCTION

The purpose of this chapter is to provide a brief background on Inquiry-based Learning and Project-based Learning, the study's purpose and questions, significance, and the statement of problem. The two learning approaches were also differentiated. This is instrumental in understanding the purpose and significance of the study.

1.1. Inquiry Based Learning

One of the key challenges educators face today globally, is finding ways to prepare students to be competitive in the current job market, and tertiary educational setting. To do this, the educator must find ways of actively engaging the students in the classroom environment to develop not only content knowledge, but also critical thinking and problem solving skills. Whatever the method of engagement the purpose always remains the same – to ensure there is acquisition of knowledge and skills that will enable the learner to function or function better, in real-time world today and in future. One of the key challenges in education is to move students beyond just receiving knowledge and skills passively and instilling a sense of being able to create innovative solutions to situations, problems and challenges that they face continuously at work and otherwise, or to become self-regulated and self-motivated learners (English &Kitsantas, 2013).

A relatively young approach to teaching and learning, that has students, their questions, observations, and the ideas at the very center of learning experiences is Inquiry-based learning. The ability to approach problems with a sense of inquiry becomes the center of learning experiences. Both the teacher and the taught have a shared responsibility for learning, with the

student taking a more active role in developing their own knowledge base, and making connections with previous learning.

The crux in this environment is to create a culture of learning, respectfully challenging, testing, redefining and present concepts as something that can be improved on to enhance the learning experience. The fundamental goal of this approach is to move the learners from a position of wonderment to a position of "*Enacted understanding and further questioning* (Scardamalia M. , 2002)."

Since both the, learners and the educators have onus of learning outcomes in inquiry based learning, it is important to understand the role of both in this environment. From the learners' perspective it involves, open-ended investigations into a question and a need to indulge in evidence-based creative problem solving. From the educator's perspective, the need is to be open-minded and responsive to student needs, right timing the ideation process enabling the learners to take their inquiry forward, while providing a context for curricular goals (Hannafin et al., 2014).

In this environment, the learning experience and outcomes are co-authored and steered by both the learners and the educators, accepting joint responsibility for planning, assessment and advancement of content and ideas that is class-wide (Fielding, 2012).

Inquiry-based learning is a pedagogical mind-set. It can be used in the classroom to engage students in a self-driven learning process, and is gaining popularity in science related curriculum, at every educational level (Pedaste et al., 2015). It can also be used in a wide variety of other contexts. It however need not be used in isolation and it does not stand in the way of

other forms of learning and teaching. It is a creative approach of combining creative and best approaches to instruction, as an attempt to build on learner curiosity.

1.2. Role of the educator in Inquiry

The key challenge to the educator in Inquiry-based learning is to move and channel learners from the position of their initial curiosity to make it a regular practice. This is a key role that the educators play. It is in this environment that educators model ideas and theories. They provoke thoughts in learners on how to carry out the investigation that is required to give them the sought answers.

The educators play the role of "provocateur." It is in this role that the educator finds creative ways introducing subject, ideas and concepts to the learners that is of interest and relevance to them enabling them to be in a sustained state of inquiry. For accelerated learning, the class could be broken up into smaller groups that could possibly pursue independent lines of Inquiry, coming together to exchange ideas, thoughts, and views.

1.3. Role of Learners as part of Responsive Learning Community

Most learners are capable of their individual contribution to a collaborative inquiry process. Some students may find it easier to respond to others' queries, while others may find it easier to connect to the "big ideas" and providing overarching theories. The role of both the sets of learners is important in furthering the cause of learning, however it is important to identify patterns of contribution to mark progress towards the outcomes intended. The role an educator plays in this kind of a setting is to encourage learners to be flexible in their approach, while encouraging dissent and different thoughts and approaches to the problem or challenge at hand.

Also, learners need to be encouraged to remind to clarify their intent in a manner that is visible to all the learners in the group or classroom.

1.4. Managing Curriculum and target based expectations

Some educators who are new to inquiry based learning approach may become seized of the fact that curriculum needs to be completed and learning targets need to be achieved. The way to do this is to focus on “big ideas” rather than specific individual learner needs. If this is done it is often seen that the outcomes usually exceed the curriculum expectations and targets(Dr. Erick Jackman Institute of Child Study, 2011).

However, it is to be cautioned that the educators need to be deeply aware of the “big ideas” in the curriculum. By this, they become sensitive to learner ideas and cues, which, when explored further would meet the overarching “big ideas” of the curriculum and meet the learning targets. Educators often observe that the ideas of the learners play an important role in this method of learning and there are opportunities where they see the need to access ideas further and express them variedly.

There are numerous key pointers to the educators that they must be wary of while implementing such questioning process. They must place the ideas at the center rather than overarching theories. They must channel the energies of the group towards common understanding. One key misconception is that there must be no formal class structure and it is not true. The educators must encourage and be truthful to the learners’ direction of learning, and finally they must teach on a need to know basis.

1.5. Project-based Learning

Students are bored in school and this seems to be a universal norm. However, there is an underlying assumption that if the students worked harder or learnt better, they wouldn't be bored. There are studies that indicate bored and unengaged students are much less likely to learn (Blumenfeld P C, 1991). Surprisingly further studies have found that even those students performing very well in the standardized tests are also bored (Csikzentmihalyi M, 1993)! By the end of the 20th century the problems that were identified were that by the end of high school, students only acquired superficial knowledge, even those students at the best schools did not have a deep understanding of the conceptual knowledge (Gardner, 1991). Learning sciences point to a potential solution to these problems. Learning scientists are uncovering solutions based on "*cognitive structure of deeper conceptual understanding* (Joseph S Kracjick, n.d.)".

Project Based Learning is a fundamental design of the learning environments. The project based learning environments have five key fundamental characteristics (Williams M, 2003):

a. They start with a problem that needs solving
b. Learners explore the driving question by participating in enquiry
c. The stakeholders to learning include learners, teachers and the community at large to find an answer to the problem that needs solving.
d. Students are provided with access to technologies that are normally beyond their usual abilities
e. Students create tangible answers to the driving problem.

The four learning pillars of Project Based Learning are:

a. “Active Construction

b. Situated learning

c. Social interactions, and

d. Cognitive Tools (Joseph S Kracjick, n.d.)”

1.6. Active Construction

Learning theorists always believed that learners comprehension was deep when the learner related to the concept being taught and constructed a meaning based on own experiences and learning only superficial when a learner passively accepts information from the educator or a book or even a computer. The process of understanding is a continuous one. Learners keep constructing and re-constructing from newer experiences and ideas as well as from prior knowledge and earlier experiences. Educators and teaching aides do not reveal knowledge to the learners. While it is the learners who actively build knowledge, which they do as they explore the world around them, observe different phenomena, create new ideas, and make connections between the newer ideas and the older experiences. In project based learning, learners are encouraged to participate in real world activities. These are like what experts keep doing. This will help them solve problems while developing newer artefacts.

1.7. Situated Learning

Learning happens most effectively when it is situated in authentic and real-world situations. In pursuit of scientific disciplines, some research is carried out in laboratories, while

other research happens with systematic observation of the natural and real world and conclusions are drawn from these observations. Situated learning in science disciplines happens when learners experience phenomena as it occurs. The learners need to get involved in scientific practices like designing of investigations, explanations, modelling and presenting their observations to other learners. The purpose of situated learning is to enable the students to realize the value of the activities that they perform. Instead, if the students were to follow detailed instructions from a text book or a lecture, and perform a science experiment, they will not see value as much as when they design their own experiment and perform it. Essentially learners need to see the meaning in what they are doing.

1.8. Social Interaction

Learning Science also emphasizes on the importance of social interaction in the learning process. The best learning is said to happen when all the stake holders of learning, viz., learners, teachers and the community work in tandem on a situated activity and create shared understanding of the problem they are trying to solve and the findings that they have received. Learners develop a deep understanding of their subjects, ideas, and concepts when they debate, and discuss ideas with other stakeholders in the learning process. The action of debating and discussing by itself, creates a kind of a community – a community of learners.

1.9. Cognitive Tools

Learning tools are important to facilitate the learning process. Cognitive tools help learners in amplifying what they have learnt. This often expands their understanding. For example, a graph is a tool that would enable learners to see patterns in their class work. Another

good example of a cognitive tools is also a computer software. Computer software often allows learners to see what would otherwise not be possible.

Learning Technologies allows students to: a) access and collect data b) provides data analysis and visualization tools c) allows for collection and sharing of information across learner groups d) allow planning and building of models, and e) allows students to make explanatory models. This expands the range of questions that can be answered and the concepts that can be understood by the learners.

1.10. The Study Purpose and Research Questions

The main purpose of the study was to "investigate the suitability of inquiry-based learning and project-based learning approaches in the science and englishlanguage at high school level and their effectiveness."

These are the study's two research questions:

RQ1: What are the perceptions of the teachersabout the suitability of IBL and PBL strategies in terms of subjects?

RQ2: Which between IBL and PBL is more effective in delivering positive student-centered learning outcomes?

Science and arts are totally different in their approach to real world phenomena. It is also observed from experience as a teacher that some students tend to learn science better and some tend to learn arts subjects better. This better learning as a concept is it because of the way the subject is taught or is it because it appeals to different segments of learners differently. This

among other things is what is motivating the researcher to delve deeper in to the above stated research question.

There is sufficient research that has been undertaken by previous researchers and theorists on the inquiry based learning and project based learning, however there are still gaps in using the applications to specific subject sets at a specific schooling level and it is into these gaps that the researcher purports to throw light into.

The fundamental theoretical frameworks on both project based learning and inquiry based learning have been introduced earlier in this paper. What the paper will further aim to do is to present data that is collected at the high school level, analyses it from the perspective of the two learning approaches for specific application into learning for science and arts subjects. The approach is that of the primary research.

The primary research has been carried out in schools where permission has been received to conduct this study, detailed explanation of the methodology, approach and further research is explained in detail in the relevant sections later in this document.

2. LITERATURE REVIEW

2.1. Theoretical Background

The previous chapter provided a basic overview of the study, the literature that provides the framework for that study, and the purpose and guiding questions. However, in order to generate an understanding of the theoretical and conceptual framework for the current research. This means expanding on the basic principles introduced in the introduction, in order to create a more complete understanding of the theories or learning that underlie both inquiry and project based instruction, and what literature already exists regarding the impact that these pedagogical approaches have on student learning. It us upon this framework that the new study, and its methodology will be constructed.

2.2. Conceptual Framework

The theoretical and conceptual framework for the current study is centered, more specifically, on the theoretical basis for inquiry based and project based learning. This includes an understanding of why these pedagogical approaches work, what the role of each participant is in the process, and how they can be actively applied to manage the curriculum, and meeting curriculum objectives in various content areas, or core subjects.

2.3. Inquiry based learning

Inquiry based learning is a fairly new theory on how to help students develop a functional understanding of course content. Inquiry based learning is, at the most basic level, an educational strategy in which students follow the scientific method, or a similar process, to construct their own understanding of new content (Keselman, 2003). This allows the students to generate a schema, or understanding of relationships between old and new

learning, that is meaningful to them, and which can be directly applied to problem solving, and creative thinking. This occurs through the creation and testing of hypotheses, and the conduction of experiments or collection of observations that are related to the student's research questions (Pedaste, Mäeots, Leijen, &Sarapuu, 2012).

Inquiry, as a learning model, follows a progression of instructional approaches, which have moved away from direct instruction, and toward student based instruction (Bybee et al., 2006). This is based on a cycle, or a recommended sequence of instruction, and learning. Justice et al., (2002) for example, states that inquiry can occur in a single phase through self-evaluation or self-inquiry. Other theorists suggest that it occurs through a series of phases which increase both self-awareness and cognitive processing of new content (de Jong and Njoo, 1992; Corlu&Corlu, 2012; Gutwill& Allen, 2012, Scanlon et al., 2011; Smyrnaiou, Foteini, &Kynigos, 2012)). More recently however, Pedaste and his peers (2015) outlined five basic phases of the inquiry based learning framework: orientation, conceptualization, investigation, conclusion and discussion. Each of these phases are critical, and contain a different element of the learning process, or the mastery of the content connected to the lesson in question.

During the orientation phase, student becomes engaged, or interested, in the learning (Pedaste et al., 2015). This stimulates curiosity, and allows them to become actively invested in the problem statement. From this point forward, the student's engagement in learning becomes self-motivated, making learning more authentic.

During the conceptualization phase, the student engages in both questioning and hypothesis generation (Pedaste et al., 2015). This is the primary process by which the student begins to

build their own theory, related to the primary question, and then expressing their understanding of the topic at hand. These questions, or hypotheses, become the basis for the student to engage in investigation or inquiry, and eventual problem solving.

The investigation phase, which is among the longest and most complex phases of the inquiry process. During this phase, the students engage in exploration of the existing data or literature, experimentation or generation of more specific primary data, and data interpretation, or making meaning from the data collected via the experiment, in order to generate new knowledge (Pedaste et al., 2015).

During the conclusion phase, the student draws conclusions based on the analysis of the data (Pedaste et al., 2015). This is the phase during which comparing various inferences, and determining how the data answers, or supports the research question and hypotheses. This is valuable, because it is the period during which students draw conclusions and generate real and applicable knowledge, as it relates to the primary learning objective.

Finally, during the discussion phase, students come back to the class of their peers in order to discuss their findings (Pedaste et al., 2015). During this phase, the students communicate, reflect on their findings, develop critiques of their work, and complete the inquiry cycle by creating final answers.

These phases are each critical, because together they allow the student to not only develop a basic understand of the topic in question, but also to make a more personal connection with the material, make meaningful connections between new learning and prior knowledge, and develop the inquisition skills that are fundamental to complex problem solving. However, looking closely at the make-up of these phases also reveals that the role of the student and

teacher are fundamentally different in the inquiry based approach. As such, the role of each of these parties must be further defined, as it relates to the theory of learning.

2.3.1. The Role of the Educator in the Process of Inquiry

In a traditional classroom setting, the teacher is the single author of knowledge. Their role, in the classroom is to author the learning experience of students through a combination of direct instruction and assessment. However, in the inquiry based classroom, knowledge, and the learning experience as a whole are co-authored by the educator and their students (Fielding, 2012). This means that the educator must take a step back, or take on a very different role than they fulfil in the traditional classroom.

The reality is that there is not a single way for the teacher to promote inquiry, but their role as director of student performance, rather than deliverer of content, is consistent (Dobber, Zwart, Tanis, &Oers, 2017). The teacher is responsible for "meta cognitive, conceptual and social regulation" of the classroom environment, but not for direct instruction of the course material or objectives (Dobber et al., 2017).

Dobber and his peers (2017) conducted a meta-analysis of 186 studies, which collectively considered the ways that teachers promote inquiry-based education. They found that teaching strategies varied widely, and that the total percentage of time spent on teacher directed, student directed, and mixed direction activities differed from classroom to classroom. Metacognitive regulation, within inquiry based instruction, or roles played by the teacher with regard to metacognition include: "focusing on thinking skills, developing a culture of inquiry, supporting inquiry discourse, and promoting nature of science" (Dobber et al., 2017). The teacher also plays multiple roles, with regard to conceptual regulation,

including: “providing information on the research topic and focusing on conceptual understanding” (Dobber et al., 2017). Finally, teacher must play the role of the social regulator, within the classroom setting, making them responsible for: “bridging the gap between high and low achievers, organizing student learning in groups and focusing on collaboration processes.” (Dobber et al., 2017). In each of these roles, the educator is acting as the facilitator of learning, and guiding the student learning process, rather than directing it.

2.3.2. The Role of Learners

This also reflects the changed role of the learner, within the inquiry based learning process. The learner becomes an active investigator, who is asking questions and discovering knowledge, rather than acting as a sponge to passable absorb what is instructed (Banerjee, 2010; Walker & Shore, 2015). This means that the learner must not only ask questions, and seek evidence, but also make connections and justify explanations, among other roles (Banejee, 2010; Bruce & Casey, 2012; Corlu&Corlu, 2012).

2.3.3. From a theoretical perspective, inquiry based instruction, and learning, are based in social constructivism (Walker & Shore, 2015). The student then takes on some of the roles that the teacher traditionally fulfils, including exploration, engagement, and stabilization of roles (Walker & Shore, 2015). This allows the student to act as a teacher, a researcher, and a consultant, within the larger social setting of the classroom. The Role of the Learning Community

This emphasizes the importance of the learning community, as a whole, or the interactive purpose of the group of students, rather than the individual student or the teacher. This is the benefit, or learning process that occurs between individuals in the learning community through collaboration (Bell, Urhahne, Schanze, &Ploetzner, 2010; Justice et al., 2002; van Joolingen et al., 2005). This collaboration comes in the form of both the form of working together to work through the inquiry phrases, and in communicating one's own findings to the larger group.

More specifically, the inquiry based model is socially constructive, or depends on collaboration and social communication to construct new learning (Walker & Shore, 2015). The learner must be part of a responsive learning community (Dong, 2016). The learning community uses student diversity to enrich learning, and to integrate cross-curricular instruction (Dong, 2016). As previously mentioned, one of the strengths of the inquiry based model is the way that it allows students to build their own schema which connects new learning to previous learning, this also supports the integration of learning from multiple subject eras.

Newmann, Bryk, & Nagaoka (2001), defined this as "authentic learning" stating that:

Authentic intellectual work involves original application of knowledge and skills, rather than just routine use of facts and procedures. It also entails disciplined inquiry into the details of a particular problem and results in a product or presentation that has meaning or value beyond success in school. We summarize these distinctive characteristics of authentic

intellectual work as construction of knowledge, through the use of disciplined inquiry, to produce discourse, products, or performances that have value beyond school. (pp. 14-15)

As such, the learning community is designed to provide an atmosphere in which level of learning, or the construction of "authentic intellectual work" is uniquely possible. The communication and exploration of knowledge, within the inquiry based learning model is dependent on the exchange of information between the students within that community.

2.3.4. Managing curriculum and target based expectations

Perhaps the greatest single concern, for instructors, is how to manage curriculum objectives, and target based expectations, when using inquiry based instruction. The fear is that if teachers use exclusively, or predominantly, inquiry based learning that students may not gain all of the objectives that are required. This is a serious misunderstanding of the inquiry based learning process. The inquiry based learning concept uses authentic inquiry to develop the understanding of specific conceptual knowledge (Banchi& Bell, 2008). Without skills, and development of conceptual knowledge, the completion of the inquiry based task would not be possible. In other words, the greater the success of the inquiry, the deeper the conceptual knowledge gained (Banchi& Bell, 2008). However, the teacher facilitates a basic framework of knowledge at the outset of the inquiry, and does find ways, within the task, and in guiding the interaction within the learning community, to ensure that curricular requirements are met (Banchi& Bell, 2008).

It is also a misunderstanding of the greater principle of student learning, to assume that all students will learn in the same way, or to the same depth. All students learn differently, and have a "best bet" way of learning, but even when the learning is presented in

a way that is interesting to them, and which activates their best method for instruction, they may not all be equally successful in gaining and retaining the information presented (Entwistle& Ramsden, 2015). This is just as true for inquiry based learning as it is for other learning based approaches.

It is, therefore, critical that the teacher act as a manager of learning, and guide the inquiry of students to ensure that students are both capable of thinking for themselves, but also developing expertise that is directly related to the specific course objectives (Kuhlthau, Maniotes, &Caspari, 2015). The idea of guided inquiry is constructivist, in nature, and assumes that all knowledge is constructed, and that the school, as a collaborative inquiry community, has a body of students capable of developing a deeper understanding or content knowledge through inquiry based learning (Kuhlthau, Maniotes, &Caspari, 2015, p.4). However, this learning is not constructed inside a vacuum. Rather, it is guided by teachers who are experts in the inquiry learning process, and who are capable of leading students through inquiry based activities designed to target curriculum objectives.

2.3.5. Summary of Inquiry Based Approach

Overall, the inquiry based approach is significant because it provides students an opportunity to not only learn basic content, but to build deeper connections between various knowledge basis, and to become strong researchers and problem solvers. Teachers and students both play an active role in this learning process, and are important members of the larger learning community, which collaboratively builds knowledge. For this to be successfully accomplished, the teacher must act as a leader within the classroom how leads students toward asking deeper questions, and developing deeper knowledge, while avoiding

direct instruction of content knowledge. It is critical, therefore, to understand that the inquiry based learning model is far more than teaching students to use the scientific method, and I instead based on the students' willingness and ability to develop questions, explore the data that relates to those questions, draw conclusions, and actively question further, in order to build meaningful connections.

2.4. Project based learning

A second, and somewhat similar approach to student learning is the project based model. Problem based learning (PBL) is an instructional methodology which, like the inquiry based model, is learner entered, and designed to empower the learner to conduct research, investigate questions, and actively apply knowledge to a defined problem (Savery, 2006). However, Project Based Learning (PBL) generally includes a greater degree of direct instruction and encourages students to explore what they have already learned, taking it deeper, rather than expecting them to discover their own learning.

More specifically, there are multiple models for project based learning, all of which are project centered, or "action oriented" using active engagement to reinforce learning (Lee, Blackwell, Drake & Moran, 2014). This pushes students to deepen knowledge, moving beyond basic recitation, to application, and problem solving. Like inquiry based learning, this application and activity is designed to help students build a stronger connection between old and new learning, and cross-curricular concepts.

One prominent and process based model for PBL is the Buck Institute for Education model. This model is focused on K-12 students using an extended process, with response to complex questions and solving a problem or challenge, to deepen learning (BIE, 2013). This

approach allows for some expression of a student's unique "voice and choice," but does not allow students free reign over their approach (BIE,2013; Lee et al., 2014). This is because every project is planned out, managed and controlled by the teacher. The focus is not on posing questions, and answering them, but rather on collaborating and communicating to generate a unique and authentic product or presentation (BIE, 2013).

Like inquiry based learning, the fundamental underpinning of the constructivism. Constructing has five basic tenants: That knowledge is constructed actively, through interaction with the world, that reality only exists in the mind of the individual, that meaning is made through interaction within a community, as it relates to the tools that we need, that all knowledge must be anchored in and indexed by the context of that knowledge, and that knowledge must be created through a desire or need to know, or a question to be answered (Marra, Jonassen, Palmer &Luft, 2014). This PBL fulfills these needs, by create a situation, or meaningful context by which a student can explore the related ideas, and make connections between their self, the body of knowledge, and community or need for learning (Hung, 2002; Marra et al., 2014).

The role of the educator in project based learning goes beyond lecturing. While they may present knowledge according to traditional delivery methods, they also send students out to further their knowledge independently, or cooperatively (Delisle, 1997). In essence, they establish a framework for learning, by generating the details of the project, and then guide students as they complete the project, in order to pose questions, make discoveries, and otherwise increase not only their knowledge, but also their ability to apply that knowledge (Delisle, 1997).

The emphasis here is on the role of the teacher in the classroom coming second to the role of the student, or continuing to push for student- centered learning. This means that the teacher instructs students how to find answer on their own, giving them a topic, and then expecting the student to question, research, and develop projects (Weina, Liang, & Fang; 2008). This allows them to both develop new skills, while also learning or reinforcing knowledge.

The teacher's primary objective, is as such, not to disseminate information to students, but rather to provide students with projects that lead them to discover information and develop a functional body of knowledge (Weina, Liang, & Fang; 2008). The teacher is active in the classroom, providing a frame for learning, and developing the students' strategies for learning (Hmelo-Silver & Barrows, 2006). Thus, the performance goals for the teacher, as a facilitator of learning are to:

P1. To keep all the students active in the learning process. P2. To keep the learning process on track. P3. To make the students' thoughts and their depth of understanding apparent. P4. To encourage students to become self-reliant for direction and information. (Hmelo-Silver & Barrows, 2006).

It is, as a result, critical that the facilitator constantly keep the learning goals in mind, and ensure that students remain focused on those learning objectives (Hmelo-Silver & Barrows, 2006). This means that the teacher, when facilitating, draws out quiet students, ensures the project process does not stall, keeps students on task, checks for understanding, and otherwise provides support for student learning, without supplementing students

learning, or transitioning from a student based to a teacher based approach (Hmelo-Silver & Barrows, 2006).

2.4.1. The Role of Learners

The primary role of the learners is, therefore, to take responsibility for learning, and to locate and provide information as it relates to the task (Savery, 2015). As the teacher provides a basic context, it is the learner's role to commit to research of the topic, and generate the body of knowledge, and determine how best to use It in order to generate the product at hand. The creation and presentation of the project is, in this respect, just as important as the context and appreciation of knowledge.

This means that the learner must consider both the problem, and the context, and use this information to analyze the problem and seek solutions (Ho & Chan, 2015). Once the teacher presents the problem statement, and context ,the student must them move through a multi-step process to complete the related project this includes: analyzing the problem statement to determine what is known, what is unknown, and what further information is needed, the formulation of an investigation plan or research approach and establishment of goals, presentation of investigation plan to peers, carrying to the investigation, and then presenting results and conclusions, or the final project outcome (Hmelo-Silver & Barrows, 2006, p.184).

This approach appears to work, when students both activate prior knowledge, as it relates to new learning, and when they work in the small group setting with peers (Schmidt, Rotgans&Yew, 2011). This means that the activities, which the student is actively engaged in, as a researcher, provide students with space to elaborate on and apply their new

knowledge. This also drives interest in learning. However, this is only possible when a community is constructed in which collaboration can actively take place.

2.4.2. The role of the learning community

PBL is innately cooperative. It is a group-based learning approach, and depends on the students being able to work cooperatively, and encourage one another, in order to pose questions, critique problem solving approaches, and overall build knowledge (Torre, van der Vleuten, & Dolmans, 2015). The problem based learning approach asserts that students have background knowledge, experiences, and ideas that are valuable to share with one another (Donnelly & Fitzmaurice, 2005). By opening up the dialogue between students, and articulation of viewpoints, students are increasingly able to engage in real conversations, debates, and critical thinking; building skills that will transfer to the real world (Donnelly & Fitzmaurice, 2005). This is critical, as it relates to the role of the learning community within the PBL approach.

The role of the community is to be both critical, in terms of providing critiques, while also providing a resource for exploring ideas together, providing access to knowledge, and innovating based on the knowledge of the community as a whole (Torre, van der Vleuten, & Dolmans, 2015). More specifically, this is rooted in the theoretical constructs of social interdependence and the social cognitive theory. These theories hold that knowledge is socially constructed, and that social interaction, between members of a shared community, allows ideas to grow, and innovation to occur (Torre, van der Vleuten, & Dolmans, 2015). The students within a classroom that uses PBL as the primary pedagogical approach demonstrate positive interdependency, and use structured peer feedback to promote

meaningful “accountability, creation and sharing of new knowledge about different topics” across multiple curriculums, or knowledge goals (Torre, van der Vleuten, & Dolmans, 2015).

2.4.3. Managing curriculum and target based expectations

Generally, the process of managing the curriculum, and target based expectations in PBL are not dissimilar from meeting the curriculum and target based expectations for inquiry based learning. High quality PBL is standards based, and so adapt lessons to address the primary objectives of the curriculum, through a PBL process (Hodges, 2015). Students must still demonstrate mastery of the learning objectives. A mixed method study by Kimberly Hodges (2015) demonstrated that middle school students acquired content knowledge at a rate similar to traditional approaches, however, that the students gained a number of benefits, including the ability to solve real world problems, and work collaboratively in addition to the mastery of curriculum related objectives (Hodges, 2015, p.131).

This mastery is seen in the use of knowledge, which is the objective of the curriculum, in solving the problem or generating the related product. PBL is most simply a strategy for instruction, but the projects assigned, or problems posed to student, still reflect the primary goals of the curriculum, and so should the final projects represent the same gain in knowledge, or serve as a summative assessment of mastery of those curriculum related goals (Hodges, 2015, p.144).

2.4.4. Summary of Project Based Learning

Overall, the project based approach to learning is significant because it provides students an opportunity to go beyond basic recitation of facts, and even beyond inquiry, and

develop a finished product, or presentation based on the knowledge gained. Teachers and students must both be actively engaged in the learning process. However, the learning is distinctly student-centered, and the teacher moves to the role of a facilitator within the larger instructional process. The teacher presents a problem, which the student must develop an approach to solve, either independently or within a group. This relies heavily on the participation of all members of the learning community, and the development of a collaborative setting, in which ideas are shared, and all programs, or processes are meaningfully critiqued by peers, in order to drive innovation.

2.5. Review and analysis of the literature

As demonstrated in the definition of each of the addressed learning approaches, or project based and inquiry based instruction, it is clear that student-based learning, regardless of its specific form have many characteristics in common. More specifically, both approaches shift the responsibility for learning away from the instructor, and the use of direct instruction, and instead move the teacher into a role as a facilitator who guides the students to discovering knowledge on their own.

There is compelling evidence that these approaches hold meaningful benefits for students, and their overall performance in the classroom. Student centered approaches have been shown to reduce the performance gap between students who are considered high risk, because of race, and socioeconomic factors. More specifically, according to Friedlaender and his peers (2014), those who are consistently educated using a student centered learning approach outperform their peers within the larger community. Four schools with underprivileged youth were used as a sample for the study, and overall results revealed that

those who were instructed via student- centered approaches, like PBL and inquiry based learning, performed at a higher level on state assessments, had a higher completion/graduation rate, had a higher percentage of students eligible for and persisting in college. Additionally, student surveys revealed that students felt that they were more capable of functioning at the college level, or in the workforce, as a result of the relationship-building and problem-solving skills gained at the secondary level, via student-centered instruction (Friedlaender et al., 2015).

Far more specifically, Freeman et al., (2014) considered the impact that active learning approaches have on students in STEM (science, technology, engineering and math) related coursework. The study found that in classrooms that used student centered approaches, that demanded an active learning approach, summative examination performance graded by half a letter grade (Freeman et al., 2014). This supports the theory that students who are educated in the student-centered classroom, and according to the overarching principles of the PBL and Inquiry based approaches are better prepared to be competitive in STEM fields, which are currently in high demand, and are, perhaps more significantly, have a better foundation for future learning in a variety of academic and professional areas.

These learning environments are consistent with constructivist view of student learning, and how students both collectively, and collaboratively benefit from an environment that engages in more open learning. This is to say that the student instruction occurs in an open learning environment, or an environment where a topic or problem is presented, and hen students use that context to determine their individual learning goals and approaches Hannafin, Hill, Land & Lee, 2014 The individual is, in this setting allowed to establish and pursue goals that are uniquely interesting to them, and as such are more likely to pursue

deeper understanding of the topic, and greater connection between new and previous learning (Hannaffin et al., 2014). These approaches are fundamentally different, because students are more active, in the learning process, and teachers act only as facilitators, rather than providing direct instruction, or leading the student to specific knowledge.

This educational approach increases the students' self-direction, and encourages self-efficacy within the learning process (Hannaffin et al., 2014; English &Kitsantas, 2013). In order for students to become effective problem solvers and critical thinkers, they must have ability to take both responsibility and control over their own learning (Hannaffin et al., 2014; English &Kitsantas, 2013). This is supported by the facilitation of a learning process that expects students to move a project from beginning to end through a specific process. This process is different for PBL and inquiry based approaches, however, most generally includes setting a goal, monitoring the research or experiment, reflecting on findings, and drawing conclusions, while sustaining motivation and momentum throughout the creation of the project (English &Kitsantas, 2013).

2.6. Summary and Conclusions

Overall, the current chapter has demonstrated that students stand to benefit from the use of active, student-centered learning strategies, including both PBL and inquiry based approaches. What is absent from the current literature, however, is an attempt at determining the specific impact that these approaches have on content based knowledge acquisition in specific educational settings or subjects. There is a lack of empirical evidence, as it relates to demonstrating the measurable impact of these pedagogical approaches on student outcomes, or knowledge acquisition and retention.

As such, the following chapter will focus on the current research questions and on filling this gap in the research. The chapter will outline the methodology for the study, defining the instruments and procedures used to collect data from the target population, as it relates to the goal of defining the impact of student-centered instruction on learning.

3. METHODOLOGY

The objective of the methodology section is to outline the different choice that the researcher made in designing the order. The samples and the type of data used in the study were also covered in the discussions. The data gathering and analysis methods are important in that it tells how the data were obtained (from whom and where) and how they were treated and interpreted.

This study employed a mixed method approach in order to explore the effectiveness of inquiry based learning strategies in secondary science and language classrooms. The rationale of the method, or justification for application of a mixed method approach, is explored, as it relates to the research and philosophy behind the mixed method approach, and its unique relationship with the current research questions, as indicated below:

RQ1: What are the perceptions of the respondents about the suitability of IBL and PBL strategies in terms of subjects?

RQ2: Which between IBL and PBL is more effective in delivering positive student-centred learning outcomes?

Robbins (2001), stated that "rigorous qualitative research can provide the 'why' behind statistically significant differences" (p.27). This is especially significant, as it relates to the development of pedagogical best practices because they must be research based, supported statistically, but also described in a way that clarifies the relationship between teacher, the teaching method, and student performance. In education, though the use of the mixed methods approach is relatively young, there is a growing body of research which supports its use (Ponce & Pagan Maldonanado, 2015, Ponce, 2014: Scott & Sutton, 2009: Ellis, 2005), and emphasizes

its significance and validity as an approach to reaching conclusions about pedagogical approach, and educational best practices (Long, 2015).

The use of both qualitative and quantitative methods, to explore a single study, or advance a single set of conclusions can enhance the total findings, if and when the study is well suited to either paradigm, individually (Tashakkori&Teddlie, 1998). More specifically, Johnson and Onwuegbuzie (2004) define this mixed method approach by stating that, "A tenet of mixed methods research is that researchers should mindfully create designs that effectively answer their research questions" (p. 20), and in some cases, this cannot be completely accomplished using a single qualitative for quantitative approach. The strength of the mixed method approach is, therefore, its ability to intentionally combine, or integrate, both descriptive, and statistically significant findings, to provide a single understanding of the evidence as a whole (Creswell, 2008).

In this research, a qualitative method is central to exploring the way that instructor view inquiry based learning, and its impact on students. A quantitative approach is also employed, to explore the measurable impact that these approaches have on student success.

3.1. Understanding the Mixed Method Approach: Philosophy and Underpinnings of Research

Historically, whether a study is qualitative or quantitative in nature was dictated by the structure of the research questions, and hypothesis, however an increasing number of researchers are restructuring their research questions, in order to meet the needs and expectations of both design types of research and to provide a more complete or well-rounded view of the topic (Phillips, 2009). This is because the qualitative research provides a rich descriptive platform for understanding the detailed elements of a complex system or topic (Kaufman, 1994;

Chenail&Maione, 1997; Creswell, 2008) while in contrast, quantitative research provides irrefutable, mathematical, evidence for establishing a causal relationship between the related variables (Denzin & Lincoln 1994; Cresswell, 2008). More specifically, the qualitative elements are best suited to answering "questions that stress how social experience is created and given meaning." (Denzin & Lincoln, 1994) In contrast, however, the quantitative approach focuses on numbers that demonstrate rather than describing relationships. Thus, when used in tandem, the quantitative provides evidence of correlation or causation, and the qualitative data creates a deeper understanding, or contextual description of the scenario.

One of the reasons that educational research is increasingly preferred in education, is because the combination of the two approaches minimizes some of the known limitations of either approach individually, while maximizing the strengths or benefits (Teddlie&Tashakkori, 2003). Historically, quantitative research was considered more verifiable or accurate, causing those who are proponents of its use to hold to the idea that "social observations should be treated as entities in much the same way that physical sciences treat physical phenomenon" (Johnson &Onwuegbuzie, 2004, p. 14). However, this stance does come with some limitations, including loss of context, observation, and meaningfully conclusions drawn from description and observation, rather than through experimentation and testing (Creswell, 2008; Creswell, Plano-Clark, Gutman, & Hanson, 2003). That said, quantitative research also has multiple strengths, which are of benefit to educational research including: the ability to test, and validate a hypothesis, the creation of generalized, but mathematically supported findings, the ability to differentiate between various subpopulations, and the use of experimental conditions to test and prove various theories (Johnson &Onwuegbuzie, 2004).

Similarly, qualitative research also has strengths and limitations which should be considered, in relation to experiment and research design. More specifically, the qualitative approach is limited in its ability to create a predictive model, and the inability to extend the findings to a larger, or more generic, population. However, the benefits of the design include insight from first-hand experience, an access to greater detail, as it relates to various human phenomenon (Creswell, 2008). Comparing the strengths and weaknesses of each approach, it becomes clear how the application of a mixed method approach can generate findings that are, overall stronger, and more comprehensive.

As such, the primary goal of using the mixed method approach is to create a deeper understanding of the things that impact or control human behaviors, by using more than one method to complete the related research, or to look at human behavior form multiple angles, and develop a comprehensive description of behavior, based on those observations (Morse, 1991). Creswell et al. (2003) defined this multi-dimensional approach as follows, stating that:

A mixed methods study involves the collection or analysis of both quantitative and/or qualitative data in a single study in which the data are collected concurrently or sequentially, are given a priority, and involve the integration of the data at one or more stages in the process of research. (p. 212)

As such, it is important to define exactly how the data will be collected, but quantitatively and qualitatively, in order to determine the total weight of the data in the current study. Further, this must occur in alignment with the mixed method paradigm, as it has been constructed and the related philosophical underpinnings.

Tashakkori and Teddlie (1998) outlined multiple key standards that underlie the mixed method approach including: the use of pragmatism to support the use of both the qualitative and the quantitative methods within a multi-stage research program; allowing a pragmatist researcher to consider questions that are more far reaching than either approach can address on their own, or allowing the research question to predominate the approach; allowing decisions based on the mixed method approach to depend on the research questions, and then be ordered according to the multiple stages of the research process; and avoiding the use of metaphysical ideas, like "truth" and instead seeking to describe multiple ways way viewing the situation or phenomenon (p. 22-30).

Johnson and Onwuegbuzie (2004), also relied heavily on the idea of pragmatism when describing the philosophical approach used to justify the use of mixed methods, stating that: research approaches should be mixed in ways that offer the best opportunities for answering important research questions" (p. 16). As such, the mixed method approach should be constructed in such a way, that the multiple stages of research, and mixture of approaches are complementary, and provide a more comprehensive view of the topic at hand, while also minimizing the weaknesses, and maximizing the strengths of the total research approach.

This is possible because the mixed method approach allows the researcher to approach the topic from multiple perspectives, and analyses the topic from a broader and more diverse number of sources, or data collections, and the triangulation of this data yields a more exacting set of conclusions (Cresswell et al., 2003, Cresswell, 2008, Johnson &Onwuegbuzie, 2004; Tashakkori&Teddlie, 2003). Bearing this in mind, the use of the mixed method approach, within the current study, should serve three primary purposes: to corroborate the findings of the first stage, in the second stage, to eliminate or minimize alternative explanations, and increase

validity, and to provide detailed explanations, or context, for any apparent diversions of contradictions within the data (Johnson &Onwuegbuzie, 2004). The three sources of data, in this case, which will be used to triangulate the final answers are the literature review, primary quantitative data, in the form of pre-and-post testing, and qualitative primary data, collected via survey of the teachers involved in the study.

This format is known as a sequential explanatory design. A sequential exploratory study, according to Cresswell et al. (2003), is "characterized by the collection and analysis of quantitative data followed by the collection and analysis of qualitative data" (p. 223). In this approach, the research and analysis are structured so that the quantitative data is collected, and analyzed, before the qualitative analysis begins. Then, in the second stage of research and development, the qualitative data is collected and analyzed. These two, independent analyses ae then used in a third and final stage of development, for the interpretation of the analysis as a whole. This approach is fundamental, or simplistic in its overall design and execution, but has the strength of explaining results that would be otherwise hard to interpret (Cresswell et al., 2003).

Bearing this in mind, the exact methods used to collect the quantitative and qualitative data, because they occur in separate stages, should be independently defined, and justified. The following section of the chapter will work to define each of these approaches. This will include outlining the design, sampling, instrumentation and procedure for each stage of data collection and analysis.

The research philosophy that was used in the study was pragmatism. Pragmatism focuses on the practical aspects of an object, topic, question, or observation. It suggests that a system can have

various forms and interpretations, but the one that can be considered to be the truth or the one that has the highest value is the one that stresses the practical consequences and or its implications. In the case of this study, the researcher aims to examine the suitability and effectiveness of IBL and PBL by examining the teachers' perceptions through a survey and actually checking the impacts of IBL and PBL in the students' test scores (pre and post). These two methodologies highlight the utilization of a practical or pragmatic approach in answering the research questions. The use of a mixed approach is ideal in this case because there are numerous ways how to pragmatically answer a research question. Generally, there are two ways: Quantitative and Qualitative. Each of these two approaches has its own set of pros and cons. By using a mixed (combined) approach, the researcher becomes able to take advantage of the pros of both, and not be limited by their disadvantages.

3.2. Step 1: Quantitative Method.

3.2.1. Design

The quantitative approach to the current study recognizes that quantitative research is essential because it provides a means of understanding how empirical observation, and its mathematical evidence, provides meaningful evidence of a relationship (Tashakkori&Teddlie, 2003). Standardized, descriptive statistical evaluation of the change in performance of students who are placed under experimental conditions can, therefore, provide meaningful evidence of the relationship between those conditions, or teaching approaches, and student success.

In this study, standardized quantitative tests were used to gain a measure of the impact of inquiry based learning on student performance. More specifically, the research was conducted via a quasi-experiment, which drew evidence for its conclusions from non-equivalent groups. The data

collection for the quantitative portion of the study was a quasi experimentalcarried out, using pre-and -post- testing within an experimental group, and a control group. However, it can only be considered a quasi-experiment, and not a true experiment, because of the use of pre-established groups.

While a true experiment would have reduced the risk of bias, especially as it relates to internal validity, the quasi-experiment was the most appropriate for the current study, because the school had already established the classes, in the previous semester. Since students had been assigned to their classes at the beginning of the school year, it was no longer possible to randomly select students to assign to a control and experiment group, further, it was not possible to ensure that the two classes had comparable make up and baseline.

3.2.2. Sampling

Educators were the subjects in the first part of the study where the survey questionnaire was used. A total of 107 educators were recruited for that part of the study. The second part of the study focused on examining the effectiveness of IBL and PBL. Students were recruited as the participants in this phase. A total of 45 of 6^{th} grade students were sampled what type of sampling?. They were divided into two groups. There were 23 students in the experimental group, and 22 students in the control group. The experimental group, was then provided with inquiry based learning/ instruction for the first semester of the school year, while the control group was taught using explicitly project based instruction. The implementation phase lasted for an entire semester.

A convenience sampling technique was implemented in the process of recruiting the participants. Students who were already assigned to a teacher and classroom, by the administration of the

school district, were recruited, based on their availability and willingness to participate. All students were, more specifically enrolled in an American curriculum school located in Al Ain. U.A.E. Permission to carry out the research at that location was approved, in advance, through the administration.

The groups were generally equivalent, with gender distribution, and racial makeup being equivalent with one another, and representative of the larger population of the school. Further, the school groups students, so that there are roughly equivalent high and low performing student in each classroom, allowing the researcher to assume that students in the groups, who took the pre-test, were statistically equivalent to one another, in terms of the factors impacting performance, overall.

3.2.3. Instrumentation

Instrumentation within the quantitative element of the study was carried out through pre and post test. The pre and posttest was designed by the researcher, and tests the students' ability to solve science related problem, in multiple niche areas. A total of 20 questions were divided into four sections of questions, all of which were based on the primary science objectives for the 6^{th} grade. More specifically, questions were asked based on 6^{th} grade objectives in: physical science, life science, science investigation, and experimentation. Five questions were asked in each sub-topic, with each worth one point, for a total of 20 points.

The baseline assessment was collected during the first week of the semester, during the first semester of the standard school year, via pre-testing. The test was a set of multiple choice questions, solved individually by students, who recorded their responses via the computer.

Then, post-testing was used, in December during the last week of the semester, to check the effectiveness of teaching, and the impact of inquiry based learning on students. This was collected by giving students the exact same test that was used to collect baseline data. It was given under the same conditions and using the same computers as the pre-test, to ensure that the measure of change was valid.

Each question on the test was similarly constructed, with one correct answer, and three distractor questions. The content validity was examined by two science teachers, not otherwise involved in the study, and one university professor, who academically specialized in science education, to check for correctness and consistency.

3.2.4. Procedure

The current study used two distinct treatments of the populations of interest, separated into an experiment and control group. The experimental group was taught using investigative learning, or an inquiry based approach. The second group, or the control group, was taught using only a project based instruction.

Both the control and experiment group were taught by the teacher following the same classroom protocols, management strategies, and daily classroom schedule, which eliminated variables, including the time of day that science was taught, classroom management style, and other similar factors. However, the pedagogical approach used was very different, following different schools of thought, or instructional approaches.

In order to check, or monitor the implementation of the assigned treatment for the control and experimental groups, both classrooms were observed by the researcher. All classroom instruction

and lesson plans were reviewed to ensure that the target instructional style was maintained. In the control group, the teacher was restricted to instruction bases in a project based approach, and could not use any inquiry based instruction. In contrast, the experimental classroom used solely inquiry based learning approaches, mapping student relationships, and making all instruction student centered, and limiting or eliminating the use of direct instruction. This means that all activities were designed to provide students with opportunities for self-expression and leadership, while minimizing the role of the teacher as a leader or instructor. The instructor's role, under the experimental conditions, is to act as facilitator to student learning, rather than a direct means of presenting new knowledge.

The topics instructed, according to these terms, and instructional approaches, were all taken from the American science curriculum for the 6th grade, and the objectives outlined for learning during the 6th grade year. The lessons were presented in the same order, and on the same days, for both classes. Thus, the only difference in the education that the two groups received was in terms of the pedagogical approach used to present the materials. More specifically topics instructed included: Math, Science, English, SPED, and other academically relevant topics as shown in the questionnaire coverage. Thus, the primary difference between the control and experiment groups, was in terms of the engagement phase of instruction. During this phase, the teacher worked to engage the students actively in their learning, either through inquiry or project, in an effort to get them interested in the topic, and to make a personal connection with the learning. Both approaches are designed to help students make connections between current and prior learning, and practically apply the target knowledge to problem solving situations. This is significant, with relation to outcome, because both approaches, as demonstrated in the literature review, are designed to orient the student thinking toward problem solving, and mastery of

objectives, or learning outcomes. In this case, it could be said that students had previous learning, based on their 5th grade science education experience, which included exploration of the concept of the cell, microbes, life cycles, and other related topics, which impact their understanding and retention of new knowledge. Overall, it can be said that the majority of instructional time in the control group was devoted to direct instruction, which staged the students' readiness for project engagement. In contrast, however, the inquiry based instruction allowed the teacher to pose a question, and then provide the students with the materials they needed to discover the new knowledge, and build their own understanding as it relates to the material. To this end, it should be said that both the project based and inquiry based groups of students used the same textbook, and curriculum base.

3.3. Step 2 - Quantitative Analysis of the Data

The quantitative data, collected via these procedures and instrumentation, was then collated into Excel, and statistically analyzed. The researcher used a variety of statistical approaches to review the data, including mean standard deviation and one-way ANCOVA testing, to determine the statistical significance of the trends seen in the data.

3.4. Step Three: Qualitative Data Collection

The qualitative phase of the research was based on the grounded theory method, which was developed by Glaser and Streauss (1967), and which supported the use of explanatory research as it relates to human behaviors. The grounded theory is inductively derived from the further study of the phenomenon it is designed to represent (Strauss & Corbin, 1990). This is to say that it is both derived from, and verified, though the systematic collection of, and analysis of data, that directly relates to the phenomenon that the study is concerned with, in this case, the

academic success of students instructed through various pedagogical approaches. This approach, according to Strauss and Corbin (1990), allows the aspects of the study which are "most relevant" to emerge.

This approach is specifically appropriate to the current study because there has been very little direct study about the impact of the inquiry based or project based approaches on specific areas of learning, or core subject areas in secondary educational classrooms.

3.5. Design

In this study, a questionnaire, which collected quantitative data via a combination of Likert-scale like questions and multiple choice questions were used to gain insight into how the teachers view the teaching approaches, including inquiry and project based learning and to shed light on, or provide context for the findings in the pre and post testing. More specifically, the research was conducted via surveys distributed to all participating teachers. The data collection for the qualitative portion of the study was carried out, in January, after the completion of the quantitative portion of the study.

3.6. Sampling

The survey was distributed to 107 teachers. A convenience sampling technique was used in the process of sampling those 107 teachers. This was also the same sampling technique used in the sampling of the student participants in the other part of the study. These teachers taught within the school district and the city where the experiment was carried out, and so their view of inquiry based learning, and the prominence with which it is used in the classroom are relevant to the research questions, and to the findings of the previous quantitative stage of the study.

3.7. Instrument

The instrument used to collect the qualitative data, as it relates to the current study was a survey, created by the researcher, which contained a series of seven demographics questions, six Likert based questions designed to gauge student background and education, six multi-choice questions and 42 Likert based questions.

3.8. Procedure

The current study used a single procedure and treatment for the collection of all surveys. The teachers represented a single population of interest, and the data collected were intended to describe and contextualize the use of inquiry based learning. All teachers received the survey in early January, as school reconvened for the second semester of the year, and after the post-testing was complete. They were asked to fill out and return the survey within 5 business days.

3.9. Step 4 - Qualitative Analysis of the Data

The qualitative data came in the form of the participants' responses to the questionnaire items, collected via these procedures and instrumentation. Each qualitative response could be interpreted quantitatively using the five-point Likert Scale. The scale equivalents (quantitative) of the qualitative responses were then collated into Excel, and analyzed as it related to trends in the data, and frequency of response and other related measure that showed trends in the data, and determined how these defined human behaviors.

3.10. Ethical Considerations

The respondents were asked to sign an informed consent form that explains the nature of their participation prior to the initiation of the study's implementation phase. The informed consent

form is a document that contains all of the important information about the study, including but not limited to the procedures that the prospective respondents (students and teachers) had to undergo. At the end of the said form was a line where the prospective respondents were asked to place their signature over printed name; the presence of which indicates the voluntary and informed nature of their participation in the study. All of the data obtained from the respondents (educators and sixth grade students) were treated privately and with confidentiality. No third party entity were given access to the database of information that the researchers collected from the participants.

3.11. Summary and Conclusion

This chapter has provided an overview of not only the theoretical basis and justification for the methodological approach, but also the procedure to be used during each phase of the multi-stage approach. More specifically, the current study is applying a mixed method approach, which will be carried out in two basic parts, via the sequential explanatory design. This means that first the quantitative method, based on a quasi-experiment which tests student performance after the application of experimental conditions. In this case, this includes the use of inquiry based instruction, within the experimental group, and project based instruction in the control group. Secondarily, or sequentially, a qualitative study will be conducted. This will be made up of a survey, completed by teachers, and providing a contextual understanding of the way that teachers view, and use inquiry based learning. This method was used to collect data. Chapter four will, therefore, present the data collected via this methodology, and outline the statistical analysis of that data, so that it can be used to develop a meaningful set of findings and recommendations.

4. DATA ANALYSIS AND RESULTS

A mixed approach composed of both qualitative and quantitative methods was utilized in the present study's implementation phase. The qualitative approach was applied in the literature review section (mainly) and the qualitative responses of the participants to the questionnaire before they were interpreted using the Likert Scale into quantitative data, while the quantitative approach was applied in the actual implementation phase, i.e. chapter four, using primary data. This was opposed to the literature review section where data coming from secondary sources were the ones mostly used. The objective of the present study was to examine the effectiveness of Inquiry-Based Learning (IBL) and Project-Based Learning (PBL) in science and language subjects that are being taught at the high school level.

As mentioned in the study's introduction chapter, one of the aims is to present data that have been collected at the high school level, and analyze those data from the perspective of the two learning approaches in question (IBL and PBL), so that the environments and scenarios where they can be best applied can be described and identified. This would of course be detrimental to the process of introducing continuous improvements in teaching outcomes (for educators) and learning outcomes (for students). Learning, after all, is not a one-way process. Both the educators and the students carry an almost equal level of responsibility to create an environment that is conducive for learning. In light of one of the present study's aims, this section was divided into two: 1) Discussion of the findings from the perspective of IBL, and 2) Discussion of the findings from the perspective of PBL.

Below is a codified version of the research instrument. It shows the actual questionnaire items that were used to obtain data from the respondents (teachers), and the possible responses

that the participants could choose (for every item). Another important part of the succeeding tables to review is the code used to systematize the process of referencing the long tail questions.

Part I				
Age	25 Years Old and Below	25 to 35 Years Old	36 to 45 Years Old	46 Years Old and Above
Gender	Male	Female		
Teaching Experience	1 to 5 Years	6 to 10 Years	11 to 15 Years	More than 15 Years
Teaches Math	Yes	No		
Teaches Science	Yes	No		
Teaches English	Yes	No		
Teaches SPED	Yes	No		
Teaches Other	Yes	No		
Teaches Elementary	Yes	No		
Teaches Middle School	Yes	No		
Teaches Secondary	Yes	No		
Math Major	Yes	No		
Science Major	Yes	No		
English Major	Yes	No		
SPED Major	Yes	No		
Other Major	Yes	No		
BS/BA Degree	Yes	No		
MA Degree	Yes	No		
PHD Degree	Yes	No		
Other Degree	Yes	No		

Figure 1 Research Instrument

Code	Question	Responses				
P1Q1	I think it is important to encourage student based learning	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
P1Q2	I frequently use inquiry based learning in my classroom	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
P1Q3	I actively look for opportunities to build inquiry into the course curriculum	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
P1Q4	I consider inquiry based learning an important part of student learning	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
P1Q5	Students academically benefit from inquiry and project based learning	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
P1Q6	I received sufficient training in inquiry and project based learning, during my educational training	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Weekly Frequency of IBL Use		Other	1-2 lessons	3-4 lessons	5-6 lessons	Every lesson
Monthly Frequency of IBL Use		Other	1-5 lessons	6-10 lessons	11-15 lessons	Every lesson

Codes	Part II Questionnaire Items	Responses				
P2Q1	The curriculum in which inquiry is most likely to be incorporated in	Other	Regular Curricular	Special activity in regular classroom	Extra-Curricular	After School Program

Course Where Inquiry-Based Learning is likely to be used in

P2Q2	Inquiry-Based Learning is likely to be used in Math	Yes	No	[redacted]

P2 Q3	Inquiry-Based Learning is likely to be used in Science	Yes	No
P2 Q4	Inquiry-Based Learning is likely to be used in English	Yes	No
P2 Q5	Inquiry-Based Learning is likely to be used in SPED	Yes	No
P2 Q6	Inquiry-Based Learning is likely to be used in Other	Yes	No

Inquiry is a natural part of the curriculum in the following classes (if any)			
P2 Q7	Inquiry is a natural part of the curriculum in Math	Yes	No
P2 Q8	Inquiry is a natural part of the curriculum in Science	Yes	No
P2 Q9	Inquiry is a natural part of the curriculum in English	Yes	No
P2 Q10	Inquiry is a natural part of the curriculum in SPED	Yes	No
P2 Q11	Inquiry is a natural part of the curriculum in Other	Yes	No

P2Q12	Inquiry based learning is, in my current school environment	Thought to take up too much time	Used only on special occasions	Considered necessary only in science courses	Thought to enhance direct instruction	Considered essential to pedagogical best practices

Figure 2 Survey Questionnaire

Descriptive Statistics

Part I			Range	Minimum	Maximum	Mean	Std. Deviation	Variance
	Age	9	3	1	4	.63	.763	.583
	Gender	9	1	1	2	.81	.393	.154
	Teaching Experience	9	3	1	4	.47	1.135	1.288
	Teaches Math	9	1	1	2	.51	.504	.254
	Teaches Science	9	1	1	2	.44	.501	.251
	Teaches English	9	1	1	2	.56	.501	.251
	Teaches SPED	9	1	1	2	.95	.222	.049
	Teaches Other	9	1	1	2	.80	.406	.165
	Teaches Elementary	9	1	1	2	.61	.492	.242
	Teaches Middle School	9	1	1	2	.49	.504	.254
	Teaches Secondary	9	1	1	2	.59	.495	.245
	Math Major	9	1	1	2	.64	.483	.233
	Science Major	9	1	1	2	.83	.378	.143
	English		1	1	2		.47	.2

	Major	9				.68	1	22
	SPED Major	9	1	1	2	.97	.183	.033
	Other Major	9	1	1	2	.78	.418	.175
	BS BA Degree	9	1	1	2	.42	.498	.248
	MA Degree	9	1	1	2	.58	.498	.248
	PHD Degree	9	1	1	2	.97	.183	.033
	Other Degree	9	1	1	2	.88	.326	.106
	P1Q1	9	4	1	5	.10	.803	.645
	P1Q2	9	4	1	5	.93	.828	.685
	P1Q3	9	3	2	5	.86	.819	.671
	P1Q4	9	3	2	5	.34	.801	.642
	P1Q5	9	4	1	5	.08	.816	.665
	P1Q6	9	4	1	5	.93	1.081	1.168
	Weekly Frequency of IBL Use	9	4	1	5	.02	1.106	1.224
	Monthly Frequency of IBL Use	9	4	1	5	.19	1.210	1.465
Part II	P2Q1	8	4	1	5	.40	.792	.627

	P2Q2	8	1	1	2	.06	.245	.060
	P2Q3	8	1	1	2	.46	.504	.254
	P2Q4	8	1	1	2	.56	.501	.251
	P2Q5	8	1	1	2	.88	.334	.112
	P2Q6	8	1	1	2	.83	.377	.142
	P2Q7	8	1	1	2	.10	.309	.095
	P2Q8	8	1	1	2	.48	.505	.255
	P2Q9	8	1	1	2	.60	.494	.244
	P2Q10	8	1	1	2	.85	.357	.127
	P2Q11	8	1	1	2	.88	.334	.112
	P2Q12	8	4	1	5	.90	1.171	1.372
	Valid N (list wise)	8						

Figure 3 Summary of Results and Findings

The table above shows a summary of the results and findings for the two parts of the questionnaire. P1Q1 refers to the first question in the first part of the questionnaire. P2Q1 refers to the first question in the second part of the questionnaire.

It is important to note that the present study's implementation and data collection phase (where primary sources of data were obtained in the form of the participants' responses to the questionnaire, and pre and post test results comparing IBL and PBL) focused more on Inquiry-based learning and less on Project-based learning. The table above also contains other statistical findings such as measures of central tendency (e.g. mean), standard deviation, and variance for each of the questionnaire items, including those that belong to the demographic section (e.g. age, gender, teaching experience, among others), and those that were aimed at examining and describing the respondents' perceptions about and attitude towards Inquiry-Based Learning.

In the first part of the questionnaire, there were a total of 6 scale-based questionnaire items. These items include P1Q1 to P1Q6. These questionnaire items were answerable using a Five Point Likert Scale type of questions with a score of 1 (lowest score) representing the qualitative response Strongly Disagree, 3 representing Neutral, and 5 (highest score) representing the qualitative response Strongly Agree. These questionnaire items were meant to describe the perceptions of the respondents about Inquiry-based Learning in a quantitative manner. That objective can be accomplished by looking at the mean of each of those six scale-based questionnaire items. A higher mean score (closer to the max score of 5) is an indication that the respondents' perception about the aspect of IBL being questioned is more positive than negative; the opposite of this is what is going to be true if the mean score is closer to the minimum score of 1. In order to identify the particular aspect of IBL that is being examined in each of these items (P1Q1 to P1Q6), it is important to refer to the research instrument file that was created to systematize the referencing of the questionnaire items.

P1Q1	**I think it is important to encourage student based learning**	**4.1**

P1Q2	I frequently use inquiry based learning in my classroom	3.93
P1Q3	I actively look for opportunities to build inquiry into the course curriculum	3.86
P1Q4	I consider inquiry based learning an important part of student learning	4.34
P1Q5	Students academically benefit from inquiry and project based learning	4.08
P1Q6	I received sufficient training in inquiry and project based learning, during my educational training	2.93

Figure 4 Survey Part 1

The figure above shows a summary of the findings of the study focusing on the perceptions of the respondents about the different aspects of IBL (From left to right: Code, Actual Question, and the Mean Score for all of the 59 respondents). The maximum score is 5. With a score of 4.1 out of 5 in P1Q1, it would be safe to suggest that the teachers who were surveyed agree that IBL is important in encouraging student-centered learning. With a score of 3.93 out of 5 in P1Q2, it would be safe to suggest that the majority of the respondents frequently use IBL-based teaching methods and strategies in their classroom. A score of 3.86 in P1Q3 indicates that the teachers are actively looking for additional ways of incorporating IBL-related strategies in their respective course curriculums. A score of 4.34 out of 5 (the highest score obtained in all Part I scale-based questionnaire items) in P1Q4 supports the idea that teachers consider IBL as an important part of their students' learning process. A score of 4.08 in P1Q5 indicates that the teachers whom were surveyed believe that the use of both IBL and PBL (combining the two) can be beneficial to the overall learning process of their students. The lowest score in Part 1 was recorded in Question 6; the score was only 2.93 out of 5; this suggests that the teachers who were surveyed did not receive sufficient training in the application of IBL

and PBL during their educational training. This can be a potential problem area because there are certain aspects of IBL and PBL that require sufficient training to be perfectly executed.

More definitive findings can be obtained by analyzing the different questionnaire items one by one, but generally, the most important findings about IBL are in line with the consensus from previously published studies about its strong and weak points, as far as effectiveness is concerned (Banchi & Bell, 2008; Bell, Urhahne, Schanze, & Ploetzner, 2010; Corlu & Corlu, 2012; Dobber, Tanis, Zwart, & Van Oers, n.d.; Gutwill & Allen, 2012).

Teaching experience is an important aspect of the respondents' demographic characteristics (Dobber, Tanis, Zwart, & Van Oers, n.d.). The consensus in previously published studies, as established in the second chapter, was that more experienced teachers tend to be more capable of delivering positive outcomes (Jackman, 2011; Gardner, 1991). It has also been established that the execution of strategies that are based on inquiry-based learning not only depends on whether the teacher executing them have been properly trained or not; the outcome of the execution of IBL strategies also depend on the teachers' experience (Jackman, 2011; Gardner, 1991). The same principle in fact applies to PBL strategies (Torre, Vleuten, & Dolmans, 2016). The ideal situation therefore, is one where only experienced educators are the ones allowed to execute these learning strategies. Then again, even less experienced educators should not be disallowed to use and execute these learning strategies, because disallowing them would make it impossible for the following generation of educators to get better at using IBL and PBL strategies (Smyrnaiou, Foteini, & Kynigos, 2012; Delisle, 1997). This is one of the grey areas in the field of education that is yet to be addressed. In the present study, it was found that the largest component of the teachers implementing either or both of the two learning strategies

(IBL and PBL) were those who were moderately experienced, with only between 6 and 10 years of teaching experience, representing 32.2. percent of the population.

It was found that some teachers who cover specific subjects did not receive formal training before being allowed to do so. In the Math subject, for example, it was found that there was a discrepancy between the teachers who were trained to teach a certain subject (i.e. Math, Science, English, SPED, and Other) and the ones who do teach the subject. This discrepancy is material, mainly because it shows that there are educators, at least in the sample population that were covered, who teach using IBL and PBL strategies in subjects that they were not really directly trained to teach. In the Math cluster, for example, it can be observed that some 49% of the total population practice teaching (Math); on the other hand, it can also be seen that only around 35% of the total population were actually trained to teach the subject. The same observation can be made in other subject areas. In the English subject, for example, it was observed that 44% of the total population (of educators) teach the subject; on the other hand, it was observed that only 32% of the total population were actually trained to teach the subject (English). The same observation can be made when analyzing the remaining subjects (Science, SPED, and Other). This can be an important issue to discuss in the policy implication section later on, as this means that there are educators who are being assigned to teach core subjects when they were not in fact formally trained to teach those subjects.

Majority of the respondents in the sample population were Bachelor's Degree (BS/BA) holders (at 57%); some 42% have a post-graduate degree (Master's). Ideally, educators who only have an undergraduate degree (Bachelor's) should not be allowed to teach. The minimum requirements in the educational sector of many states is for a teacher to be, at least a

postgraduate degree holder. The statistical findings presented earlier clearly show that this is not the case for the educators who were surveyed. This calls into question the effectiveness of the state's education department's implementation of its existing policies and regulations concerning the qualifications of the teachers in both public and private institutions.

Code	Question	**Frequency**	**Range**	**Min**	**Max**	**Mean Score**
2Q1	The curriculum in which inquiry is most likely to be incorporated in	**48**	**5**			**2.4**
2Q2	Inquiry-Based Learning is likely to be used in Math	48	2			1.06
2Q3	Inquiry-Based Learning is likely to be used in Science	48	2			1.46
2Q4	Inquiry-Based Learning is likely to be used in English	48	2			1.56
2Q5	Inquiry-Based Learning is likely to be used in SPED	48	2			1.88
2Q6	Inquiry-Based Learning is likely to be used in Other	48	2			1.83
2Q7	Inquiry is a natural part of the curriculum in Math	48	2			1.1
2Q8	Inquiry is a natural part of the curriculum in Science	48	2			1.48
2Q9	Inquiry is a natural part of the curriculum in English	48	2			1.6
2Q10	Inquiry is a natural part of the curriculum in SPED	48	2			1.85
2Q11	Inquiry is a natural part of the curriculum in Other	48	2			1.88
	Inquiry based learning is, in my	48	5			3

2Q12	current school environment	.9

Figure 5 Part 2 Survey Findings

A scale-based type of analysis was also used to investigate the effectiveness of Inquiry-based learning further. The table above focuses on Part 2 (P2) items in the questionnaire. The two most important numbers to look at would be the max score and the mean score. The max score shows the range of the scale used while the mean score shows the actual perceptions of the participants who answered the survey about the different aspects of IBL's effectiveness. A mean score that is closer to the max possible score suggests that the respondents' perceptions about IBL is more positive than negative.

P2Q2 which focuses on IBL's likelihood of being used in Math subjects was the item with the lowest mean score at only 1.06 out of 2. This means that nearly half of the respondents disagreed with the statement that IBL is likely to be used in Math; this is an indication of their belief about IBL's inapplicability to Math. The second lowest score was also related to Math, P2Q7, at only 1.1 out of 2. This indicates that the respondents do not believe that IBL strategies are a natural part of the curriculum used in Math subjects. These two findings can be used as a strong indication that Math and IBL strategies are two incompatible variables. From a theoretical perspective, these two findings show the areas where IBL strategies may be ineffective (i.e. math subjects and curriculums, mainly because of incompatibilities).

It was also found that IBL is compatible with SPED subjects. This is evidenced by the mean score in P2Q5 (focusing on IBL's likelihood of being used in SPED subjects), at 1.88 out of 2 (the highest in the scale-based questionnaire items in the second part of the survey, that had a range of 2 (min 1, max 2). This means that the respondents agree on the idea that SPED subjects can be best delivered and covered using IBL strategies. P2Q10 was another SPED-related questionnaire item; however, unlike P2Q5, it focused on IBL's being a natural of SPED

curriculums. This was the second questionnaire item (in the survey's second part, i.e. P2) with the highest score, at 1.85 out of 2. This score indicates that nearly all of the respondents agree on the idea that IBL is a natural part of curriculums being used in SPED subjects. Combined, these two findings show that IBL strategies and SPED are two variables that have a high level of compatibility.

IBL also has a high level of compatibility with English subjects and curriculums. This is evidenced by the mean score that was computed in P2Q4 (focusing on IBL's likelihood of being used in English subjects) at 1.56 out of 2; and in P2Q9 (focusing on IBL's being a natural part of English curriculums), at 1.6 out of 2.

These findings are important both from a policy, practical, and theoretical perspective. Theoretically, these findings confirm the findings from previously published studies in Chapter II. In previously published studies, the consensus was that the onus of looking for the most applicable scenarios and environment where the use of IBL can be effective (and appropriate) is on the teachers (Dobber, Tanis, Zwart, & Van Oers, n.d.; Pedaste, et al., 2015; Corlu & Corlu, 2012). Practically, these findings can be used to guide educators in their study and lecture planning; mainly in knowing when to use and when not to use IBL. In such cases, the use of PBL may be more applicable (Savery, 2015). It is important to note, however, that a contextual incompatibility with IBL does not automatically equate to a contextual compatibility with PBL, because there are specific frameworks and scenarios where PBL may be incompatible with, just like its IBL counterpart (Torre, Vleuten, & Dolmans, 2016). From a policymaking perspective, regulators in the field of education can draft and enforce new policies that are aimed at ensuring the compatibility of the teaching strategies with the target educational outcomes. Such policies,

however, may have a direct impact on the educators' level of freedom and use of creativity when creating their lecture and lesson plans, among others.

SI	IBL Pre Test	IBL Post Test	PBL Pre Test	PBL Post Test	IBL Test Impact (Difference)	PBL Test Impact (Difference)
1	3	6	5	6	3	1
2	7	8	3	4	1	1
3	6	7	6	7	1	1
4	6	8	2	3	2	1
5	3	6	6	6	3	0
6	4	5	6	7	1	1
7	5	7	6	7	2	1
8	4	5	3	4	1	1
9	2	5	2	3	3	1
10	5	6	4	6	1	2
1	5	6	2	3	1	1

1						
1	4	5	3	5	1	2
2						
1	2	4	3	4	2	1
3						
1	2	6	3	4	4	1
4						
1	5	7	6	7	2	1
5						
1	5	7	6	7	2	1
6						
1	4	5	3	4	1	1
7						
1	6	7	3	5	1	2
8						
1	5	7	6	6	2	0
9						
2	6	8	4	6	2	2
0						

21	6	8	4	6	2		2
22	6	8	4	6	2		2
23	4	6	NA	NA	2	NA	
Average	4.57	6.39	4.09	5.27	**1.83**		**1.18**

Figure 6 Pre and Post Test Comparison IBL vs PBL

The second research question focuses on the process of determining which among the two approaches to learning is more effective: IBL vs PBL. In order to accomplish that the researcher compared the impact of the IBL and PBL strategies on the pre-test scores of the students (in sixth grade). In the IBL group. This impact was measured by comparing the post-test scores of the students with their pre-test scores, after either the IBL or PBL strategy (depending on the group where they belong) has already been implemented. Generally, the use of IBL and PBL strategy leads to higher post-test scores. However, the research question asks which among the two is more effective, i.e. which has the capacity to lead to a higher test score. The difference between the pre and post-test scores of the respondents in both groups were averaged. For the IBL group, the mean was 1.83 while it was 1.18 for the PBL group. This means that on average,

students should expect to score 1.83 points higher on their post-test score after being subjected to an IBL strategy, compared to only 1.18 in the PBL group.

5. DISCUSSION,CONCLUSIONS, RECOMMENDATIONS, & LIMITATIONS

5.1. Discussion

There are numerous approaches that an educator can use to create or reinforce an environment in such a way that it would be conducive to learning. There are, in general, three approaches. There is the inquiry-based learning; there is also the project-based learning; and finally, there is the problem-based learning. In this study, the researcher only focused on the first two: Inquiry-based and Project-based Learning (IBL and PBL). For the sake of discussion, however, these three are worth discussing and differentiating, albeit just briefly. First on the list would be problem-based learning; it is a learning approach that suggests that the process of acquiring knowledge is akin to (i.e. shares a lot of similarities with) solving a problem. Problem-based learning, even though it is not really included in the present study's theoretical framework, is directly related to Inquiry-based learning, in that they both place emphasis on processes like questioning, critical thinking, and problem solving. To minimize redundancy, the researcher chose to exclude Problem-Based Learning, because Inquiry-Based Learning was going to be included anyway.

Inquiry-based learning is an active learning approach that centers on the student. An educator who is using an IBL strategy to teach students would most likely avoid presenting known facts or an already established and widely known solution to a problem, as if to spoon feed the students. Inquiry-based learning strategies almost always begin with asking questions, citing problems (that are yet to be solved), and presenting challenges that are designed to be thought-provoking. A teaching session that is based on the ideas of IBL would most likely start

with the teacher posing an interesting question to the students. The teacher's role would then shift from being a teacher to that of someone who facilitates the process of discovery answers; in that case, the educator helps the students learn by teaching them how to think so that they can later discover the answer themselves (using their own thought process), instead of encouraging them to simply memorize the answers to the posed question. It has been established in previously published studies that students inside a traditional classroom rarely, if ever, have a homogenous thought process. This means that using a single approach, say, memorization, to educate them, would most likely not work. The almost certain existence of a heterogeneous (rather than a homogenous) set of thought processes means that using a mono-modal approach would be automatically ineffective, especially from the perspective of the students whose thought process is incompatible with the learning approach being utilized. This, according to previously published studies, is one of the use case scenarios of Inquiry-Based Learning strategies. One of the fundamental goals of IBL strategies is to hone the students' thought processes so that they may be able to find their way to the process of solving a problem even in the absence of external stimuli (i.e. support, feedback). The students in a controlled environment (e.g. a classroom) where IBL strategies are being implemented would not have to rely on their instructors' to come up with an answer to a problem, inquiry, or to overcome a challenge. This means that their differences in terms of thought processes would not matter anymore because they can utilize whatever kind of thought process that they have while participating.

Project-based Learning (PBL) is another approach; strategies that are based on this approach often begin with a challenge or question, just like those that are based on IBL. However, one distinct characteristic of PBL strategies is that they tend to focus more on the process of exploring the answer, instead of simply discovering it. IBL is much more focus on the

process of simply solving the problem, which is to say that its goals and scope are narrower and more confined. Precise would also be an accurate term to use in describing the way how IBL strategies are supposed to help students develop unique and actually usable learning skills. PBL strategies' goals and scope are broader. IBL is akin to a bottom to top approach of learning because students participating in an IBL strategy-based environment would find themselves being placed in a chaotic scenario first, before being able to find the precise answer to the question that has been fielded (hence bottom to top). PBL, on the other hand, is akin to a top to bottom approach of learning. Students participating in a PBL strategy-based environment would most likely find themselves being bombarded with new sets of information and discoveries every time they get closer to the point of solving a problem. What can be inferred from this discussion so far is that there is a stark difference between the way how IBL and PBL strategies are supposed to educate students. This means that there are subjects and scenarios where IBL strategies can be appropriate and also ones where it can be inappropriate. The same is true for PBL strategies. In terms of subject compatibility, for example, IBL strategies are commonly used in science-related subjects, based on previously published studies (Banchi & Bell, 2008) (Corlu & Corlu, 2012). The compatibility of IBL strategies and science-related subjects is mainly due to the fact that most of the problems in this field can only be solved using a bottom to top approach. The primary research findings (Survey Questionnaire Part 2) of this study corroborated with the IBL strategy and science-related subject compatibility theory as well. In terms of compatibility, however, IBL strategies were found to be most compatible with English and SPED subjects, and least compatible with Math subjects. This may be due to the fact that English and SPED subjects tend to feature problems that are only decipherable using a bottom to top approach, just like those that tend to be featured in Science subjects. Math subjects, on the other hand, tend to

feature problems that are only decipherable using a top to bottom approach, in that there can be more than one way to arrive at an answer, which means that the teaching and learning process should focus less on discovery (which is what IBL is all about), and probably more on exploration (which means that PBL strategies may potentially be more applicable). It is important to note that these inferences and remarks are merely based on the primary research findings in relation to how the author of the present study made sense of the consensus in previously published studies. These inferences and remarks may still be debatable; there are, for example, studies that contradict these findings (e.g. studies suggesting that science, English, and SPED subjects share a higher level of affinity with PBL strategies than IBL ones).

The first part of the survey questionnaire also presented interesting findings regarding the use of IBL strategies in the classroom. The respondents said that they generally agree that IBL is important to encourage student-based learning; that it is worth using IBL learning in the classroom frequently; that they generally find themselves continuously looking for opportunities to build inquiry into the course curriculum, that they consider IBL as an important part of student learning. Interestingly, there was a questionnaire item that described both IBL and PBL in one sentence and the participants responded in a generally positive manner (as evidenced by their score), referring to P1Q5. This indicates that a combined approach that features not just one of the two student learning-based strategies that were covered in the present study may work equally, if not better, than just a unitary approach.

The weakest point of the IBL in terms of its effectiveness is the educators' lack of sufficient formal training in using IBL strategies to promote student-centered learning. This was examined in the first part of the survey questionnaire. This was also evident in the analysis of the descriptive statistics. It was found that the number of participants who were using IBL strategies

in the subjects that were covered (Math, English, Science, SPED, and Other Subjects) was significantly larger than those who said they received formal training to use IBL strategies in the classroom. Additionally, most of the participants only have an undergraduate degree (Bachelor's, either BS or BA). The global educational landscape is changing, and minimum qualifications for teaching even at the secondary level are becoming more stringent. In some countries, educators have to at least have a graduate degree (Master's degree or higher) before they can be allowed to handle students, let alone use still controversial student-centered learning approaches such as IBL and PBL. This is an important policymaking issue that regulatory bodies in the country should review, and ideally, amend, depending on the results of their assessment (Corlu & Corlu, 2012; Gardner, 1991; Weina, Liang, & Fang, 2008).

5.2. Conclusion

The main purpose of the study was to investigate the suitability of inquiry-based learning and project-based learning approaches in the science and language at the high school level and their effectiveness. In terms of suitability, only the IBL was sufficiently covered by the primary research findings, although the literature review section did a good job in covering the suitability of PBL (although just through qualitative means). It was found that IBL was most suitable in settings where Science, SPED, and English subjects are being thought; it was grossly incompatible with Math. Based on the literature review, it can be inferred that PBL may be more suited than IBL in Math subjects. In terms of effectiveness, the researcher created a table using the pre and post-test scores of the students in the IBL and PBL groups were compared against each other. Their scores were then compared in such a way that the researcher would be able to determine which among the two (IBL and PBL) has created a bigger impact on the students' scores (comparing pre and post). The approach that has the higher impact is the one that is more

effective. Based on this, it was found that IBL strategies can, in theory, have a much bigger positive impact on learning outcomes, at least based on the methodology that was employed using pre and post-test scores.

5.3. Limitations

5.3.1. Research Design is more Focused on Analyzing Inquiry Based Learning

The present study's research design was unique in that it used a mixed approach, featuring both quantitative and qualitative approaches. The qualitative focused was used mainly in the review of related literatures and the interpretation of the primary research findings. The quantitative approach was used mainly in the statistical analysis of the participants' responses to the survey questionnaire. While this is a novel way of implementing this type of research, the present study's research design is limited in that it clearly focused more on the analysis of IBL and less on PBL, when its goal in fact was to compare the two. It is important to note, however, that PBL was also included in the analysis, but majority of the items in the research instrument were about assessing IBL. The fact that the present study was also meant to cover PBL only became evident during the analysis of the pre and post test results (presented in the Summary of Findings section).

5.3.2. Low Level of External Validity

Based on the study's research design, the research instrument can be divided into three parts. The first two part would be represented by parts one and two of the Survey Questionnaire. The first part of the survey questionnaire utilized a sample population size of 59, while the

second part utilized 48. The third part would be represented by the pre and post testing (for IBL and PBL), where a total of 45 respondents were recruited (23 for IBL and 22 for PBL). This brings the total number of respondents used in the study to 152 (n = 152). For a study that used two unique research instruments (survey questionnaire and comparison of pre and post test scores), this is a small sample population size. One of the consequences of which is a low level of external validity.

5.4. Implications for Practice

Each educator has his or her own way of managing a classroom. The results and findings of this study can be used by educators as a tool that can guide them when and where to use and not to use IBL and PBL strategies. An educator who teaches Math to high school students, for example, would now know that using IBL strategies may not be suitable because IBL strategies and Math subjects are grossly incompatible, at least based on the primary research findings of this study.

5.5. Recommendations

There are two key recommendations for future areas of research (i.e. further research). First, a more unitary research design where there is only one research instrument instead of three should be used. The research aims and objectives should be well narrowed down from the beginning (first chapter). This should allow future researchers to focus more on answering their research questions more accurately and reliably (i.e. high external validity). Second, a bigger sample population size is needed. Ideally it should be at or higher than 200. This should make the results and findings of future studies in this area of research (i.e. IBL vs PBL) more reliable and conclusive. The research instrument should also be unified or further scaled down in order to

prevent any potential confusion about the actual goals and objectives of the study. Focusing on a specific demographic group (e.g. teacher versus students) would also be beneficial as this would allow the researcher to focus on one perspective (student or teacher's perspective), which was not possible in this case because both teachers and students were included in the data gathering and data analysis processes.

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Appendix I

Teacher Questionnaire:

This questionnaire investigates the teacher perceptions of the use of inquiry based, and project based, learning in the high school and how these approaches are used to impact student learning. The information is used for academic research, and confidentiality is protected. So, kindly answer all questions

Part A) Demographics

Age:

□ younger than 25 yrs. □25-35 yrs. □ 35-45yrs. □45+ yrs.

Gender:

M F

Years of Teaching:

□1-5 yrs. □6-10 yrs. □11-15 yrs. □More than 15 yrs.

Courses Taught:

□ Science □Math □English □ SPED □ Other

Grade level taught (check all that apply):

□ 9th □10th □ 11^{th} □ 12^{th}□ Other

Major:

□ Science □Math □English □ SPED □ Other

Degree Completed:

□ B.A. /B.S. □M.A. □ Ph.D. □ Other

Part B: Please rate your agreement with each statement according to the scale provided :

I think it is to encourage student based learning:

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I frequently use inquiry based learning in my classroom

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I actively look for opportunities to build inquiry into the course curriculum.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I consider inquiry based learning an important part of student learning:

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Students academically benefit from inquiry and project based learning:

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I received sufficient training in inquiry and project based learning, during my educational training?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Part C: Check the box indicating your preferred response (Note: there are no right or wrong answers).

On average, how many times per week do you use inquiry based learning in the classroom .

□1-2 lessons □3-4 lessons □5-6 lessons □every lesson □other

On average, how many times per month do you use inquiry based learning in the classroom .

□1-5 lessons □5-10 lessons □10-15 less □every lesson □other

The curriculum in which inquiry is most likely to be incorporated is:

□ extra-curricular □ after school program □ regular curricular
□ special activity in regular classroom □ others

In what courses is inquiry or project based learning most likely to be used

□ Science □Math □English □ SPED □ Other

Inquiry is a natural part of the curriculum in the following classes (if any):

□ Science □Math □English □ SPED □ Other

Inquiry based learning is, in my current school environment

□ considered essential to pedagogical best practices

□ considered necessary only in science courses

□ thought to enhance direct instruction

□ thought to take up too much time

□ used only on special occasions

Appendix II

Test

1. To a scientist, _____ is information collected during a scientific investigation.

2. _____ are standards that help engineers measure how well their design is doing its job.

3. _____ are organs that support and protect the body.

4. A/An _____ is a characteristic passed from parents to their offspring

5. A place where two or more bones meet is a _____

6. Some organisms completely change form as they grow. This process is called _____.

7. The process of rocks breaking apart is called _____.

8. At the center of Earth is a _____ made of metal.

9. A force of attraction between two objects is called _____

10. Reflection is the bouncing of light off an object. Refraction is the bending of light as it passes at an angle from one type of matter into another.