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A COMPARISON OF TEACHERS' BELIEFS OF THE USE OF INQUIRY
TEACHING, ORIGIN OF KNOWLEDGE OF INQUIRY TEACHING, AND
STUDENT ACHIEVEMENT BETWEEN INTERNATIONAL BACCALAUREATE
AND NON-INTERNATIONAL BACCALAUREATE PRIMARY YEARS
PROGRAMME SCHOOLS

by

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A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Education
in the School of Teaching, Learning, and Leadership
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at the University of Central Florida
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ABSTRACT

The goal of improving student achievement is of paramount interest to all public schools. The focus of this research was to determine the difference between inquiry based teaching strategies and student achievement. Additionally, the researcher investigated the origin of inquiry based teaching knowledge and International Baccalaureate Primary Years Programme (IBPYP) affiliation. IBPYP affiliation was studied due to the nature of the IBPYP as an inquiry based philosophy of teaching. The McGill Strategic Demands of Inquiry Questionnaire (MSDIQ) was used to determine teacher beliefs of inquiry based teaching strategies. Student achievement was measured using Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) levels.

Results from the MSDIQ indicated strong beliefs among participants of inquiry based teaching indicators within three domains: planning, enactment, and reflection. The researcher recommended further research into the origin of inquiry based teaching strategies knowledge to determine accurate professional development from districts that require inquiry based teaching strategies in evaluation systems. In addition, further research was recommended to determine the relationship between IBPYP affiliation and student achievement.

To my students who have inspired me throughout my journey
and my family who encourages me always

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“The most important attitude that can be formed is that of desire to go on learning.”

-John Dewey, *Experience and Education*

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TABLE OF CONTENTS

LIST OF TABLES	ix
CHAPTER 1 THE PROBLEM AND ITS CLARIFYING COMPONENTS.....	1
Introduction.....	1
Statement of the Problem.....	3
Purpose of the Study	4
Background of the Study	4
Theoretical Framework	8
Operational Definitions.....	9
Assumptions.....	10
Delimitations of Study	11
Limitations of Study	11
Research Questions.....	12
Methodology	13
Population and Sample	13
Data Collection Strategies.....	14
Data Analysis	15
Summary	18
CHAPTER 2 REVIEW OF THE LITERATURE	19
Introduction.....	19
Constructivism	21
Vygotsky 1896-1934.....	21
Dewey 1859-1952.....	23
Piaget 1896-1980	24
Constructivism Dissentation	26
Inquiry.....	28
Inquiry Teaching.....	33
Teacher Acquisition of Inquiry-based Teaching Strategies.....	36
Inquiry and Student Achievement	42
The International Baccalaureate	46
History.....	46
Philosophy and Practices	48
IB Current Research.....	51
Programme Impact.....	52
Programme Development	54
IB Literature and Inquiry Elements	55
Summary	55
CHAPTER 3 METHODOLOGY	58
Introduction.....	58

Problem and Purpose Statement	58
Research Questions	59
Selection of Participants	60
Instrumentation	61
Data Collection	63
Data Analysis	64
Summary	69
CHAPTER 4 ANALYSIS OF THE DATA	71
Introduction.....	71
Student Achievement Variables.....	74
McGill Strategic Demands of Inquiry Questionnaire Variables.....	75
Research Question 1	81
Research Question 2	83
Research Question 3	84
Research Question 4	86
CHAPTER 5 SUMMARY, DISCUSSION, AND RECOMMENDATIONS.....	92
Introduction.....	92
Summary of the Study	92
Discussion of the Findings.....	97
Research Question 1	97
Research Question 2	98
Research Question 3	100
Research Question 4	101
Implications for Practice	102
Recommendations for Further Research.....	103
Summary	105
APPENDIX A MCGILL STRATEGIC DEMANDS OF INQUIRY QUESTIONNAIRE (MSDIQ).....	107
APPENDIX B INSTITUTIONAL REVIEW BOARD APPROVAL.....	115
APPENDIX C RESEARCHER COMMUNICATIONS WITH SCHOOL DISTRICT REPRESENTATIVES	117
REFERENCES	122

LIST OF TABLES

Table 1	Research Questions and Statistical Tests used in Data Analyses	17
Table 2	Research Questions, Statistical Tests, and Equations Used in Data Analyses ...	69
Table 3	Demographic Descriptors for Participating Teachers (N = 19).....	73
Table 4	Mathematics and Reading Student Achievement Data: FCAT 2.0 Levels in 2012-2013	74
Table 5	McGill Strategic Demands of Inquiry Questionnaire: Planning.....	76
Table 6	McGill Strategic Demands of Inquiry Questionnaire: Enactment.....	78
Table 7	McGill Strategic Demands of Inquiry Questionnaire: Reflection	80
Table 8	Results from the Mann-Whitney Test U: Origin of Inquiry Teaching and Student Achievement in Mathematics and Reading	83
Table 9	Mann Whitney Test: Origin of Inquiry Teaching Strategies and Teacher Beliefs About Inquiry Teaching Strategies	85
Table 10	Kendall's Tau Results From Planning, Enactment, and Reflection Domains of Inquiry Teaching and Student Achievement Levels in Mathematics	88
Table 11	Kendall's Tau Results From Planning, Enactment, and Reflection Domains of Inquiry Teaching and Student Achievement Levels in Reading	89
Table 12	Summary Table of Research Questions and Results	90

CHAPTER 1 THE PROBLEM AND ITS CLARIFYING COMPONENTS

Introduction

Much research has been conducted as to which optimal teaching strategies might yield the highest student achievement results. Identifying similarities and differences, generating and testing hypotheses, questioning, cueing, and using advanced organizers, are some of the instructional strategies that yield a high effect size in student achievement (Marzano, 2003). According to Sigel and Sanders, questioning is crucial for students and allows them to “distance themselves in time and space from the present,” (Cecil, 1995, p. 3). The use of inquiry as a method of teaching mathematics and sciences has had significance in the research for a growing number of years (Donovan & Bransford. 2005; National Research Council (1996)). An inquiry stance, as it has been referred to by Short (2009), is not necessarily a series of teaching strategies but rather a fundamental system in the way humans can most successfully go about acquiring new knowledge.

The Race to the Top grant, proposed by the Obama administration, has challenged states to reform public education through four federal initiatives: improvement of the quality of teachers and leaders, establishment of data systems to track student achievement, the turning around of low performing schools and the adoption of more rigorous standards (U.S. Department of Education, 2010). The greatest weighted area within the grant application has been the focus on improving teachers and principals, specifically improving teacher and principal effectiveness as related to student achievement. A total of 42% of the points in section D, Great Teachers and Leaders, and

12% of the entire application for the grant, focused on improving teacher and principal effectiveness (U.S. Department of Education, 2010). Thus, efforts have been made for every state grantee to overhaul its teacher evaluation system, thereby facilitating the emphasis on improving the quality of the teacher and principal workforce.

In Florida, the passage of the Student Success Act in 2011 created new requirements for the evaluation of teachers and principals (Florida Department of Education, 2012). This included the addition of a value added model, creating the two most widely used evaluation systems based on the work of Robert J. Marzano (2003, 2011) and Charlotte Danielson (2013). These include higher order thinking questions and probing for deeper learning as successful teaching strategies that yield high student achievement (Florida Department of Education, 2012).

The International Baccalaureate (IB) Primary Years Programme (PYP) stated the following:

Inquiry, as the leading pedagogical approach of the PYP, is recognized as allowing students to be actively involved in their own learning and to take responsibility for that learning. Inquiry allows each student's understanding of the world to develop in a manner and at a rate that is unique to that student.

(International Baccalaureate Organization, 2009, p. 29)

There are currently 144 IB schools in the state of Florida, 30 of which have the PYP (Florida League of IB Schools, 2013).

Reform of public education, a political priority, as evidenced through legislation such as the Race to the Top grant and the Student Success Act, highlights the importance

of examining which teaching strategies improve student achievement. In an effort to determine the effectiveness and the origin of teacher training of teachers who use inquiry methods in their classroom, the study sought to determine the relationship between inquiry teaching, student achievement, and origin of professional development within the context of IB affiliation.

Statement of the Problem

To date there has been little research to determine the relationship between the origin of teachers' knowledge of inquiry teaching strategies and student achievement. Educational pioneers such as Dewey, Piaget, and Vygotsky provided the theoretical framework to substantiate such rationale (Dewey, 1964; Woolfolk, 1998). Manconi (2003) established a rationale for inquiry teaching within the classroom as an essential tool for growing student knowledge.

The results of research have been inconclusive in documenting a relationship between student achievement data from International Baccalaureate Primary Years Programme schools and schools without the IBPYP (Jordan, 2009; Sillisano, 2010, Tan & Bibby, 2012). Teaching through the use of the inquiry process has been one of the foundational beliefs of the IBPYP philosophy, subscribing to the theories of Piaget's constructivism and Vygotsky's zone of proximal development (Woolfolk, 1998). The International Baccalaureate Organization has offered specific professional development in the concept of inquiry through its global professional development department. The question existed as to how effective the professional development was for teachers in

implementing the IBPYP and in raising student achievement. Successful acquisition of pedagogical knowledge regarding inquiry teaching has been important to the non-IBPYP schools such as those in the state of Florida where the teacher evaluation systems contained observed inquiry components.

Purpose of the Study

One purpose of this study was to learn where teachers gain knowledge of inquiry teaching. A second purpose was to determine the difference in student achievement between teachers affiliated with the International Baccalaureate Primary Years Programme (IBPYP) and non-affiliated IBPYP teachers. Data from the study provided evidence as to the origin of teachers' knowledge of inquiry teaching and the relationship that existed with student achievement. In addition, IBPYP affiliation was evaluated.

Background of the Study

Education reform is a paramount political issue and one that has generated much legislation. The first two decades of the 21st century have been filled with a national shift towards greater accountability in the form of high stakes testing, teacher and leadership evaluation systems, and a standards movement. Federal initiatives such as Goals 2000, No Child Left Behind, and most recently, Race to the Top, have catapulted states toward many changes, all with the aim of improving student achievement for all students (H.R. 1804--103rd Congress, 1993; No Child Left Behind [NCLB], 2002; U.S. Department of Education, 2010).

With the overhaul of teacher evaluation systems in the state of Florida based upon Senate Bill 736, much work has been conducted by the local education agencies (LEAs) to determine the best means to evaluate teacher performance. Many LEAs selected prefabricated evaluation instruments from the work of Robert J. Marzano, Charlotte Danielson, and Educational Management Consultant Services (Florida Department of Education, 2014) Brevard County, along with 10 other school districts, created unique evaluation instruments. All evaluation instruments contained elements pertaining to the use of inquiry strategies, indicating connection of inquiry teaching strategies and student achievement.

Schools that wish to become International Baccalaureate Primary Years Programme (IBPYP) schools must have dedication to the IBPYP philosophy, curriculum framework, and teaching and learning methodologies which embrace an inquiry stance (International Baccalaureate Organization, 2009). The journey of becoming a PYP school not only requires a pedagogical shift but also has costly financial implications. A minimum annual fee of \$7,600 is required of all schools. The fee does not include mandated ongoing professional development or resources and curriculum materials necessary to implement the program. Evidence of the 73 Programme Practices and Standards yields an authorized IBPYP school delineation (International Baccalaureate, 2011).

Inquiry can be defined in many different ways. Short (2009) constructed a meaning of inquiry as the “collaborative process of connecting to and reaching beyond current understandings to explore tensions significant to learners” (p. 12). She reported

that inquiry is more than just posing and answering a series of questions at differing levels, but that inquiry is a stance; a belief in the way learners gain new knowledge through an inquiry cycle. This understanding is also the delineated position of the IBPYP as articulated in the *Making the PYP Happen* program document (International Baccalaureate Organization, 2009). The International Baccalaureate Organization has defined inquiry further, relying on Li's 2012 definition that "Inquiry-based learning is an important constructivist approach, allowing knowledge construction via asking questions. Inquiry-based learning needs to be well structured and scaffolded, and inquiry cycles can be effectively applied in various educational settings" (p. 2).

Marzano (2011) established a need for inquiry for successful student achievement in his teacher evaluation system using language such as "presenting unusual or intriguing information helping students to practice and deepen new knowledge" (p. 1). In 2003, Marzano had noted that inquiry methods were alluded to through vocabulary such as higher order thinking and questioning.

Danielson (2013) developed a teacher evaluation system called the Framework for Teaching which included 22 indicators in four domains. Within this system, the concept of inquiry was mentioned in two different domains and in three indicators. The third domain contained the word inquiry synonymous with the term lesson, as it pertained to the teacher's ability to engage students in a "science lesson" (p. 59). The term inquiry was used in the fourth domain, to indicate an expectation that teachers should engage in "professional inquiry" (p. 99). The other references to inquiry teaching by Danielson were indicated by stressing higher level thinking through questioning and discussion.

Additional definitions, such as that offered by the National Research Council in 1996 exist:

[Inquiry is] a multifaceted activity that involves observations; posing questions, examining books and other resources of information to see what is already known; planning investigations; reviewing what is already known in the light of experimental evidence; using tools to gather, analyze and interpret data; proposing answers, explanations, and predictions; and communicating the results. (p. 23).

Puntambekar, Stylianou, and Goldstein (2007) discussed inquiry as a very complex way of teaching that leads students through many tasks such as brainstorming, gathering ideas, and producing new knowledge. Yet another definition by Supovitz, Mayer and Kahle (2000), considered inquiry as “a student-centered pedagogy that uses purposeful, extended investigations set in the context of real-life problems as both a means for increasing students capacities and as a feedback loop for increasing teachers’ insights into student thought processes” (p. 577).

Additionally, Aulls, Shore, and Delcourt (2008) discussed the varying degrees of inquiry teaching versus good teaching, stating three primary factors: a varying number and degree of teacher roles during inquiry instruction, a varying number and degree of student roles during inquiry teaching, and the actual learning engagement itself. In their literature review of over 1,500 documents, researchers Aulls et al. found approximately 23 different definitions of inquiry within three domains: process, learning and instruction, which included terms such as inquiry, discovery, problem solving and research.

Theoretical Framework

Constructivism, from a behavioral scientist perspective, provided the foundation for this study. Constructivism is a pedagogical term stemming from a variety of researchers in learning theory such as Dewey, Vygotsky, and Piaget. Cunningham and Duffy (1996) argued that there were too many variations of the idea of constructivism, yet they distinguished two similarities among all. “Learning is an active process of constructing rather than acquiring knowledge, and instruction is a process of supporting that construction rather than communicating knowledge” (p. 2). Perkins (1999) discussed three different roles in constructivism: the social learner, the active learner, and the creative learner. The three different roles work together through different means to help the learner gain new knowledge. Manconi (2004), would agree that constructivism stresses knowledge acquisition as a product of one’s own cognitive experiences and acts.

Dewey, as cited in Sutinen (2008) stated that “thinking arises in a situation in which something happens that is an incomplete event, from the individual’s point of view. . . [the thinking] reveals the deepest essence of thinking connected with the process of inquiry” (p. 2). Dewey believed that thinking was a creative process mimicking the scientific process that called for “observation of the problem, as a consequence of an examination and observation of the characteristics of the problem to the formulation of hypotheses and then to their experimental testing” (Sutinen, 2008, p. 3).

Another contributor of constructivist thought was Piaget. Piaget posited that the act of organizing experiences in one’s environment was essential to the development of intellectual structures (Piaget, 1977). Yet, Davis and Samara (2002) stated that Piaget did

not use the term, constructivist. Rather, he eluded to the idea with the use of similar words such as construct and structure. Davis and Samara cautioned readers that Piaget's work was in language acquisition, not the larger cognitive ability. In contrast, Liu and Matthews (2005) suggested that Piaget's contribution to constructivist theory was rooted in cognitive or radical constructivism whereby learners are engaged in a learner-centered environment, allowing them to construct their own knowledge.

Vygotsky (1978) suggested that learners must experience disequilibrium in gaining new knowledge while retaining support from their teachers and peers. The term zone of proximal development or ZPD has been commonly referred to in describing Vygotsky's teaching construct of pushing learners just beyond their understanding, with support, so that learning can occur (Woolfolk, 1998). Liu and Matthews (2005) contended that Vygotsky's work pertained to the social or realist constructivism, whereby "learners are believed to be enculturated into their learning community and appropriate knowledge, based on their existent understanding, through their interaction with the immediate learning environment" (p. 388).

Operational Definitions

Florida Comprehensive Achievement Test 2.0 (FCAT): The Florida Comprehensive Achievement Test 2.0 is the state developed criterion referenced assessments in mathematics and reading for students in Grades 3-11. For the purpose of this study, achievement was indicated by levels of achievement on a five-point scale as indicated in mathematics and reading for Grades 3, 4, and 5.

Inquiry: Inquiry is the process of allowing students to be active participants in their learning environments through a myriad of teaching methodologies, not limited to higher order discourse, questioning, testing and hypothesizing and designing their own learning through questioning. Short (1996) defined inquiry as “immersing one’s self in a topic and having time to explore that topic in order to find questions that are significant to the learner and then systematically investigating those questions” (p. 100).

International Baccalaureate (IB): The International Baccalaureate Organization began in the late 1960s and early 1970s as a pre-university international curriculum. The IB now contains four different programs reaching students aged 3-19, promoting at its core an internationally-minded curriculum.

Primary Years Programme (PYP): The Primary Year Programme (PYP) was established in 1997 as the early years program in the growing IB continuum. Based on research, the program is both a curriculum and approach to teaching that is designed to “develop inquiring, knowledgeable and caring young people who help to create a better and more peaceful world through intercultural understanding and respect” (International Baccalaureate Organization, 2009, p. 2).

Student Achievement: Student achievement is measured by the state assessment in both mathematics and reading, Florida Comprehensive Achievement Test 2.0.

Assumptions

1. Participants were asked to self-report FCAT 2.0 scores from the 2012-2013 school year in order to maintain confidentiality of teacher data. Therefore, the

assumption was made that participants were truthful in self-reporting their data.

2. Though inquiry is a recognized pedagogical approach, it has many definitions and understandings. Therefore, in evaluating teachers' origin of inquiry teaching, the assumption was made that participants would have varying degrees of knowledge of the term, inquiry.

Delimitations of Study

The delimitations of the study were established to help the researcher understand the direct relationship among teacher origin of knowledge of (a) inquiry teaching strategies, (b) student achievement, and (c) IB affiliation. Participants were delimited to public school districts in the state of Florida that contained at least one IBPYP school. The school districts were Brevard Public Schools, The School District of Osceola County, and The School District of Palm Beach County. The total number of IBPYP schools was three. The participants from the non-IB schools were also from the same Florida school districts selected for the IBPYP schools. The total number of non-IB schools was five.

Limitations of Study

The study had the following limitations:

1. IBPYP participants were limited to the state of Florida, with only 30 schools authorized. Thus, the sample size was contingent upon participation consent of those IBPYP schools.
2. Due to the nature of self-reporting data from the 2012-2013 school year, not all respondents answered the student achievement items. Therefore, the data were limited in number.

Research Questions

In order to determine the outcome of the problem statement, the researcher developed the following research questions regarding inquiry teaching strategies:

1. What is the difference between third-, fourth-, and fifth-grade teachers' origin of inquiry teaching knowledge and student achievement as measured on the Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013?

 H_{01} : There is no difference between third-, fourth-, and fifth-grade teachers' origin of inquiry teaching knowledge and student achievement as measured on the FCAT 2.0 in mathematics and reading in 2012-2013.
2. What is the difference in student achievement of third-, fourth-, and fifth-grade International Baccalaureate Primary Years Programme (IBPYP) students and non-IBPYP third-, fourth-, and fifth-grade students as measured on the Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013?

H₀₂: There is no difference in student achievement as measured by FCAT 2.0 between IBPYP and non-IBPYP third-, fourth-, and fifth-grade students in mathematics and reading in 2012-2013.

3. What is the difference between teachers' beliefs about inquiry teaching and origin of inquiry teaching knowledge?

H₀₃: There is no difference between teachers' beliefs about inquiry teaching and origin of inquiry teaching knowledge.

4. What is the relationship of student achievement, as measured on the Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) in mathematics and reading of third-, fourth-, and fifth-grade students, and teachers' beliefs about inquiry teaching during the 2012-2013 school year?

H₀₄: There is no relationship between student achievement as measured on the FCAT 2.0 in mathematics and reading and teachers' beliefs about inquiry teaching.

Methodology

Population and Sample

The population of the study included teachers in Grades 3, 4, and 5 in the state of Florida. The population was delimited to public school districts in counties that included at least one IBPYP school that consented to the research. The participating school districts included two medium sized districts, Brevard Public Schools and The School

District of Osceola County, and one large district, The School District of Palm Beach County. At the time of the study, all three school districts had at least one IBPYP school. The participating IBPYP schools totaled three. Due to the small number of counties, the participating non-IB schools totaled five.

The sample was a convenience sampling of teachers in Grades 3, 4, and 5 and included a sampling of IBPYP and non-IBPYP schools from each participating county. In all, there were 13 teachers from the IBPYP schools and five teachers from the non-IB schools. Teachers ranged in number of years teaching from 0-17 and represented a variety of origins of inquiry teaching styles.

Data Collection Strategies

Student achievement data were the dependent variables as measured by the Florida Comprehensive Achievement Test 2.0 levels, which provided ordinal data. The independent variables of the origin of inquiry knowledge, affiliation with an IB school and number of years teaching were nominal data. Ordinal data were collected using a beliefs of inquiry survey, the McGill Strategic Demands of Inquiry Questionnaire (MSDIQ). The MSDIQ was a 79-item, criterion-referenced, learner-focused questionnaire that addressed three phases of inquiry engagement: planning, enactment, and reflection. A copy of the MSDIQ is included in Appendix A (Shore, Chichekian, Syer, Aulls, & Frederiksen, 2012).

Prior to initiating the study, the researcher sought and received approval to conduct the study from the Institutional Review Board of the University of Central

Florida (Appendix B). To initiate the study, the researcher contacted the three school districts selected to participate, due to the presence of at least one IBPYP school, in fall 2013. After receiving school district approval, IBPYP principals in the interested districts were contacted to participate in the study. Based upon the IBPYP school participation distribution, non-IBPYP schools were also contacted in the respective counties in fall 2013. Copies of communications with school districts and principals are contained in Appendix C.

Student test data were collected from the 2012-2013 school year along with data from the participant survey. These data were analyzed by IBPYP affiliation and subject area to determine a difference, if any, between student achievement, teacher inquiry beliefs, and the origin of teacher inquiry knowledge. The MSDIQ was administered using an online software program called Qualtrics to all third-, fourth-, and fifth-grade participating teachers during fall 2013 and spring 2014 terms.

Data Analysis

To respond to Research Question 1 as to the difference between third-, fourth-, and fifth-grade teachers' origin of inquiry teaching knowledge and student achievement as measured on the Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013, a Mann-Whitney *U* was employed. This test was used to determine the difference between two groups of teachers' origin of inquiry teaching knowledge and the five levels of student achievement as measured on the FCAT

2.0 in mathematics and reading. The independent variables of FCAT 2.0 achievement levels were changed to ordinal data to allow the Mann-Whitney *U* test to be applied.

The Mann-Whitney *U* test was also used to analyze data to respond to Research Question 2 as to the difference in student achievement of third-, fourth-, and fifth- grade International Baccalaureate Primary Years Programme (IBPYP) students and non-IBPYP third-, fourth-, and fifth-grade students as measured on the Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013. The Mann-Whitney *U* was used to determine the difference between teachers of the International Baccalaureate Primary Years Programme (IBPYP) and non-IBPYP in the student achievement levels on FCAT 2.0 in both mathematics and reading. The independent variables of FCAT 2.0 achievement levels were changed to ordinal data to allow the Mann-Whitney *U* test to be applied.

For Research Question 3 which focused on the difference between teacher beliefs of inquiry teaching and origin of inquiry teaching knowledge, the Mann-Whitney *U* was once again used to determine the difference between the origin of inquiry teaching knowledge and the teacher beliefs of inquiry teaching as measured on the McGill Strategic Demands of Inquiry Questionnaire (MSDIQ). The means of each of the 79-item questionnaire were averaged into three subcategories: planning, enactment, and reflection. The origin of inquiry teaching strategies was ranked into two groups for the Mann-Whitney *U* statistical test to be run.

To analyze the data to answer Research Question 4 as to the relationship of student achievement, as measured on the Florida Comprehensive Achievement Test 2.0

(FCAT 2.0) in mathematics and reading of third-, fourth-, and fifth-grade students, and teachers' beliefs about inquiry teaching during the 2012-2013 school year, the Kendall Tau was employed. The Kendall Tau was used to determine the relationship between the student achievement levels in mathematics and reading on the FCAT 2.0 and teachers' beliefs of inquiry teaching within the three sub-domains of planning, enactment, and reflection.

Table 1

Research Questions and Statistical Tests used in Data Analyses

Research Questions	Data Analysis
1. What is the difference between third-, fourth-, and fifth-grade teachers' origin of inquiry teaching knowledge and student achievement as measured on the Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) in math and reading in 2012-2013?	Mann-Whitney <i>U</i>
2. What is the difference in student achievement of third-, fourth-, and fifth-grade International Baccalaureate Primary Years Programme (IBPYP) students and non-IBPYP third-, fourth-, and fifth-grade students as measured on the Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013?	Mann-Whitney <i>U</i>
3. What is the difference between teacher beliefs of inquiry teaching and origin of inquiry teaching knowledge?	Mann-Whitney <i>U</i>
4. What is the relationship in student achievement as measured on the Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) in mathematics and reading of third-, fourth-, and fifth-grade students' and teachers' beliefs of inquiry teaching during the 2012-2013 school year?	Kendall's tau

Summary

Chapter 1 has presented an introduction to the study, a problem statement, the background of the study and the purpose of the study. In addition, the theoretical framework was discussed. The methodology, including research questions, null hypotheses, population and sample, data collection and data analysis was presented. Finally, operational definitions, limitations, and delimitations were discussed. A comprehensive literature review of constructivism, inquiry, and the International Baccalaureate is presented in Chapter 2. Chapter 3 details the methods and procedures used to conduct the study, and Chapter 4 contains the analysis of the data. Chapter 5 presents a summary and discussion of the findings, implications of the study, and recommendations for further research.

CHAPTER 2 REVIEW OF THE LITERATURE

Introduction

The quest for education is constantly articulated by defining the best and most appropriate way to educate future generations. Educational researchers have purported specific teaching methodologies throughout the course of history, debating student-centered approaches compared to teacher-centered approaches. Originated by Socrates, inquiry has been supported as a method of learning for centuries. Socrates' death was due to his advocacy for others to question and inquire in their teaching (Pyle, 1997). More recently, educational philosophers and researchers such as Dewey, Piaget, Vygotsky, and von Glasersfeld have expounded on the fundamental understanding of inquiry in the form of constructivism. It is constructivism that provided the theoretical framework for the present study (Cunningham & Duffy, 1996; Davis & Sumaras, 2002; Sutinen, 2008).

Many educational theorists have contributed to the growing body of knowledge of constructivism. Dewey (1964), a prominent early 20th century theorist, wrote profusely on the need for humans to construct their knowledge through experience with the environment in which they existed. His writings on reflective thinking were supported by scientific inquiry processes (Cunningham & Duffy, 1996).

Vygotsky also contributed to the theory of constructivism, especially as learning pertains to language and consciousness. He believed that consciousness was "the ability to perceive meaningfully" (Liu & Matthews, 2005, p. 394). The consciousness, as

defined by Vygotsky, was a process of generating meaningful ideas by connecting relationships between concepts and objects, conducted within a social experience which then turned into an internal experience (Liu & Matthews, 2005).

The idea of inquiry, then, is the result of the thinking of many different educational theorists and cognitive psychologists and has led to many publications. In fact, the use of inquiry as a method of teaching mathematics and science has had significance in the research literature for a growing number of years (Donovan & Bransford, 2005; National Research Council (1996).

Though commonly referred to in the literature in a variety of ways, inquiry has lacked a cohesive definition (Anderson, 2002; Audet, 2005; Banchi & Bell, 2008; Herron, 1971). Barell (2003) noted that inquiry in teaching and learning was capitalizing on student curiosity and creating knowledge. More specifically, according to Shore et al. (2009), “inquiry is learning by questioning and experimenting” (p. 141).

A direct result of constructivist theory, inquiry has been evinced by the International Baccalaureate Primary Years Programme (IBPYP) philosophy, and inquiry has been placed at the center of the pedagogical delivery method in IBPYP documents. Optimal learning occurs for learners as constructors of knowledge both within and with their environments (International Baccalaureate, 2009).

This review of literature begins with a discussion of constructivism, its history and interpretations. A more detailed look at three educational theorists’ positions on constructivism and inquiry follows along with a discussion of inquiry with implications for teaching and learning. The review is concluded with a brief history of the

International Baccalaureate Organization (IB), an explanation of the IB philosophy and practices, and a brief summary of the research directly related to the impact and development of the International Baccalaureate Primary Years Programme.

Constructivism

Liu and Matthews (2005) have written that the underpinnings of constructivism emerged in the cognitive psychology field in the 1970s. In response to behaviorism, constructivism allowed for a less narrow and isolated standpoint. Fundamentally, constructivists believe that learning occurs within a social construct and through individual interactions within that construct (Applefield, Huber, & Moallem, 2001; Liu & Matthews, 2005). Three types of constructivism have been identified: (a) exogenous constructivism, (b) endogenous constructivism, and (c) dialectical constructivism, based upon the theory of realism (Applefield et al., 2001). Liu and Matthews (2005), conversely, defined two types of constructivism: (a) cognitive, sometimes called personal or radical constructivism; and (b) social constructivism. In either case, there is a difference in the way in which learning occurs, either primarily through the individual or through the environment.

Vygotsky 1896-1934

Vygotsky is most known for his theory of human development in which the subject develops himself through experiences with the ever changing social and material environment (Lee & Smagorinsky, 2000). An understanding of both historical and

cultural contexts are fundamental to Vygotsky's theory in which the underpinnings of development are not only genetic but also exist within an interconnected time and space. Finally, according to Wells (2000), Vygotsky believed that society itself is shaped and maintained by the persons who interact at a specific point in time. Therefore,

the way in which an activity is played out on a particular occasion depends on the affordances of the situation, including the cultural tools available, on the way in which the participants construe it, and on the resource of knowledge and skills they can bring to solving the problems that they encounter. (Wells, 2000, p. 4)

This is not exclusive of the past experiences and cultural situations which the learner has experienced. The relationship of development within the individual is a constant dance among the cognitive processes and the societal environment and materials with which the learner engages.

The zone of proximal development is a construct in which the learner's knowledge growth is capitalized upon through interaction with the environment, either as human to human contact or through contact with artifacts (Wells, 2000). This expression of the new knowledge is through language symbols. Language is the way in which learners confirm, express, question, and probe knowledge.

The premise of Vygotsky's social constructivist theory in education lies within student selection of activities in which they manipulate situations, under minimal guidance, and problem observe and problem solve (Mayer, 2004). "[Social constructivism] calls for an approach to learning and teaching that is both exploratory and

collaborative,” (Wells, 2000, p. 8). Experiences should have a connection to the student and make meaning for them as a learner (Vygotsky, 1978).

According to social constructivist theory, Syer, Chichekian, Shore, and Aulls (2013) argued that pre-service teachers must engage in discourse about teaching and learning through inquiry so that they may learn from others as well as collaboratively engage in inquiry. In addition, meaning is a negotiation among the social members. Therefore, the process of constructing knowledge together strengthens the individual’s understanding of inquiry concepts.

Dewey 1859-1952

Dewey (1938), one of the most renowned Western educational theorists of the late 19th and 20th centuries, defined inquiry as reflective thought. He explained the process of inquiry as the contradiction of epistemological dualism whereby the learner engages with and within a problem or some uncertainty. The process is social in nature and ever changing (Schön, 1992). In articulation of the epistemological dualism of science and common sense, Dewey argued that the inquiry pattern or process existed in both; however, the practicality of each subject was the difference. Therefore, it is the process of inquiring scientifically in any discipline, the interaction between human and environment that creates knowledge.

Dewey described the purpose of education is to “develop above all else the will for co-operation and the spirit which sees in every other individual one who has an equal right to share in the cultural and material fruits of collective human invention, industry,

skill and knowledge,” (Dewey, 1964). The reality of children, therefore, is rooted in their experiences and is meaningful if the whole experience is considered, both educationally and non-educationally (Splitter, 2009). As a pragmatist, Dewey wrote about education as a way to construct reality built upon experiences. Students are to be actively engaged through sense making of the world in a manner that is developmentally appropriate to the learner. Dewey (1938) encapsulated the idea of inquiry as it related to the purpose of education as increasing knowledge very succinctly, “If inquiry begins in doubt, it terminates in the institution of conditions which remove need for doubt. The latter state of affairs may be designated by the words belief and knowledge” (p. 7).

Dewey (1964) expressed a need for the study of pedagogy for the sake of growing as a teacher. Thus, he advocated for ongoing professional development from an inquiry perspective. Furthermore, according to Schön (1992), the metacognitive process of inquiry in which the learner articulates the inquiry process, should be common practice in the educational field.

Piaget 1896-1980

Piaget (1977) purported the learner to be a continuous constructor of knowledge based upon a series of discrepancies whereby the learner seeks new truths to solve the discrepancies. The discrepancy that the learner faces is termed disequilibrium. The learner moves from understanding to puzzlement and uses the context and symbols in the environment to resolve the puzzle. Learning is more discovery-oriented through the environment which provides the stimulus for the disequilibrium (Liu & Matthews, 2005).

This theory is based upon Piaget's 60 years of research, whereby he studied, both qualitatively and quantitatively, logical thinking in children (DeLisi, 1979). Piaget concluded there was a dichotomy between inert intelligence and knowledge structures. Knowledge structures, according to Overton (2003), are developed through an interaction with the individual and objects, thereby creating a structure within the individual. Through the process of maturation, the individual gains the ability to learn and make sense of the structures in which they are engaged (Piaget, 1977b). DeLisi (1979) contended "[knowledge] resides in an organized environment and is copied or learned by children" (p. 15).

von Glasersfeld (2001) articulated Piaget's idea of person perceiving: objects exist with no relation to each other except in the case of the observer's perception. To illustrate, von Glasersfeld used an example whereby an observer of a cut up apple understands that the whole apple has been cut into multiple pieces; however, the apple pieces do not provide evidence of understanding that the others exist. The educational understandings as a result of this philosophy of thought are evident: if learners are to conceptualize new knowledge, the process must first stem from the learners themselves.

Educational implications for Piaget's theory of constructivism have been articulated by DeLisi (1979). He contended that teacher education is imperative to shifting the culture of education from the teacher as the owner of knowledge to the teacher as the cultivator of knowledge. "The source for [intelligent] development lies within all children, and our schools can make use of it by providing a climate of thinking instead of learning, which is often at too high or too low a level," (DeLisi, 1979, p. 28).

Piaget advocates for teachers to become researchers of their students so that pedagogy can meet the needs of students' cognitive development and so that the environment can be shaped by the teacher so that maximum growth can be achieved. According to DeLisi (1979), Piaget also supported classroom environments that supported active learning, specifically in science, yet he called for more research to be conducted in other disciplines.

Constructivism Dissention

Phillips (1995), in a dissention piece in the literature, referred to constructivism as a "powerful folktale" (p. 5). He commended constructivism as a means to engage the learner in a social setting as well as applaud the theory for spearheading an important discussion about how students learn. He wrote, however,

The tendency within many forms of constructivist epistemology towards relativism or towards teaming the justification of our knowledge as being entirely a matter of sociopolitical processes or consensus, is toward the jettisoning of any substantial rational justification or warrant at all (as is arguably the case with the radical constructivists) (p. 11).

Specifically, Phillips wrote in response to philosophical theorists such as von Glasersfeld, a self-described radical constructivist. In further response to Phillips, von Glasersfeld (1996) responded by stating his position that radical constructivism allows for experiences within one's world to influence the concepts, theories and actions. However, it is not these forces that guide the thinking. The individual is the constructor of

knowledge. von Glasersfeld (2001) also contended that constructivism in the social context he suggested exists as a theory of rational knowing rather than a metaphysics stance of knowing.

There exists a growing body of research that has put forth the notion that constructivism is not a sound way to instruct children. In this literature, it has been contended that with newer research on cognitive functioning, synonymous terms such as constructivist, problem-based, inquiry, and discovery learning are not supported by the literature (Kirschner, Sweller, & Clark, 2006). These researchers summarized inquiry-based learning as minimal guidance teaching which precludes long term memory growth due to the fact that the working memory is overloaded in this process. Kirschner et al. defined learning as the change in long term memory and sought to refute the very essence of inquiry-based teaching, citing 14 various studies in science teaching. The fallacy of this initiative is rooted in the limited definition of inquiry based teaching which has been described in many different ways.

Mayer (2004) also provided an extensive rationale against constructivism as a proper teaching method when equated with the idea of discovery learning. In many studies throughout the 1960s, 1970s, and 1980s, he reported that discovery learning, as the primary model of constructivist theory, was not a reliable single source for teaching and learning. Mayer argued that a constructivist classroom should include cognitive activities such as selecting, integrating knowledge and organizing, not just behavioral activities such as hands-on and discussion. The primary dissention, however, according

to Mayer, lay within the construct that constructivism equals discovery learning in an unguided and unsupported way by the teacher.

von Glasersfeld (2001) argued that discussion was a cognitive activity in which learners engage in a social constructivist experience. In this experience, students articulate thinking which can bring about inconsistencies and disconnects between concepts. In fact, students engaged in a hands-on activity, coupled with rich discourse guided by the teacher through neutral questioning, will increase conceptual knowledge (von Glasersfeld, 2001).

Inquiry

Inquiry, as a method of knowledge acquisition, was described in the literature as early as Socrates and Vico. However, its prominence increased after the writings of Dewey (1938) and the launch of Sputnik I in 1957 by the Soviets (Barrow, 2006). Since then, inquiry has been written about extensively. The definition of inquiry has many meanings in the literature (Bell et al., 2010; Short, 2009), and there have been a myriad of definitions of inquiry teaching strategies. In 1999, the National Science Foundation defined inquiry as an approach to learning whereby the learner engages in a process of exploring both the natural and material world through questioning, exploring, testing and observing.

Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and

conducting investigations, using appropriate tools and techniques to gather data, thinking crucially and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments. (National Research Council, 1996 p. 105).

The National Research Council [NRC] expanded their definition of inquiry. “A set of interrelated processes by which scientists and students pose questions about the natural world and investigate phenomena: in doing so, students acquire knowledge and develop a rich understanding of concepts, principles, models, and theories,” (NRC, 1996, p. 214). In 2012, the standards document was updated to include purposeful language that involves a range of cognitive, social, and physical practices to fully implement inquiry (Quinn, Schweingruber, & Keller, 2012). These clarifications of inquiry are mostly absent in other disciplines. In fact, Syer (2007) identified inquiry as instruction that was collaborative between teachers and students, whereby questions are posed, followed by planning, solutions, and communicating and reflecting on the learning. Such a definition encompasses more than just the discipline of science but broadens the idea of inquiry as a truly constructivist approach to learning.

Dewey (1964) described the process of inquiry as deriving from the . . . intellectual possibilities of this and that course of activity-statements on the basis of carefully directed and observed experience of the questions that have arisen in the connection with them and of the kind of information found useful in answering them, and of where that knowledge can be had. (p. 179)

Audet (2005) would agree, claiming inquiry is the “practice of extracting meaning from experience” (p. 6).

Banchi and Bell (2008) identified four types of inquiry: confirmation, structure, guided, and open. Confirmation inquiry entails a question and experiment with known results. Students engage in the experiment, recording observations and analyzing data. In structured or challenge (National Science Foundation, 1999) inquiry, students provided with the question and procedure then created the rationale of the results supported by their observations. In the third type of inquiry, guided, students generated the procedure and analyzed the results when only the question was provided by the teacher. Short (2009) described the process further in the belief that inquiry was both problem-posing and problem-solving. She also contended that guided inquiry was inquiry where the teacher was the problem-poser. Finally, in open inquiry, students created the question, designed the procedure and, finally, observed and analyzed results (National Science Foundation, 1999). According to Banchi and Bell (2008), students must experience inquiry in the lower level to higher level order for success. Short described this process as individual inquiry, whereby students pose a problem and derive their own procedures to arrive at new conceptual understandings.

Through their own inquiry in teaching, Short and Burke (1996) provided a rationale for inquiry as curriculum with three interacting factors: personal and social knowing, knowledge systems, and sign systems. The authors contended that all inquiry must stem from the learners’ knowledge and experience. It is subsequently guided through knowledge systems such as science and social studies and crystallized using sign

systems. Through the different human-made schemes of knowledge, systems such as biology or anthropology, learners are able to construct their own knowledge from a variety of perspectives and to comprehend through various sign systems, e.g., language and mathematics.

Short (2009) described inquiry as not a series of practices, but a stance, a series of beliefs about how teachers engage students in learning. She argued there were five underlying beliefs that guide inquiry as a stance. First, inquiry is a natural process in learning. Children are natural inquirers, constantly observing, experimenting, and developing new concepts to be developed further. Second, inquiry is rooted in making connections. In order for learners to begin to construct new learning, they must build on prior connections and continue to make connections throughout the inquiry cycle. These connections should be meaningful and relevant toward students' lives. The third belief was that inquiry is conceptual in nature. Especially significant to 21st century learning, the conceptual age demands learners use creativity and analysis of a constant stream of information to problem-pose and problem-solve. Learning should occur first through a conceptual lens to then lead the learner to various understandings about different topics. Fourth is the belief that inquiry is both problem-posing and problem-solving. Aligned with Freire's (2000) belief that the learner who posed the question is in control of the learning, this belief contends that the learner is at the heart of constructing the question to be investigated. Three types of inquiry are defined within this context; guided inquiry, personal inquiry and collaborative inquiry. Guided inquiry allows for the teacher to be the problem-poser. Personal inquiry puts the learner in control of both the problem-

posing and problem-solving process. Finally in collaborative inquiry, both students and teachers generate the question to guide the learning process.

Inquiry in the classroom, as defined by Short (2009), always begins with the connection to the learner's experience. It is followed by a series of practices joined with arrows in either direction: invitation, tension, investigation, demonstration, re-vision, representation, valuation, action. Bell, Urhahne, Schanze, and Ploetzner (2010) delineated nine different processes in the inquiry process, whereby the collaborative piece in the inquiry process was traditionally found at the end of an inquiry. These processes included orientation and questioning, hypothesis generation, planning, investigation, analysis and interpretation, model, conclusion and evaluation, communication, and prediction. The researchers presented 10 different studies which highlighted similar frameworks for inquiry. However, they presented different terms for each of the nine processes.

In addition, Quintana (2004) defined inquiry as a threefold process: sense making, process management, and articulation and reflection. White and Frederiksen (1998) authored an inquiry cycle consisting of elements consistent with the scientific method: question, predict, experiment, model and apply. There were many similarities to problem based learning or project based learning, whereby the learner engages in the investigation of a question, to collaboratively produce a product in the end (Bell et al., 2010).

According to Cochran-Smith and Lytle (1999), there are three different conceptual frameworks: (a) practical inquiry, (b) inquiry as a stance where inquiry permeates, and (c) social inquiry where knowledge is constructed by all within the

community. Though these conceptual frameworks are specifically geared toward teacher research, they provide an interesting parallel to inquiry-based teaching strategies within the classroom. Practical inquiry is the method in which students acquire that discipline which is inquiry based, such as science (Kirschner et al., 2006). Inquiry as a stance, modeled after Short (1999), has been described more as a philosophy of teaching and learning that is organic and from within. Social inquiry is similar to Vygotsky's theory of constructivism (Liu & Matthews, 2005).

Inquiry Teaching

The National Research Council (1996) advocated five features of inquiry teaching in science: creating scientific questions, the collection of evidence and observations, explanation of observations in connection to the questions, evaluation of the explanations, and justification through communications of the explanations. This process was likened to the typical scientific process. Through the process, students were able to learn about the subject matter, develop abilities within the discipline and cognitive abilities about the discipline as well as understand the process of inquiry itself.

Inquiry teaching, according to Audet (2005), includes “an overarching set of principles, process skills and a comprehensive information base that is relevant for thinking about effective classroom practice in all fields of study” (p. 6). Schulz and Mandzuk (2005) made the case for inquiry teaching within teacher preparation programs as well. Teacher education was a way “of preparing teachers who think systematically about their own practices, seek the advice of others, draw on research to deepen their

knowledge, and then adapt their teaching in ways that must effectively support student learning” (Schulz & Mandzuk, 2005, p. 316). Inquiry-based strategies towards teaching pre-service teachers assist in creating the cycle of inquiry for teachers themselves.

According to Splitter, (2009) authentic learning occurred when students internalized skills and behaviors specific toward inquiry-based learning which led to higher level thinking skills such as examining, testing and reflecting. He described such learners as engaged learners rather than passive learners of expert knowledge. In agreement, von Glasersfeld (2005) articulated learning as, “conscious reflection is the secret of understanding,” (p. 172). McTighe, Seif and Wiggins (2004) agreed, positing that authentic learning occurs when the learner engages in processes and content like that of practitioners in different disciplines. In addition, students will more likely make meaning of their learning if learning occurs built upon prior knowledge as well as if conceptualized through questioning.

Li (2012), however, cautioned teachers that there needs to exist enough content knowledge so that the inquiry can be effective. In addition, the importance of meeting the learners where they are in their development is essential for cognitive growth. Students should have a varying amount of control dependent upon their age.

The role of the teacher in inquiry learning has been described as a facilitator of learning, one who crafts conceptual frameworks about which students will inquire. In addition, the teacher creates educational spaces in which students can collaborate and discuss new questions and new learning. Inquiry-based teaching also utilizes high motivating strategies, engages student interests, exists in an active learning environment

with a multitude of resources, and provides many opportunities for social interaction, (Audet, 2005). Through inquiry, learners engage in the following process skills: observing, questioning, hypothesizing, predicting, investigation, interpreting, and communicating. The International Baccalaureate Primary Years Programme (IBPYP) calls these skills the thinking skills of a larger set of transdisciplinary skills: self-management skills, thinking skills, communication skills, research skills, and social skills (International Baccalaureate Organization, 2009).

Marshall et al. (2007) identified four contributing factors related to inquiry instruction: grade level, support for inquiry instruction, self-efficacy for inquiry instruction and subject matter knowledge. The findings described some of the perceptions of teachers engaged in inquiry as increased for elementary teachers compared to those of middle and high school teachers. In addition, a greater comparison between the time taught through inquiry and the ideal time spent using inquiry methods was evident for science teachers as compared to mathematics teachers. The researchers also found the need for collegial support from administration and peers as a greater factor in inquiry teaching for elementary teachers as compared to high school and middle school teachers. The curriculum to be used was also a contributing factor. The more inquiry-based the written curriculum was, the more likely the teachers were to use inquiry-based methods of teaching. Teachers who had higher self-efficacy scores devoted more time to inquiry teaching methodologies.

Thus, Audet (2005) articulated five elements that were essential to any inquiry classroom, “Activities that are congruent with the developmental readiness of students,

frequent opportunities to ask and answer questions, a gradual but steady movement toward student control over the learning environment, and a growing record of successful accomplishments” (p. 14). In addition, through problem-posing and problem solving, students develop cognitive flexibility which can allow them to apply concepts to a variety of situations and disciplines.

According to Piaget’s theory articulated by von Glasersfeld (2001), one of the most successful ways of teaching through inquiry is to provide stimulus and situations that behave differently than the learner would typically think. Furthermore, inquiry in what von Glasersfeld called didactic constructivism was viewed as essential for fostering student growth through conceptualization of new knowledge. He also stated the importance of pre-assessing student knowledge so that the teacher can facilitate ongoing conceptualization of subject matter through supportive discourse. Motivation can be lowered when a student responds with incorrect answers. von Glasersfeld suggested that learning about student knowledge, experience, and interest prior to engaging in learning, can assist a successful learning process.

Teacher Acquisition of Inquiry-based Teaching Strategies

Researchers have not agreed on how best to teach through inquiry (Anderson, 2002). In addition, more research is needed on teacher’s attitudes toward inquiry-based teaching, as a teacher’s beliefs and values are integral to the teaching and learning process. The demands on new teachers from technical, political, and cultural

perspectives play a significant role in the enactment of inquiry teaching strategies (Anderson, 2002).

Colburn (2006) made a case for educators to further develop ongoing professional development into the ideas of inquiry-based pedagogy. Syer et al. (2012) agreed. They found teacher explicit instruction in teacher preparation programs essential to the teacher engaging in teaching and learning through inquiry. Schulz and Mandzuk (2004) identified the shift in education as one where the teacher is the “knower, thinker, leader and change agent” (p. 315). The shift indicated a need for teacher preparation courses and professional development that provides support in inquiry-based teaching strategies. Studies have been conducted to investigate the impact of teacher pedagogical knowledge and inquiry based teaching strategies. Several of these studies are described in the following paragraphs.

Results from a study by Alake-Tuenter, Biemans, Tobi, & Mulder (2013) indicated that subject matter knowledge and pedagogical content knowledge were essential for pre-service teachers in order to use inquiry methods in the teaching of science curriculum. However, the findings also indicated ongoing professional development of both subject matter knowledge and pedagogical content knowledge was necessary. In addition, it was also reported that subject matter knowledge was difficult to extrapolate due to the nature of primary teaching and the fact that primary teachers have been recognized as generalists. Finally, there were no differences in the attitudes essential toward inquiry teaching between novices or more experienced teachers. All

teachers required confidence in both subject matter knowledge and pedagogical content knowledge in order to successfully carry out inquiry-based instruction.

Kim and Tan (2011) agreed that content knowledge was imperative for implementation of inquiry science teaching in their study of 38 Korean education students. Furthermore, they stated teachers need to understand the interconnectedness of teaching and learning between students, curriculum, and classroom through a pedagogical context in order to be have self-efficacy and practical inquiry-based teaching strategies. A barrier to inquiry-based instruction in the classroom was a perceived lack of content knowledge. An additional barrier was the ease in adhering to a prescribed curriculum. Especially for new teachers, balancing all that is teaching, management, safety, testing and so forth, created opportunities for new teachers to succumb to what the authors called “cookbook” (p. 483) teaching. Therefore, as a result of Kim and Tan’s (2011) research, one suggestion, repeated throughout the literature, was ongoing support and guidance.

Syer et al. (2012) researched teacher perception of inquiry teaching strategies among pre-service teachers in the first and fourth year of their university elementary programs. They also studied the conceptualization of inquiry teaching strategies in physiology students in the fourth year of their programs. Use of the Strategic Demands of Inquiry Questionnaire (X-SDIQ), the same instrument used in this research, resulted in a difference in the importance of the elements of planning, enactment and reflection between pre-service teachers in year one and year four. Students in year four placed greater importance on inquiry processes than students in year one. The researchers concluded that explicit teaching of inquiry-based teaching strategies probably impacted

the student responses. Interestingly, the year four psychology students did not generalize high importance of inquiry-based teaching strategies as compared to the year four elementary teaching students. Although psychology students understood the inquiry process from the perspective of a practice, they were not able to transfer that understanding toward the importance of inquiry teaching strategies as demonstrated on the instrument.

Additional barriers to the use of inquiry teaching strategies have been identified in the literature, e.g., the standards movement of the 21st century. With more accountability placed on high stakes testing, pre-service and practicing teachers have been more inclined to teach to the test rather than through inquiry-based strategies (McTighe, Seif, & Wiggins, 2004a). Textbooks have supported this thought in creating teachers' manuals that direct specific teaching towards standards based activities that dispense knowledge rather than engage the learner in the process.

Schultz and Mandzuk (2005) investigated pre-service teachers over a three-year period as to their understanding and experiences with inquiry. Results demonstrated a need for continuous community support from administration and colleagues in order to effectively implement inquiry based strategies in the classroom setting. In addition, the researchers echoed Dewey's philosophy of life-long learning ". . . if we believe in the importance of inquiry and a commitment to life-long learning, we have a responsibility to inquire into our own pedagogy of inquiry" (Schultz & Mandzuk, 2005, p. 327).

A total of 23 competencies have been identified and categorized into groups called subject matter knowledge elements, pedagogical content knowledge elements, and

attitude elements, in order to ascertain the importance of inquiry-based teaching in science and the National Science Teaching Standards (Alake-Tuenter et al., 2013). Specifically, the research sought to determine the connections primary teachers had to the competencies in the Netherlands. Subject matter knowledge elements included indicators such as an understanding of related facts and concepts and the relation of facts and concepts to other disciplines. Pedagogical content knowledge included elements such as design, scaffolding, and evaluation in relation to connection of science to the real world. Finally, attitude included elements of importance, pleasure, and self-efficacy.

According to Supovitz et al. (2000) who studied the longitudinal effects of systematic professional development in inquiry-based teaching strategies for Ohio teachers in both mathematics and science, statistically significant growth was shown in three areas: teachers' attitudes toward inquiry, teacher preparation to use inquiry-based strategies and the use in the classroom of inquiry-based teaching strategies. Also of interest was the impact of school climate on teachers' use of inquiry strategies and preparation of inquiry teaching strategies, but not toward their attitudes. This finding aligned with Short's (2009) inquiry as a stance on curriculum, whereby teaching through inquiry was viewed as a belief rather than a scripted program in teaching.

There was no statistically significant difference in the number of years taught and time devoted to inquiry teaching strategies according to Marshall, Horton, Igo, and Switzer (2009) and Nadelson et al. (2013). Likewise, there was no significant difference between maximum degree and time devoted to inquiry teaching strategies (Marshall et al., 2009). It was suggested that graduate programs are either not instructing in inquiry

teaching strategies or that the programs are ineffective in their implementation of inquiry-based teaching strategies. In addition, the teachers who had a career in a science, technology, engineering or mathematics (STEM) prior to teaching (N = 123) had a smaller amount of time of teaching with inquiry strategies than those not having a career in STEM prior to teaching. The researchers encouraged further longitudinal research to determine the impact of continued professional development of in-service teachers and inquiry teaching strategies. It was also suggested that further research into professional development with pedagogical instruction be conducted.

Nadelson et al. (2013) stated “Teachers cannot be expected to develop knowledge and confidence with inquiry instruction without support, feedback, and adequate time for reflection” (p. 159). They conducted a study using purposeful, inquiry-based, professional development in the STEM fields with two cohorts of teachers. Their findings concluded that professional development that increases teacher content knowledge and is ongoing would increase the likelihood that STEM concepts and inquiry methodologies were used.

According to Manconi (2003), the work of Aulls and Shore created four conceptual descriptions based on the various definitions of inquiry in the literature: inquiry as process, inquiry as context, inquiry as content and inquiry as strategy. All four domains delineated specific teacher and student behaviors that indicate inquiry instruction. Such behaviors included shared decision making, modeling skills, an understanding of key concepts, development and testing of hypotheses and reflection. Based upon this research, the researchers created the McGill Strategic Demands of

Inquiry Questionnaire (MSDIQ). The instrument measures self-regulated learning in regard to inquiry-based teaching through three subsets: planning, enactment, and reflection. A question raised by Supovitz et al. (2000) in their research, was in regard to the direct relationship of inquiry teaching with student achievement.

Inquiry and Student Achievement

As part of an inquiry for previous studies relating inquiry teaching and student achievement, a study conducted in Florida determined there was no correlation between middle school teachers who used constructivist strategies and those who did not and school grade, an indicator of student achievement. A possible reason suggested might be a lack of training in constructivist teaching strategies. The research asked participants to delineate a difference between constructivist assessment practices and constructivist teaching. Although no correlation was determined, there was a relationship between more constructivist teaching strategies and less behavior referrals (Henry, 2003).

The majority of student outcome measures based on inquiry based teaching have been rooted in the science discipline. Though Anderson (2005) determined that inquiry teaching had produced positive results, how to teach through inquiry remained inconclusive. In Puntambedar et al.'s 2006 study of a sixth-grade science, inquiry-based classroom, students outperformed a classroom in which elements of inquiry were evident but were missing key components. The students in the inquiry-based classroom performed statistically significantly better in open-ended and conceptual tasks. However, there was no statistically significant difference in the multiple choice portion of the test.

The researchers stated the difference lay in the execution of the discussions that facilitated the learning within the classroom.

[the teacher] focused more on enabling students to ground the current topic in what they already knew about simple machines, whereas in the later discussions she asked questions that encouraged students to reason about the science that they were learning, and she helped to make connections between abstract science principles and their concrete hands-on experiences and connections between concepts,” (Puntambedar et al., 2006, p. 117).

Dewey (1964) viewed activating prior knowledge as essential to an inquiry classroom. This perspective is important during a time of multiple-choice statewide assessments. Student learning based on these measures may be the same; however, the conceptual understanding can be deeper in a classroom where students are engaged in concept connection, building on prior knowledge, and question generating rather than a simple hands-on curriculum.

Gee and Wong (2012) also found statistically significant differences in students who engaged in inquiry practices and student achievement on the Program for International Student Assessment (PISA) in 2006 in eight countries: United States, Mexico, Japan, Finland, Australia, Canada, Spain and Italy. Based on the four indices from PISA that indicated inquiry-based teaching and learning, the researchers captured student perceptions of the indices in their instruction. The four indices were application, hands-on learning, interaction in science teaching, and student investigations in science teaching and learning. Students who reported high levels of application of science

concepts had increased scores in science. The hands-on learning had a positive impact on student achievement except in Mexico and Italy, and there was no difference in Australia and Spain. Interestingly, students who engaged in more investigations independently tended to have lower achievement in the science. Gee and Wong's findings supported the work of Kirschner et al. (2006) who suggested that unstructured investigations did not improve student achievement. However, Gee and Wong (2012) also suggested that scaffolding and guided inquiry did have a place in inquiry instruction in science classrooms.

Kitot, Ahmad, and Seman (2010) conducted a quasi-experimental study to determine the effectiveness of inquiry teaching on critical thinking abilities of two groups of students. The Form 4 students in a secondary school were placed in a control and experimental groups in their science class. Kitot et al. found a positive significant difference in students' critical thinking abilities for those who received eight weeks of inquiry-based teaching as compared to those students who did not. Inquiry teaching was defined as confirmation inquiry, structured inquiry, guided inquiry, and open inquiry. In confirmation inquiry, students engaged in dedicated procedures to confirm known truths. Structured inquiry required teachers to pose a question and lead students through procedures to come to new student understandings. Guided inquiry allowed for students to design procedures to answer questions posed by the instructor. The fourth type of inquiry teaching was open inquiry in which students were involved in designing and carrying out inquiry experiments.

Bredderman conducted a meta-analysis in 1983 of three specific packaged science programs that were activity-based and which contained many elements of inquiry. All programs provided teachers with hands-on activities. The degree to which the inquiry process was structured varied in all three programs. The researcher concluded positive results between activity-based instruction and student achievement in performance based assessments. There was a greater effect size between scientific process and student achievement than the science content and student achievement. In a later project, Zachos, Hick, Doane, and Sargent (2000), researchers of a New York high school, concluded that increased student scientific conceptual understanding was directly correlated to students' scores of scientific inquiry capabilities which consisted of measuring inquiry skills, dispositions and the implementation of the scientific process.

In a meta-analysis, Shymansky, Hedges, and Woodworth (1990) concluded that although some studies showed a direct correlation to higher student achievement in inquiry science classrooms, the data were not conclusive due to the numerous definitions of inquiry. Likewise, Von Secker (2002) found there was a correlation between higher student achievement in science and inquiry-based practices within the secondary science classroom. However, he also found that the disparity among some groups of children and others could be either exacerbated or reduced due to the nature of social context differences among groups of children in the same class. Findings were based upon five items of inquiry-based instruction from the National Education Longitudinal Study sponsored by the National Center for Education Statistics: (a) eliciting student interest

and engagement, (b) using appropriate laboratory techniques, (c) problem solving, (d) conducting further studies, and (e) writing in science.

In order to further the advancement of research on student outcomes, Saunders-Stewart, Gyles, and Shore (2012) developed the McGill Inventory of Student Inquiry Outcomes (MSDIQ) based on an extensive literature review. Based upon four areas in which inquiry can occur in classrooms, the categories of process, content, context, and strategy were developed as grouping variables (Manconi, Aulls, & Shore, 2008). Saunders-Stewart et al. derived a 23-item criterion-referenced student inventory, whereby student outcome could be measured based upon engagement in inquiry. Student achievement specifically could be measured in the content category. The literature supporting this indicator was directly related to science instruction and yielded positive student achievement results. von Secker (2002) recommended multimodal methods of inquiry with learning styles and student interests likely to contribute to advanced student achievement. More support in other academic areas is needed to support the relationship between student achievement and inquiry instruction.

The International Baccalaureate

History

The International Baccalaureate (IB) was formed in the late 1960s and early 1970s as an educational foundation in Geneva, Switzerland. The program began with the Diploma Programme, a rigorous college preparatory curriculum, aimed at the

international school community. From 1970 to the present, the programme has grown from 11 Diploma Programme schools to over 3,500 schools globally, offering programs to students aged 4-19. Serving high school students for the first 24 years, the IB developed a programme for middle years students, aged 11-16, in 1994 and launched the Primary Years Programme for students, aged 4-11, in 1997. Most recently, the IB created an International Baccalaureate Career-related Certificate Programme for students aged 16-19. This program provides opportunities for students to receive specialized training as well as a tailored academic program which prepares students for the workforce and university (International Baccalaureate, 2012b).

The Primary Years Programme (PYP) was formed initially by a group called the International Schools Curriculum Project (ISCP) which was comprised of a group of principals from international schools in Europe in 1990. Simultaneously, the IB was beginning to move in the direction of supporting national systems that would be an international curriculum. This involved extending the IB philosophy earlier in the educational sequence. In addition, collaboration from the European Council of International Schools (ECIS) helped to launch the curriculum documents paramount to the implementation of the PYP. After a series of meetings, conferences and discussions, the ISCP was absorbed by the IB. The first PYP school to be authorized was a public school in the state of Colorado in 1998 (International Baccalaureate, 2012a).

The development of the curriculum of PYP began with the development of a social studies curriculum that would be applicable to an international community that, at its core, contained inquiry as a dominant pedagogical approach. The elements that

surrounded the pedagogical approach included: concepts, skills, attitudes, action, and content or knowledge. Committee groups proceeded to unfold the curriculum as it pertained to different content areas. It was noted that a concern of the mathematics committee was how to give students the tools for inquiry. However, this was resolved according to Alquist, a contributor in the mathematical committee.

The whole point of primary school is firstly to make kids literate and numerate, because that's how you inquire. . . the proviso being that we teach them through inquiry and by using the sound pedagogical principles of constructivism. (International Baccalaureate, 2012a)

It was then that the transdisciplinary themes (who we are, where we are in time and place, how we express ourselves, how the world works, how we organize ourselves and sharing the planet) came to be. Amended from Bartlett (1996) and from Boyer (1995), the themes represented an interconnectedness between the disciplines and the systems of the world (International Baccalaureate, 2012a).

Philosophy and Practices

Rooted in a deep belief in an intercultural respect, the IB programmes have aimed to develop students who are internationally-minded through a conceptual and rigorous curriculum in which learners construct knowledge through inquiry. More specifically, and as stated in International Baccalaureate (2009),

The International Baccalaureate aims to develop inquiring,
knowledgeable and caring young people who help to create a better

and more peaceful world through intercultural understanding and respect. To this end the organization works with schools, governments and international organizations to develop challenging programmes of international education and rigorous assessment. These programmes encourage students across the world to become active, compassionate and lifelong learners who understand that other people, with their differences, can also be right (p. 2).

The philosophy is supported with a Learner Profile, a set of attributes that encapsulates what the IB strives for in all students and adults pursuing the IB mission. These attributes include: inquirer, thinker, communicator, and risk-taker. Through the IB, individuals will be knowledgeable, principled, open-minded, caring, balanced, and reflective. The IB is concentrated in four areas: development of curriculum, assessment of students, training and professional development of teachers, and the authorization and evaluation of schools (International Baccalaureate, 2013a).

A set of guiding standards and practices provides parameters for schools seeking IB authorization and maintaining IB status. The authorization and ongoing evaluation process uses a set of 76 program standards to ensure the ongoing fidelity of the programmes. The standards are both conceptual and evidence-based in nature (International Baccalaureate Organization, 2010a). The following big ideas are covered in the Programme standards: philosophy, leadership and structure, resources and support, collaborative planning, written curriculum, teaching and learning, and assessment (International Baccalaureate Organization, 2010b).

In order to facilitate the programme standards and practices, ongoing professional development is required by schools who participate in the IBPYP (International Baccalaureate Organization, 2010b). Professional development has been cultivated by the International Baccalaureate Organization to meet three goals: (a) to provide an introduction to the philosophy and practices of the IB programme of interest (Primary Years Programme, Middle Years Programme or Diploma Programme); (b) to promote best practices and improved pedagogical practices such as assessment and inquiry; and (c) to provide in-depth study for practicing professionals into specific areas of study such as pedagogical leadership or learning theory. Alake-Tuenter et al. (2013) suggested the importance of professional development that investigates how knowledge, skills, and attitudes are connected to each other through an integrated model of competence development. Schultz and Mandzuk (2005) echoed the need for an inquiry-based teacher preparation programs to further support inquiry-minded teachers who embody an inquiry stance within their classrooms.

One of the main charges in implementing an International Baccalaureate Primary Years Programme is to create a transdisciplinary curriculum that is concept-based taught through inquiry. Audet (2005) supported this type of teaching, especially in an elementary setting, due to the myriad of disciplines and standards that are required. Teaching through elements of inquiry allows for a multitude of concepts across many disciplines to be more effectively understood by learners.

The curriculum model has undergone changes throughout the programme's existence. Most recently (International Baccalaureate, 2012c) the model shifted from a

hexagon to a circular model which better articulates the commonalities among all four IB programmes (PYP, MYP, DP, and IBCC). At the center of the concentric circles lies the learner. It is with the learner that the programme begins and exists. The attitudes, concepts, and approaches to learning are in the next circle, followed by the action and the culminating experience of the Primary Years Programme, the exhibition. The discipline areas (science, social studies, mathematics, language, arts, and physical, personal, and social interaction) are next. The following ring encapsulates the disciplines with the transdisciplinary themes. Finally, the concept of international-mindedness is the outermost circle, which embodies the Learner Profile and encourages IB learners and practitioners to become inquirers and knowledgeable thinkers, communicators, and risk-takers who are principled, open-minded, caring, balanced, and reflective.

Within the curriculum model, there is the curriculum cycle expressed by “How best will we learn?” “What do we want to learn?” and “How will we know what we have learned?” (International Baccalaureate, 2009, p. 8). This cycle represents the written, taught, and assessed curriculum based upon the McTighe and Wiggins’ (2004b) concept of backwards design which encapsulates inquiry at the heart of each of the three components (International Baccalaureate, 2010c).

IB Current Research

The IB houses a research department to continue the scholarly task of maintaining a quality program. Research is conducted in the following areas: programme impact, quality assurance, programme development, and assessment. Through two different

offices, research is conducted through a school division and an academic division. What follows is a discussion of the research on programme impact and programme development as it pertains to inquiry-based teaching and learning. Research that focused on globalization, admissions, and policy issues was not included in this review.

Programme Impact

To date there have been 12 published studies, both independent and commissioned, by the IB to research the programme impact in four areas: (a) standards alignment; (b) programme implementation; (c) student performance; and (d) the learner profile (International Baccalaureate, 2013b). Three of these studies are related to this study and will be discussed further.

Tan & Bibby (2012) were commissioned by the International Baccalaureate through the Australian Council for Educational Research for a study over the course of several years. They researched the student performance of over 23,000 primary years programme (PYP) and middle years programme (MYP) students compared with non-IB students (N = 14,317) on the International Schools' Assessment. With the exception of narrative writing in fifth grade and mathematics in third grade, IBPYP students scored higher in expository writing, narrative writing, reading, and mathematics. The study was conducted with students in Europe, Oceania, Africa, Americas and Asia. In the Americas region, student performance of IBPYP children was equal to or better than non-IB students in all domains at all grade levels.

In the second part of the research, student perceptions of well-being and attitudes were studied through four domains: student and teacher interaction, social connectedness, personal development outcome and study engagement. The IBPYP students showed a moderately higher proportion of satisfaction across all four domains than the non-IB students. The questionnaire was only given to students in Grades 5 and 6 so as to be developmentally appropriate (Tan & Bibby, 2012).

Sillisano et al. (2010) engaged in a study of IB schools in Texas, commissioned by the IB and conducted through Texas A & M University which enabled a quantitative and qualitative comparison of IPPYP students and non-IB students on the state standardized test for reading and mathematics, the Texas Assessment of Knowledge and Skills. A total of 22 PYP schools and 21 MYP schools were included in the study. For the purposes of this literature review, only the results significant to PYP are discussed.

Quantitatively, students who were in the PYP schools performed as well as the non-IB students in both subject areas. In the qualitative case study of 90 classrooms, it was observed that teachers engaged in ongoing feedback, generated interest-based lessons using assessed prior knowledge and engaged in discussions with students. Specifically, in the PYP schools, more exploration of new skills was observed. Overall, students in the IB classrooms were engaging in learning activities that connected ideas and concepts and were learner-centered. The caveat to the results, the authors cautioned, was the various stages of implementation of the PYP. However, they also noted the positive impact that IB professional development had on professional practices within the PYP schools.

A third study, conducted in South Carolina, sought to determine student achievement based on the Palmetto Achievement Challenge state assessment in English Language Arts (Jordan, 2009). In the study, scores of students in Grades 3, 4, and 5 in one IBPYP school were compared to those of the same grade levels in 16 non-IB schools. After controlling for gender, ethnicity, and socio-economic levels, the students in the PYP school in all grades scored significantly higher than their peers in non-IB schools. Data collected for this study was trend data over a five-year period.

Programme Development

To date there have been 13 papers published in regards to programme development, including literature reviews, position papers and discussion documents. These papers represent IB commissioned work to experts in the field who provide analytical, guiding documents to support the evolution of all IB programmes (International Baccalaureate, 2012b). The paper of primary interest to this study was the literature review conducted by Na Li (2012). The researcher defined constructivism as the primary vehicle in which students learn the emphasized skills of creative and critical thinking, metacognitive, social and affective skills. Li concluded that inquiry, derived from constructivist theory has cultural implications. An implication for the international program, IB, the researcher posited cultures which can be more directive in nature have demonstrated difficulty in implementing inquiry teaching strategies. Likewise, the fidelity with which inquiry-based teaching strategies are implemented has been shown to be dependent upon the level of professional development and ongoing support in their

use. Similarly, the individuals who implement and share new technologies, tools and research to teachers of inquiry- based teaching strategies have shown they are only as successful as their own training and understanding (Li, 2012).

IB Literature and Inquiry Elements

An analysis of the literature related to the International Baccalaureate and inquiry, was conducted by Chichekian (2011). The literature review was coded according to the 79-item instrument, the McGill Strategic Demands of Inquiry Questionnaire (MSDIQ) which contained items in three domains: planning, enactment, and reflection. Findings suggested a focus on the teacher planning components of inquiry rather than student oriented elements of inquiry. Specifically, the four questions pertaining to planning were found in IB research, but only 29% of the questions pertaining to students' planning for inquiry and 33% of the questions pertaining to enactment of inquiry processes were found in the research. Finally, only two of the six student reflection questions were addressed in the research. Chichekian (2011) concluded that the IB research reviewed did not provide adequate support for inquiry-based strategies for teaching and learning as they pertained to student engagement and that more research was needed from the metacognitive and self-regulation perspective of student learning through inquiry.

Summary

The standards movement of the 21st century has demonstrated an increase in high stakes testing (NCLB, 2002). However, a review of teacher evaluation systems (Brevard

Public Schools, 2014; Danielson, 2013; Marzano, 2011) revealed elements of inquiry throughout. Therefore, research into the myriad of inquiry definitions and implications for student achievement is relevant for student growth.

The case for inquiry in the classroom has been well documented through much research, particularly in the field of science education (Bedderman, 2013; Herron, 1971; Quintana et al.; von Seker, 2002). Numerous studies have applied constructivist approaches in learning to both student outcomes and pedagogical approaches. The review of literature has attempted to describe some of the fundamental theorists (Vygotsky, Dewey, and Piaget). In addition, the work of contemporary theorists such as von Glasersfeld and Phillips was highlighted.

A discussion of the multitude of definitions of inquiry included connections to the International Baccalaureate Primary Years Programme philosophy. Inquiry-teaching and learning were discussed through both the acquisition of inquiry-based teaching strategies as well as implementation in a classroom setting. Inquiry and student achievement were documented primarily through science education studies, and further research in all disciplines was documented.

The instrument for this study was also discussed. The MSDIQ is a tool to ascertain teacher perception and attitudes towards three segments of inquiry teaching and learning: planning, enactment, and reflection. It was described as it related to the literature of inquiry teaching and learning.

Finally, a discussion of the International Baccalaureate (IB) and the Primary Years Programme (PYP) concluded the literature review. The history of the IB and PYP

was summarized along with the philosophy, standards and practices. Current research findings involving IBPYP were presented as they relates to this study.

The aim of this literature review was not to be exhaustive, but rather to encompass both the historical and multiple perspectives on constructivism and inquiry-based teaching. Inquiry research is vast and ongoing. Since Socrates, where persecution prevailed for asking questions of the world, learners have constructed knowledge through cognitive processes within the context of humans and materials that exist in society. This literature review has shown that as society changes, so, too, has the quest to best engage learners in new knowledge.

CHAPTER 3 METHODOLOGY

Introduction

Chapter 3 includes a description of the methodologies that were used to determine the relationship among inquiry teaching strategies, origin of inquiry teaching strategies, observation of inquiry teaching strategies, and student achievement among International Baccalaureate Primary Years Programme (IBPYP) affiliated schools and non-IBPYP affiliated schools. Data were obtained from the participating teachers' responses to Shore et al.'s (2012) McGill Strategic Demands of Inquiry Questionnaire (MSDIQ) and reporting of Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) achievement levels in mathematics and reading. This chapter has been organized into the following sections: statement of the problem, research questions, selection of the participants, instrumentation, data collection, and data analysis.

Problem and Purpose Statement

The Florida legislature has directed local education agencies (LEAs) to improve teacher evaluation systems in the state of Florida. The purpose of the improvements is to improve student achievement (SB 736, 2011). Though a review of the literature on inquiry teaching strategies demonstrated a variety of definitions of inquiry (Bell, 2010; Manconi, 2003), the four main evaluation systems that have been approved all include elements of inquiry teaching elements, and the International Baccalaureate Primary Years

Programme (IBPYP) establishes inquiry as the primary philosophy in which teachers should engage (International Baccalaureate, 2009).

A goal of this study was to learn where teachers gain knowledge of inquiry teaching. Additionally, the study was conducted to determine the difference in student achievement between students affiliated with the International Baccalaureate Primary Years Programme (IBPYP) and those in non-affiliated IBPYP schools. Data from the study provided evidence as to the origin of teachers' knowledge of inquiry teaching and the relationship that existed with student achievement. Finally, teacher beliefs of inquiry teaching strategies were evaluated.

Research Questions

In order to determine the outcome of the problem statement, the researcher developed the following guiding research questions regarding inquiry teaching strategies:

1. What is the difference between third-, fourth-, and fifth-grade teachers' origin of inquiry teaching knowledge and student achievement as measured on the Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013?

H_{01} : There is no difference between third-, fourth-, and fifth-grade teachers' origin of inquiry teaching knowledge and student achievement as measured on the FCAT 2.0 in mathematics and reading in 2012-2013.

2. What is the difference in student achievement of third-, fourth-, and fifth-grade International Baccalaureate Primary Years Programme (IBPYP)

students and non-IBPYP third-, fourth-, and fifth-grade students as measured on the Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013?

H₀₂: There is no difference in student achievement as measured by FCAT 2.0 between IBPYP and non-IBPYP third-, fourth-, and fifth-grade students in mathematics and reading in 2012-2013.

3. What is the difference between teachers' beliefs about inquiry teaching and origin of inquiry teaching knowledge?

H₀₃: There is no difference between teachers' beliefs about inquiry teaching and origin of inquiry teaching knowledge.

4. What is the relationship of student achievement, as measured on the Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) in mathematics and reading of third-, fourth-, and fifth-grade students, and teachers' beliefs about inquiry teaching during the 2012-2013 school year?

H₀₄: There is no relationship between student achievement as measured on the FCAT 2.0 in mathematics and reading and teachers' beliefs about inquiry teaching.

Selection of Participants

The target population of the study was elementary teachers in Grades 3 through 5 in the state of Florida. The sample was comprised of a convenience sample of third-, fourth-, and fifth-grade teachers from both International Primary Years Programme

(IBPYP) affiliated schools and equivalent non-IBPYP affiliated schools. The diverse sample was obtained from three public school districts within the state: Brevard Public Schools, The School District of Osceola County, and The School District of Palm Beach County. School districts with IBPYP schools also were home to the participating non-IBPYP schools.

Teachers were selected based on the grade level taught. Teachers in grades where the Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) was administered were chosen so that a standard measure of student achievement data could be collected. Because there is no state-wide, standardized student achievement data for Kindergarten through second grade students, those teachers were not selected for participation.

Instrumentation

According to Gay, Mills and Airasian (2009), validity is the amount of confidence that one has that an instrument measures the intended concept for a specific population. Validity standards must be met for relationships or differences to be interpreted. The Florida Comprehensive Achievement Test (FCAT 2.0) measures the achievement of students on the Next Generation Sunshine State Standards (NGSSS). Students in Grades 3 through 10 take the FCAT 2.0 in reading and mathematics, the measurements of student achievement that were used for this study. According to the 2004 FLDOE Assessment and Accountability Briefing Book, the FCAT reports criterion-related validity and content-related validity. Criterion validity was established with the Stanford 9 test and generated high validity results. Content validity was established using varying methods

including the use of bias committees and curriculum specialists to review item selection committees' test items. In addition, content validity was established by field testing (FLDOE, 2004, p. 27).

Reliability describes an instrument's ability to accurately measure what is designed to measure constantly over time (Gay et al., 2009). The reliability coefficient reports how much the error affects the score. Reliability coefficients are reported on a scale from zero to one and the lower the error, the higher the coefficient. "[Reliability] is determined by the ratio of the variation of the true performance to the variation in observed test scores. If the error is minimal, the ratio will be close to 1" (FLDOE, 2005, p. 106). Documentation purports a reliable test based on committee reviews. In addition, the internal consistency reliability was determined by Cronbach's Alpha $> .88$ in mathematics and $> .90$ in reading. The item response theory procedures were also reported, $> .88$ in mathematics and $> .90$ in reading (FLDOE, 2004).

The McGill Strategic Demands of Inquiry Questionnaire (MSDIQ), developed by Shore et al. (2012) was used to determine the knowledge level of inquiry teaching among the teacher participants. The survey, a criterion-referenced, learner-focused instrument, has been validated. The instrument contains three inquiry domains which assess the value a respondent places on each item in the context of inquiry based teaching: planning, enactment, and reflection. Within the three domains are 14 highly intercorrelated factors that demonstrate the skills evident in the inquiry literature: time and task organization, setting the task in context, co-construction, planning to solve the problem, taking into account students' interests and needs, linking ideas including view

of the future, students' entering knowledge and affect, skills for collecting data and analyzing data, defining the problem space in terms of data characteristics, social context of solving the problem, communication of results, expanding the data or information search, explanation, reflection and evaluation, and questioning the results and follow-up questions (Shore et al., 2012, p. 333).

The sample size used in the validation study consisted of 205 pre-service teachers and psychology students, resulting in an internal consistency; α values ranged from 0.81 to 0.97. This indicates internally consistent responses. Likewise, the split-half coefficient ranged from 0.83 to 0.99.

Data Collection

Student achievement data comprised the dependent variable as measured by the Florida Comprehensive Achievement Test 2.0, 2012-2013 levels (FLDOE, 2011). The level scores were used as ordinal data rather than the scale scores which are used as interval data. Student levels were collected in order to facilitate ease in data collection. Data were collected from the respondents through self-report using Qualtrics, an electronic survey tool. Data for the independent variables were collected using the survey instrument containing the MSDIQ items along with the nominal data of origin of inquiry teaching beliefs, IB school affiliation, number of years taught, and grade level taught.

Origin of inquiry teaching strategies contained the following categories: undergraduate school, graduate school, district provided training, International

Baccalaureate (IB) workshop, or other. Interval data were collected using a Likert-type scale containing items regarding the knowledge of inquiry teaching in 14 dimensions contained in three domains: planning inquiry, enactment of inquiry and reflection of inquiry (Shore et al., 2012).

Data Analysis

Two statistical tests were used to analyze the data obtained for each research question using the statistical package from IBM, SPSS 20; the Mann-Whitney *U* and the Kendall tau. Two assumptions must be true when applying the Mann-Whitney *U*. “First, the subject only contributes one score. Second, the data are ordinal in measurement and are able to be converted to rank data for the application of the *U* test. The *U* statistic demonstrates the number of times the rank of a score in one group precedes the rank of a score in the other group” (Kiess, 1996, p. 406). The student achievement data, represented in ordinal levels were treated as rank data for the application of the test in Research Questions 1, 2, and 4.

Research Question 1 was concerned with the difference between third-, fourth- and fifth-grade teachers’ origin of inquiry teaching beliefs and student achievement as measured on the Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013. A Mann-Whitney *U* was performed to determine the difference between the origin of inquiry teaching strategies and student achievement levels in reading and mathematics based on the FCAT 2.0. Though a total of 19 surveys were completed, only nine respondents provided student achievement data. The Mann-

Whitney U is a statistical non-parametric test that compares the differences between two groups and a test variable. It was selected due to the abnormal distribution of the data, thereby negating the assumptions necessary for the parametric independent t-test.

For Research Question 1, the rank data of student achievement were analyzed for a difference between the two groups of origin of inquiry teaching strategies: undergraduate, graduate, and other in one group; district provided workshop and International Baccalaureate workshop in the second group. The origin of knowledge of inquiry teaching strategies groups were combined due to the small number of responses, $N = 19$.

Research Question 2 sought to determine the difference in student achievement of third-, fourth-, and fifth-grade International Baccalaureate Primary Years Programme (IBPYP) students and non-IBPYP third-, fourth-, and fifth-grade students as measured on the Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013. A Mann-Whitney U was performed to determine the difference between the International Baccalaureate Primary Years Programme (IBPYP) affiliation and student achievement levels in reading and mathematics based on the FCAT 2.0. As was the case for Research Question 1, though 19 surveys were completed, only nine respondents provided student achievement data. The Mann-Whitney U is a statistical non-parametric test that compares the differences between two groups and a test variable. It was selected due to the abnormal distribution of the data in student achievement levels (Kiess, 1996). Again, student achievement levels, as ordinal data, were converted to rank data for the analysis between the two groups of International Baccalaureate affiliation.

Research Question 3 was posed to identify the difference between teacher beliefs of inquiry teaching and origin of inquiry teaching knowledge. To accomplish this, a Mann-Whitney *U* was performed to determine the difference between the origin of inquiry teaching strategies and teacher beliefs of inquiry teaching strategies based on data obtained from participant responses on the McGill Strategic Demands of Inquiry Questionnaire (MSDIQ). The 79-item MSDIQ generated Likert-type scale information, from the MSDIQ which was averaged within the three domains of planning, enactment, and reflection. The mean was used in the analysis for each of the two grouping variables. The origin of inquiry teaching knowledge was recoded from five groups to two in order to meet the statistical requirements of the Mann-Whitney *U*. Undergraduate school, graduate school and other comprised one group. International Baccalaureate workshop, district provided workshop comprised the second group. The origin of knowledge of inquiry teaching strategies groups were combined due to the small number of responses, $N = 19$. The Mann-Whitney *U* is a statistical non-parametric test that compares the differences between two groups and a test variable. It was selected due to the abnormal distribution of the data, thereby negating the assumptions necessary for the parametric test ANOVA (Kiess, 1996).

Research Question 4 investigated the relationship in student achievement as measured on the Florida Comprehensive Achievement Test 2.0 (FCAT 2.0) in mathematics and reading of third-, fourth-, and fifth-grade students and teachers' beliefs about inquiry teaching during the 2012-2013 school year. A Kendall's tau rank coefficient was used to determine the relationship between student achievement levels as

indicated by the FCAT 2.0 and teacher's beliefs of inquiry teaching strategies based on the McGill Strategic Demands of Inquiry Questionnaire (MSDIQ). Of the 19 surveys completed, only nine respondents provided student achievement data. When using a sample size less than 10, the Kendall tau is the appropriate statistic (Gay et al., 2009).

The 79-item MSDIQ, Likert scale information, from the MSDIQ was averaged within the three domains of planning, enactment, and reflection and treated as rank data. The student achievement levels, ordinal data, were also treated as rank data. Therefore, the Kendall tau, a non-parametric statistic, was used to determine the relationship. The relationship is considered by each pair of data and determining their value compared to zero. If the value of $(x_1 - x_2)/(y_1 - y_2)$ is greater than zero, it is considered concordant. If the value of $(x_1 - x_2)/(y_1 - y_2)$ is less than zero, it is considered discordant (Kendall, 1938). Each observation is compared with each other observation resulting in the equation;

$$N = \frac{1}{2} n (n - 1) \quad (1)$$

This equation yields the number of coordinate pairs, C and discordant pairs, D.

$$\tau = \frac{C - D}{N} \quad (2)$$

Finally, if tau equals one, the variables are in the same order. If tau equals zero, there is no relationship. If tau equals negative one, then there is a reverse order relationship. The tau b handles any ties in the data by subtracting those instances;

$$n_x = \sum_i \frac{t_i(t_i - 1)}{2} \quad (3)$$

Resulting in the final equation for tau b;

$$\tau_b = \frac{C-D}{(N-n_x)(N-n_y)} \quad (4)$$

Table 2 contains the four research questions which were used to guide the study, the statistical tests used to answer each of the questions, and the equations used in the analyses.

Table 2

Research Questions, Statistical Tests, and Equations Used in Data Analyses

Research Questions	Statistical Test and Equations
1. What is the difference between third-, fourth-, and fifth-grade teachers' origin of inquiry teaching knowledge and student achievement as measured on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013?	Mann-Whitney U $U_{A1obs} = n_{A1}n_{A2} + \frac{n_{A1}(n_{A1} + 1)}{2} - \sum R_{A1}$
2. What is the difference in student achievement of third-, fourth-, and fifth-grade International Baccalaureate Primary Years Programme (IBPYP) students and non-IBPYP third-, fourth-, and fifth-grade students as measured on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013?	Mann-Whitney U $U_{A1obs} = n_{A1}n_{A2} + \frac{n_{A1}(n_{A1} + 1)}{2} - \sum R_{A1}$
3. What is the difference between teacher beliefs of inquiry teaching and origin of inquiry teaching knowledge?	Mann-Whitney U $U_{A1obs} = n_{A1}n_{A2} + \frac{n_{A1}(n_{A1} + 1)}{2} - \sum R_{A1}$
4. What is the relationship in student achievement as measured on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in mathematics and reading of third-, fourth-, and fifth-grade students' and teachers' beliefs of inquiry teaching during the 2012-2013 school year?	Kendall's tau $\tau_b = \frac{C - D}{(N - n_x)(N - n_y)}$

Summary

Chapter 3 has provided detailed information on the methods and procedures used to conduct the study. Included were an introduction, a restatement of the problem and purpose, and the research questions and null hypotheses. The population, sample, data collection strategies, and data analysis were also discussed. Descriptions of the

instruments, i.e., the Florida Comprehensive Assessment Test 2.0 and the McGill Strategic Demands of Inquiry Questionnaire were discussed along with the validity and reliability of the instruments. Chapter 4 contains the results of the analysis of the data. Chapter 5, the concluding chapter of the dissertation, presents a summary and discussion of the findings of the study and recommendations for practice and further study.

CHAPTER 4 ANALYSIS OF THE DATA

Introduction

This study was conducted to investigate the differences between teachers' origin of inquiry teaching strategies, teacher's beliefs of inquiry teaching strategies, International Baccalaureate affiliation, and student achievement in reading and mathematics based on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0). In addition, the researcher sought to determine a relationship between student achievement and teacher beliefs of inquiry teaching strategies. The purpose was achieved by surveying teachers in FCAT 2.0 tested Grades 3-5 through an electronic version of the McGill Strategic Demands of Inquiry Questionnaire (MSDIQ). The data were analyzed using the Statistical Package for the Social Sciences 22 (SPSS). Mann-Whitney *U* and Kendall's Tau were used to determine the differences and relationships (respectively) between four independent variables: origin of inquiry teaching strategies, student achievement in mathematics and reading, International Baccalaureate affiliation, and inquiry teaching strategy beliefs. This analysis led the researcher to reject or accept the null hypotheses. In this chapter, descriptive statistics, including an item analysis of the MSDIQ and participant data, are presented as preliminary information followed by a summary of the data analysis performed to respond to each research question.

Descriptive Statistics

The population of the study included teachers in third, fourth and fifth grades in the state of Florida. The population was delimited to school districts that included at least

one International Baccalaureate Primary Years Programme (IBPYP) school and consented to the research. The participating school districts included two medium sized districts (Brevard Public Schools, The School District of Osceola County) and one large district, The School District of Palm Beach County. At the time of the study, all three school districts had at least one IBPYP school. The participating IBPYP schools totaled three. Due to the small number of participating school districts, the participating non-IB schools totaled five.

The sample size was 124 teachers from the eight schools in three school districts. The sample was selected from teachers who taught third, fourth or fifth grades in order to capture student achievement data as measured by FCAT 2.0. Of the 124 surveys distributed, 21 surveys were returned partially or fully completed resulting in a 17% response rate. Of the 21 respondents, 19 replied as to the grade level taught, years of experience, and the origin of their inquiry teaching strategies; 18 indicated their IB affiliation. The frequencies and percentages of responses are presented in Table 3.

There was a fairly even distribution of responding teachers in Grades 3 (7, 36.8%), 4 (7, 36.8%), and 5 (5, 26.3%) Almost half (8, 42.1%) of the participants had been teaching more than 10 years. Nine (57.9%) teachers had been teaching less than 10 years.

A total of 18 teachers provided a response to the affiliation item. Of the 18, 13 (72.2%) indicated that they were affiliated with an IB program, and five (27.8%) indicated no affiliation. In addition, eight of nine participants who provided student achievement data were from an IBPYP school.

Teachers were also asked to respond as to their best source of knowledge of inquiry-based teaching strategies using five categories: undergraduate school, graduate school, district provided workshops, International Baccalaureate (IB) workshops, or other which could include professional reading, webinars, and social media. District provided workshops (6, 31.6%) and IB workshops (5, 26.3%) were selected by 11 of the 19 responding teachers.

Table 3

Demographic Descriptors for Participating Teachers (N = 19)

Descriptors	N	Percentage
Grade Taught		
3	7	36.8
4	7	36.8
5	5	26.3
Years of Experience		
0-3	5	26.3
4-7	4	21.1
7-10	2	10.5
10+	8	42.1
International Baccalaureate Affiliation		
Yes	13	72.2
No	5	27.8
Origin of inquiry strategies		
Undergraduate school	2	10.5
Graduate school	2	10.5
District provided workshops	6	31.6
International Baccalaureate workshops	5	26.3
Other	4	21.1

Student Achievement Variables

Teachers self-reported student achievement scores using the defined levels of Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) achievement, 1-5 in both mathematics and reading. Nine respondents completed these items. Table 4 displays the average number of students per participant in each level of achievement in mathematics and reading. In addition, the overall mean of the students reported per level is displayed.

In mathematics, all participants reported student achievement levels at proficiency level with two exceptions. One participant reported one student as a level 1 in mathematics. Five students were reported at a level 2. No participants reported any students as achieving a level 1 in reading. The data demonstrate proficiency in reading for all but 9% of the student achievement data reported who were reported as a level 2.

Table 4

Mathematics and Reading Student Achievement Data: FCAT 2.0 Levels in 2012-2013

Achievement	Average Students Per Participant	M	SD
Mathematics			
Level 1	0.50	2.17	3.07
Level 2	1.25	5.99	2.68
Level 3	4.44	22.26	9.70
Level 4	8.67	44.42	9.01
Level 5	7.00	30.52	11.43
Reading			
Level 1	0	.000	.00
Level 2	2.83	12.89	16.98
Level 3	3.78	17.99	7.34
Level 4	7.56	36.76	9.34
Level 5	7.44	37.21	17.22

McGill Strategic Demands of Inquiry Questionnaire Variables

The McGill Strategic Demands of Inquiry Questionnaire required respondents to respond to a 79-item, questionnaire about teachers' beliefs of inquiry-based teaching and learning within three domains: planning, enactment, and reflection. Using a Likert scale of 0-10, participants ranked their perception of 14 different factors within the three domains including the following: time and task organization, setting the task in context, co-construction, planning to solve the problem, taking into account students' interests and needs, linking ideas, including views of the future, students' entering knowledge and affect, skills for collecting data and analyzing data, defining the problem space in terms of data characteristics, social context of solving the problem, expanding the data or information search, communication of results, explanation, reflection and evaluation, and questioning the results and follow-up questions. Table 5 provides the mean, median, variance and standard deviation for each of the items in the planning domain (N=12). Items that received lower importance by participants were a teacher provided mentor, student creation of a concept map or some other graphic organizer, and for the student to have back up plans should the project fail (M=8.17, 8.50, 8.67, respectively). Teachers believed that the most important items were for the teacher to encourage creative risk-taking and for the teacher to be flexible in time management (M=10.58, 10.75, respectively).

Table 5

McGill Strategic Demands of Inquiry Questionnaire: Planning

Item	M	Median	Variance	SD
How important is it in inquiry based learning and teaching...				
For the teacher to provide a mentor	8.17	9.50	5.79	2.41
For the student to make a concept map or web or cluster	8.50	8.00	5.55	2.35
For the student to have back up plans at the end should the project stall	8.67	8.00	2.97	1.72
For the student and teacher to have co-ownership of the question	8.75	9.00	5.84	2.42
For the student and teacher to share construction of the curriculum	8.75	9.00	4.57	2.14
For the student and teacher to share decision-making	8.83	9.00	5.06	2.25
For the teacher to explore his or her interest	9.08	9.50	4.45	2.11
For the student to have previous experience with similar activities	9.08	9.00	2.27	1.51
For the student to have different plans in advance to accomplish the task	9.08	9.00	2.27	1.51
For the student to foresee possible outcomes of the activity	9.10	9.50	3.21	1.79
For the teacher to listen as much as he or she speaks	9.33	9.00	2.42	1.56
For the student to divide the task into a coherent sequence of doable steps	9.42	9.00	2.27	1.51
For the student to organize time and space	9.58	10.00	1.72	1.31
For the student to make a plan	9.67	10.00	1.70	1.30
For the teacher to address his or her needs and student's needs	9.75	10.00	1.30	1.14
For the student to set aside preparation time	9.75	9.50	0.75	0.87
For the student to understand key concepts	9.83	10.00	2.88	1.70
For the student to brainstorm his or her ideas	9.92	10.00	0.99	1.00
For the teacher to model skills needed for the inquiry	10.00	10.00	1.45	1.21
For the student to understand the goal of the task	10.00	10.50	1.45	1.21
For the student to extend inquiry beyond the classroom	10.08	10.50	1.36	1.16
For the teacher to encourage honest criticism of idea	10.08	10.50	1.17	1.08
For the student to describe his or her own problem-solving strategies	10.17	10.50	1.06	1.03

Item	M	Median	Variance	SD
For the student to understand instructions	10.25	10.50	0.93	0.97
For the student to work in a nurturing and creative environment	10.33	11.00	0.97	0.98
For the teacher to tap into the student's and his or her own interests	10.33	11.00	0.79	0.89
For the student to connect old and new knowledge	10.42	11.00	0.63	0.79
For the teacher to encourage creative risk-taking	10.58	11.00	0.45	0.67
For the teacher to give the amount of time needed, be flexible with time	10.75	10.00	1.66	1.29

Table 6 provides the mean, median, variance and standard deviation for each of the items in the enactment domain, N=12. External motivation such as earning prizes and high grades proved to be of small importance to the participants (M=4.08, median=2.00, variance= 3.54, SD=3.68; M=7.75, median=8.00, variance=5.84, SD=2.42 respectively). Participants consistently rated both of these items low in importance which was consistent with the MSDIQ results in previous studies (Syer, 2007). Participants believed the most important items in the enactment domain were for children to ask questions and to communicate learning to others (M=10.67, median=11.00, variance 0.24, SD=0.49; M=10.67, median 11.00, variance 0.42, SD=0.65 respectively).

Table 6

McGill Strategic Demands of Inquiry Questionnaire: Enactment

Item	M	Median	Variance	SD
How important is in inquiry based learning and teaching...				
For the student to win a prize	4.08	2.00	13.54	3.68
For the student to get a high grade	7.75	8.00	5.84	2.42
For the student to present data in tables and graphs	9.08	9.00	3.72	1.93
For the student to anticipate and respond to arguments in opposition to one's view	9.25	8.50	2.02	1.42
For the student to address doubts directly	9.33	10.00	3.15	1.78
For the student to classify data	9.42	9.50	1.90	1.38
For the student to develop expectations of what will happen next	9.58	9.50	1.72	1.31
For the student to recognize hidden meanings in data	9.58	9.50	1.54	1.24
For the student to consider diverse means of communication	9.58	9.50	2.08	1.44
For the student to value personal judgment	9.67	10.00	2.24	1.50
For the student to record methods, results, and conclusions	9.67	10.00	1.88	1.37
For the student to offer hypotheses about outcomes	9.75	10.00	1.30	1.14
For the student to find patterns in data	9.75	9.50	1.66	1.29
For the student to organize the presentation of the project	9.75	10.00	2.02	1.42
For the student to restate or reformat the problem	9.83	10.00	2.15	1.47
For the student to identify where to obtain data	9.83	10.00	1.61	1.27
For the student to verify data or information	9.83	9.50	1.24	1.11
For the student to record data	9.92	10.50	1.72	1.31
For the student to understand how preconceptions affect learning	9.92	10.00	0.81	0.90
For the student to be aware of how the inquiry event affects him or her personally	9.92	10.00	1.36	1.16
For the student to assist others to make observations	9.92	10.00	0.99	1.00
For the student to compare and contrast data with someone else's	9.92	10.00	1.17	1.08
For the student to seek different viewpoints	9.92	10.00	1.17	1.08
For the student to have a mental representation of the task	9.92	10.00	1.17	1.08
For the student to make careful observations	10.08	10.00	0.81	0.90

Item	M	Median	Variance	SD
For the student to construct new knowledge	10.08	10.50	1.36	1.16
For the student to use vocabulary appropriate to the audience and topic	10.08	10.00	0.81	0.90
For the student to search for resources beyond textbooks	10.09	10.00	1.09	1.04
For the student to feel free to use imagination	10.17	10.00	0.52	0.72
For the student to have self-motivation	10.17	10.00	0.70	0.83
For the student to apply new knowledge to future experiences	10.18	10.00	0.96	0.98
For the student to make suggestions	10.25	11.00	0.93	0.97
For the student to share emotions, feelings, ideas, and opinions	10.25	10.00	0.57	0.75
For the student to keep an open mind to change	10.25	10.00	0.57	0.75
For the student to test ideas and hypotheses	10.25	10.50	0.75	0.87
For the student to interact with or manipulate his or her surroundings	10.25	10.50	0.75	0.87
For the student to search the internet and world wide web	10.27	11.00	1.22	1.10
For the student to separate relevant and irrelevant information	10.33	11.00	0.79	0.89
For the student to accept that more than one solution might be appropriate	10.36	11.00	0.85	0.92
For the student to keep motivated	10.42	10.50	0.45	0.67
For the teacher to give sensitive feedback, positive reinforcement, praise for persistence	10.50	11.00	0.45	0.67
For the student to apply previous knowledge to new concepts	10.55	11.00	0.47	0.69
For the student to ask questions	10.67	11.00	0.24	0.49
For the student to communicate one's learning with others	10.67	11.00	0.42	0.65

As shown in Table 7, the belief that students should explain the results of their inquiry yielded the highest mean within the reflection domain (M=10.42). The least important item to the participants was the need for the students to follow up the inquiry with a new set of questions; however, the importance was high, (M=9.58, median=9.50, variance=2.08, SD=1.44).

Table 7

McGill Strategic Demands of Inquiry Questionnaire: Reflection

Item	M	Median	Variance	SD
How important is it in inquiry based learning and teaching...				
For the student to follow-up the project with a new set of questions	9.58	9.50	2.08	1.44
For the student to evaluate the inquiry experience	9.75	9.50	1.11	1.06
For the student to discuss what has been learned compared to what was known before	10.00	10.00	1.27	1.13
For the student to question the findings	10.25	11.00	0.93	0.97
For the student to reflect upon his or her inquiry experience	10.25	10.50	0.75	0.87
For the student to explain the results	10.42	11.00	0.81	0.90

Testing the Research Questions

In testing the research questions, the data were analyzed for patterns. None of the variables in the study (IB affiliation, student achievement levels, origin of inquiry teaching strategies, nor teacher beliefs in inquiry-teaching strategies) were normally distributed. Therefore, non-parametric tests were used in analyzing the data to respond to each of the research questions (Keiss, 1996).

Research Question 1

What is the difference between third-, fourth-, and fifth-grade teachers' origin of inquiry teaching knowledge and student achievement as measured on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013?

H_{01} : There is no difference between third-, fourth-, and fifth-grade teachers' origin of inquiry teaching knowledge and student achievement as measured on the FCAT 2.0 in mathematics and reading in 2012-2013.

The first research question examined the differences between levels of student achievement as measured by FCAT 2.0 proficiency levels in mathematics and reading and the primary source of information about inquiry teaching strategies among teachers. The teacher-reported FCAT 2.0 levels in both mathematics and reading were computed as overall class percentages. As a nonparametric test that compares the difference in mean ranking of a dependent variable between two groups, the Mann-Whitney U was selected due to the non-normal distribution of the data. The frequency tables show a majority of the students receiving a level 3 or above on both the mathematics and reading FCAT 2.0. The independent variable, origin of inquiry teaching knowledge was recoded from five groups to two in order to avoid making inferences on extremely small group sizes. The first group consisted of undergraduate school, graduate school and other. The second group consisted of International Baccalaureate workshop and district-provided workshop.

Ten separate Mann-Whitney tests, one for each student achievement level and subject, were conducted to determine the differences in the mean ranks of student achievement as measured by FCAT 2.0 between the two groups representing origin of inquiry teaching strategies represented in Table 8. In nearly all subjects and achievement levels, no statistically significant difference was found between the mean ranks of student achievement and the origin of teachers' knowledge of inquiry-based teaching strategies. However, a nearly statistically significant difference in mean ranks of the percentage of students scoring at level 4 in mathematics was present, $U=.000$, $Z=-1.94$, $p=.053$. Teachers who believed they acquired inquiry teaching knowledge from formal education or other areas had a mean rank of 1.50 in this category of achievement as compared to teachers who believed their inquiry teaching knowledge originated from district or International Baccalaureate workshops; this group indicated a mean rank of 5.00, suggesting a higher level of performance among these students. The null hypothesis was not rejected in any level or subject.

Table 8

Results from the Mann-Whitney Test U: Origin of Inquiry Teaching and Student Achievement in Mathematics and Reading

Achievement	Mann-Whitney U	Z	p
Mathematics			
Level 1	.000	-1.00	.317
Level 2	.000	-1.225	.221
Level 3	2.00	-1.162	.245
Level 4	.000	-1.936	.053
Level 5	4.00	-.387	.699
Reading			
Level 1	1.00	.0000	1.00
Level 2	3.00	.000	1.00
Level 3	4.00	-1.050	.294
Level 4	6.50	-.300	.764
Level 5	4.00	-1.050	.294

*p<.05

Research Question 2

What is the difference in student achievement of third-, fourth-, and fifth- grade International Baccalaureate Primary Years Programme (IBPYP) students and non-IBPYP third-, fourth-, and fifth-grade students as measured on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013?

H_{02} : There is no difference in student achievement as measured by FCAT 2.0 between IBPYP and non-IBPYP third-, fourth-, and fifth-grade students in mathematics and reading in 2012-2013.

To answer Research Question 2, the teacher reported FCAT 2.0 levels in both mathematics and reading were planned to be utilized. However, inferential statistics could not be computed due to the limited number of participants who provided student achievement data from non-IBPYP schools. Of the nine participants who did provide student achievement data, eight were affiliated with IBPYP schools. Because inferences could not be made based upon student achievement data from one participant from a non-IBPYP school, the null hypothesis could not be tested.

Student achievement data provided by IBPYP affiliated participants is presented in Table 4. Of the students from the IBPYP affiliated schools, 97% demonstrated proficiency (level 3 or above) on the FCAT 2.0 in mathematics, and 91% of the students from the IBPYP affiliated schools demonstrated proficiency (level 3 or above) on the FCAT 2.0 in reading.

Research Question 3

What is the difference between teachers' beliefs about inquiry teaching and origin of inquiry teaching knowledge?

H_{03} : There is no difference between teachers' beliefs about inquiry teaching and origin of inquiry teaching knowledge.

On each of the 79 items pertaining to teachers' beliefs of inquiry teaching, participants were asked to determine the extent to which they believed the item was important within the context of inquiry based teaching and learning. To answer Research

Question 3, the 79 items from the MSDIQ were averaged within the three domains of planning, enactment, and reflection. Each served as a dependent variable. The origin of inquiry teaching knowledge independent variable used the same recoding as used in Research Question 1, in which the first group consisted of undergraduate school, graduate school and other; and the second group consisted of International Baccalaureate workshop and district provided workshop. Results of the Mann-Whitney tests, one for each MSDIQ phase, are reported in Table 9. No significant difference was found in any of the domains representing teacher beliefs of inquiry-teaching strategies between the two different groups. Specifically, for the planning domain which included items from Table 5, there was not a significant difference between the two groups ($U=13.00$, $Z= -.189$, $p=.850$). Both the enactment domain (items from Table 6) and the reflection domain (items from Table 7) showed no statistically significant difference between teachers who believed their inquiry based teaching strategies knowledge was from formal education or workshops and other methodologies. Therefore, the null hypothesis could not be rejected.

Table 9

Mann Whitney Test: Origin of Inquiry Teaching Strategies and Teacher Beliefs About Inquiry Teaching Strategies

MSDIQ Phases	Mann-Whitney U	Z	p
Planning	13.00	-.189	.850
Enactment	10.00	-.756	.450
Reflection	10.50	-.679	.497

Note. MSDIQ = McGill Strategic Demands of Inquiry Questionnaire

Research Question 4

What is the relationship of student achievement, as measured on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in mathematics and reading of third-, fourth-, and fifth-grade students, and teachers' beliefs about inquiry teaching during the 2012-2013 school year?

H₀₄: There is no relationship between student achievement as measured on the FCAT 2.0 in mathematics and reading and teachers' beliefs about inquiry teaching.

For each of the 79 items pertaining to teachers' beliefs of inquiry teaching, participants were asked to determine the extent to which they believed the item was important within the context of inquiry based teaching and learning. To answer Research Question 4, responses to the 79 items from the MSDIQ were averaged within the three categories of planning, enactment, and reflection. The teacher reported FCAT 2.0 levels in both mathematics and reading were computed as class percentages. Student achievement levels did not show a normal distribution, as the majority of student achievement levels were at level 3 or above.

Kendall's tau, a nonparametric correlational test, was run between the variables of student achievement and the perceived importance of each domain in inquiry-based teaching and learning. One test was run per combination of achievement level, subject, and domain score. With two subjects, five achievement levels, and three domains, the end result was 30 separate correlations. Tables 10 and 11 show the results for the Kendall's tau correlations. None of the tests indicated significant relationships between any of the three domains (planning, enactment and reflection) and student achievement

levels in either mathematics or reading. Of importance, however, were students who achieved a level 4 in mathematics and the correlation between both the enactment domain and reflection domain. Although not statistically significant, both domains reflected a strong correlation. (See Table 10 enactment $\tau = -.556$, $p = .060$ and reflection $\tau = -.550$, $p = .070$). In addition, student achievement in mathematics of a level 3 had a correlation of .550 ($p = .070$).

Also of importance was the correlation of students who received a level 4 in reading ($\tau = .522$, $p = .056$) and the planning domain (see Table 11). Because there was no statistically significant relationship between the variables, however, the null hypothesis could not be rejected.

Table 10

Kendall's Tau Results From Planning, Enactment, and Reflection Domains of Inquiry Teaching and Student Achievement Levels in Mathematics

Domains	Correlation Coefficient	Significance	N
Planning			
Mathematics Level 1	-1.00	-	2
Mathematics Level 2	-.333	.602	3
Mathematics Level 3	.407	.167	8
Mathematics Level 4	.185	.530	8
Mathematics Level 5	-.185	.530	8
Enactment			
Mathematics Level 1	-1.00	-	2
Mathematics Level 2	-.333	.602	3
Mathematics Level 3	.481	.102	8
Mathematics Level 4	-.556	.060	8
Mathematics Level 5	-.259	.379	8
Reflection			
Mathematics Level 1	-	-	2
Mathematics Level 2	-.816	.221	3
Mathematics Level 3	.550	.070	8
Mathematics Level 4	-.550	.070	8
Mathematics Level 5	-.304	.301	8

Table 11

Kendall's Tau Results From Planning, Enactment, and Reflection Domains of Inquiry Teaching and Student Achievement Levels in Reading

Domains	Correlation Coefficient	Significance	N
Planning			
Reading Level 1	-	-	3
Reading Level 2	-.429	.243	6
Reading Level 3	.000	1.000	6
Reading Level 4	.522	.056	9
Reading Level 5	-.232	.397	9
Enactment			
Reading Level 1	-	-	3
Reading Level 2	-.143	.697	6
Reading Level 3	.174	.595	9
Reading Level 4	.116	.672	9
Reading Level 5	-.058	.832	9
Reflection			
Reading Level 1	-	-	3
Reading Level 2	-.074	.843	6
Reading Level 3	.246	.384	9
Reading Level 4	.123	.664	9
Reading Level 5	-.123	.664	9

A summary of the results of the analysis for each research question is presented in Table 12. Data to answer Research Question 1 were analyzed using the statistic Mann-Whitney U comparison of mean ranks. Data for Research Question 2 could not be analyzed using Mann-Whitney U due to the small number (1) of non-IBPYP participants who provided student achievement data. Data to answer Research Question 3 were, again, analyzed using the Mann-Whitney U to determine the difference between teacher beliefs about inquiry teaching and origin of inquiry teaching knowledge. For Research

Question 4, a Kendall's tau was used to determine the relationship between student achievement and the three domains of inquiry teaching beliefs as indicated on the MSDIQ.

Table 12

Summary Table of Research Questions and Results

Research Question	Results
1. What is the difference between third-, fourth-, and fifth-grade teachers' origin of inquiry teaching knowledge and student achievement as measured on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013?	H ₀ 1: There was no difference between third-, fourth- and fifth-grade teachers' origin of inquiry teaching knowledge and student achievement as measured on the FCAT 2.0. The null hypothesis failed to be rejected.
2. What is the difference in student achievement of third-, fourth-, and fifth-grade International Baccalaureate Primary Years Programme (IBPYP) students and non-IBPYP third-, fourth-, and fifth-grade students as measured on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013?	H ₀ 2: There was no difference in student achievement as measured by FCAT 2.0 between IBPYP and non-IBPYP third, fourth and fifth grade students. The null hypothesis failed to be rejected.
3. What is the difference between teachers' beliefs about inquiry teaching and origin of inquiry teaching knowledge?	H ₀ 3: There was no difference between teacher beliefs of inquiry teaching and origin of inquiry teaching knowledge. The null hypothesis failed to be rejected.
4. What is the relationship of student achievement, as measured on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in mathematics and reading of third-, fourth-, and fifth-grade students, and teachers' beliefs about inquiry teaching during the 2012-2013 school year?	H ₀ 4: There was no relationship in student achievement and teachers' beliefs of inquiry teaching. The null hypothesis failed to be rejected.

Summary

In this chapter, the statistical tests and analyses that were to be discussed were reviewed followed by a presentation of demographic data for teachers responding to the survey. Descriptive tabular data were provided for each of the four variables in the study: International Baccalaureate Primary Years Programme (IBPYP) affiliation, origin of inquiry teaching strategy knowledge, and student achievement levels in mathematics and reading as measured by the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0). An item analysis of teachers' beliefs about inquiry-teaching strategies as measured by the McGill Strategic Demands of Inquiry Questionnaire (MSDIQ) was also presented in a series of tables and discussed. The chapter concluded with a summary of the analysis of data for each of the four research questions which guided the study.

Results from the study indicated no statistical difference in the origin of inquiry teaching strategies and student achievement levels or in the origin of inquiry teaching strategies and teacher beliefs of inquiry teaching strategies. No difference could be determined between IBPYP affiliation and student achievement. There was no statistical relationship between the three domains of teacher beliefs in inquiry teaching strategies and student achievement levels.

Chapter 5 contains a summary and discussion of the findings of the study. Also offered are implications for practice and recommendations for further research.

CHAPTER 5 SUMMARY, DISCUSSION, AND RECOMMENDATIONS

Introduction

In the preceding chapter, the presentation and analysis of data have been presented. Chapter 5 consists of a summary of the study, discussion of the findings, implications for practice, and recommendations for further research. The purpose of the latter portion of the chapter is to advance the discussion of best teaching practices and to provide knowledge to both administrators and teacher leaders as to the specific impact of inquiry on best teaching practices. In addition, recommendations for further study are presented in order to facilitate decision making in school districts and teacher preparation programs in the continuous attention that inquiry teaching strategies commands both nationally and internationally.

Summary of the Study

This chapter begins with a summary of the purpose and outline of the theoretical framework. The research questions and major findings related to inquiry-based teaching, origin of inquiry based teaching; student achievement and International Baccalaureate affiliation are discussed. Implications on teacher evaluation systems and educational leaders will be discussed. Finally, recommendations for further research will be presented.

The purpose of this study was to examine the difference between not only the origin of teaching inquiry strategies and student achievement but also the specific belief

systems of inquiry-based teaching of teachers and student achievement. In addition, the difference between school affiliation with the International Baccalaureate Primary Years Programme (IBPYP) and student achievement was sought. Finally, the study aimed to determine the relationship between student achievement and teacher's beliefs of inquiry-based teaching strategies.

Through legislation both nationally and locally, the improvement of teachers with the direct relationship to improved student achievement is prevalent. The Race to the Top Grant in 2010, challenged states to improve the quality of teachers and leaders as well as track student achievement, turn around low performing schools and the adoptions of more rigorous standards (U.S. Department of Education, 2010). The passage of the Student Success Act in Florida in 2011 demanded districts overhaul the teacher evaluation systems to include not only a value added model but also a measure that evaluates higher order thinking questions and probing for deeper learning as successful teaching strategies that yield high student achievement (Florida Department of Education, 2012). The systems that have been adopted or created include elements of inquiry based teaching and learning to meet the legislation.

The International Baccalaureate Primary Years Programme (IBPYP) is a curriculum philosophy that is derived from a constructivist approach, rooted in inquiry based teaching. Teachers and students affiliated with an IBPYP school are engaged in inquiry teaching and learning throughout six units of inquiry. The IB organization offers guidance in the approach through both written texts and professional development.

The legislative shifts from both the Florida state government and federal government which focus on improving teachers and accountability coupled with the availability of the IBPYP as a curricular program that emphasizes inquiry based teaching led to four research questions:

1. What is the difference between third-, fourth-, and fifth-grade teachers' origin of inquiry teaching knowledge and student achievement as measured on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013?
2. What is the difference in student achievement of third-, fourth-, and fifth-grade International Baccalaureate Primary Years Programme (IBPYP) students and non-IBPYP third-, fourth-, and fifth-grade students as measured on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013?
3. What is the difference between teachers' beliefs about inquiry teaching and origin of inquiry teaching knowledge?
4. What is the relationship of student achievement, as measured on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in mathematics and reading of third-, fourth-, and fifth-grade students, and teachers' beliefs about inquiry teaching during the 2012-2013 school year?

Three Florida public school districts, all of which had at least one IBPYP school at the time of the study, were contacted in regard to participation in the study. 124 teachers from eight schools in three counties were subsequently contacted (three IBPYP

schools and five non-IBPYP schools). Of the 124 surveys sent, 21 surveys were returned, resulting in a 17% response rate. Of the 21 surveys returned, 19 respondents replied to the demographic items and nine responded to the student achievement items.

For this study, student achievement was measured by self-reporting of responding teachers based on the 2012-2013 Florida Comprehensive Assessment Test 2.0 (FCAT 2.0). Teachers were asked to report the number of students per score level on both mathematics and reading.

In order to measure the beliefs of inquiry-based teaching strategies, teachers responded to a 79-item, Likert-type scale instrument, the McGill Strategic Demands of Inquiry (MSDIQ). The instrument contains three inquiry domains which assess the value a respondent places on each item in the context of inquiry-based teaching: planning, enactment, and reflection. Within the three domains are 14 highly intercorrelated factors that demonstrate the skills evident in inquiry literature: time and task organization, setting the task in context, co-construction, planning to solve the problem, taking into account students' interests and needs, linking ideas including view of the future, students' entering knowledge and affect, skills for collecting data and analyzing data, defining the problem space in terms of data characteristics, social context of solving the problem, communication of results, expanding the data or information search, explanation, reflection and evaluation, and questioning the results and follow-up questions (Shore et al., 2012). Respondents were asked to indicate the importance in inquiry based learning and teaching of the 79 items on an 11-point scale (0-10). The median of the three

domains were used to determine the difference between origin of inquiry teaching strategies and the relationship with student achievement.

The origin of inquiry teaching strategies were self-reported by responding teachers in one of five categories; undergraduate school, graduate school, district provide workshop, International Baccalaureate (IB) provided workshop or other such as professional reading or social media. Due to the small number of participants, the groups were combined into two groups: undergraduate school, graduate school and other in one group; district provided workshop and IB provided workshop in the second group.

Research Questions 1 and 2 were answered using the FCAT 2.0 student achievement data and groupings of either origin of inquiry teaching strategies or IB affiliation. A Mann-Whitney U was used to determine the difference. Research Question 3 was also answered using Mann-Whitney U to seek a difference between the two groups of origin of inquiry teaching strategies and the three medians from the MSDIQ within the three domains of planning, enactment, and reflection. Finally, Research Question 4 was answered using a Kendall's tau to determine the relationship between the medians from the MSDIQ and the student achievement levels on the FCAT 2.0 in both mathematics and reading.

Discussion of the Findings

Research Question 1

What is the difference between third-, fourth-, and fifth-grade teachers' origin of inquiry teaching knowledge and student achievement as measured on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013?

Student achievement was indicated through the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in both mathematics and reading. Achievement as a result of this test, encompasses an understanding of both the requirements of knowledge of a subject matter according to the adopted state standards and the process through which students solve problems and respond to questions. In the literature, there exists support for teachers to have extensive knowledge of both subject matter and pedagogical knowledge (Alake-Tuenter et al., 2013).

Through previous research, Henry (2003) concluded teachers who used more constructivist approaches had fewer office referrals. However, no correlation was established between greater constructivist approaches and higher student achievement as indicated by school grade. The researcher also stated the possible lack of training in constructivist approaches as a possible variable that could contribute to the acceptance of the null hypothesis.

The descriptive analysis revealed that four of the 19 participants believed they received knowledge of inquiry-based teaching strategies from either undergraduate or

graduate formal education. A total of 15 participants stated their understandings were from district provided workshops, International Baccalaureate provided workshops or other sources. It is of concern in school districts that contain elements of inquiry teaching within their evaluation systems that formal education did not always provide teachers with the tools needed to effectively implement inquiry-based strategies according to the descriptive data of this study. If a correlation exists between a school district's support in inquiry-based teaching strategies and an increase in student achievement, as indicated on an evaluation system, it is important to consider the professional development implications for districts.

Research Question 2

What is the difference in student achievement of third-, fourth-, and fifth- grade International Baccalaureate Primary Years Programme (IBPYP) students and non-IBPYP third-, fourth-, and fifth-grade students as measured on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in mathematics and reading in 2012-2013?

No difference could be determined due to the small number of participants who responded to the student achievement questions. There were a total of nine respondents, and eight were affiliated with an IBPYP school. Therefore, no statistical test could be run to test the relationship between IB affiliation and student achievement.

The lack of response could be due to the nature of self-reporting student achievement levels. The survey instrument was distributed in the fall of 2013.

Participants were asked to recall student achievement levels from the 2012-2013 school year. In addition, participants may have elected to not share student achievement data due to the sensitivity of the data. Student achievement data have been included in the value added model (VAM), making results of individual student achievement on the FCAT 2.0 50% of a teacher's evaluation (Florida Statute, 2013).

The student achievement data reported by eight IBPYP participants and one non-IBPYP participant were not normally distributed data. Proficiency on the FCAT 2.0 is established at level 3 in both mathematics and reading. Of the 187 student achievement scores reported for mathematics, only six students were reported having a level 1 or level 2. Therefore, 97% of the student achievement scores in mathematics were reported as a level three or above.

For reading, the raw data indicated 17 students earned a level 2 and no student earned a level 1. Thus, 91% of the student achievement scores in reading were reported as a level 3 or above.

According to Tan and Bibby (2012), students in IBPYP schools in the Americas region, scored at or above non-IBPYP peers on the International Schools' Assessment in expository writing, narrative writing, mathematics, and reading. The participants in this study indicated strong proficiency levels on the FCAT 2.0. Although a difference could not be determined between non-IBPYP student achievement and IBPYP student achievement, the levels reported did indicate a high student achievement rate.

Research Question 3

What is the difference between teachers' beliefs about inquiry teaching and origin of inquiry teaching knowledge?

There was no statistically significant difference between the two groups in origin of inquiry teaching knowledge (formal education and non-formal education) and teacher beliefs in inquiry teaching strategies within the three domains of planning, enactment, and reflection. Alake-Tuenter et al. (2013) indicated all teachers, regardless of years of service, required confidence in both subject matter knowledge and pedagogical content knowledge in order to successfully carry out inquiry-based instruction. The researchers also found ongoing professional development was essential to inquiry-based instruction.

The McGill Strategic Demands of Inquiry Questionnaire was designed to capture the “influence of social constructivist historical roots of inquiry teaching and learning” (Shore et al., 2011, p. 333). All of the 14 dimensions within the three phases of planning, enactment, and reflection, encapsulate the active role of the student in their knowledge acquisition. As shown in Tables 5-7, the item analysis demonstrates a very high level of importance in all of phases depicted. Of the upmost importance in the planning domain were “for the student to connect old and new knowledge,” (M=9.42) “for the teacher to encourage creative risk-taking” (M=9.58) and “for the teacher to give the amount of time needed, be flexible with time” (M=9.75). In the enactment domain, the concept of students making connections with prior knowledge once again demonstrated high importance, M=9.55. In addition, student engagement with asking questions and sharing learning with others demonstrated high importance, M=9.67. The same beliefs were

echoed by participants in the reflection domain. Participants believed students should question findings (M=9.25), reflect on the process (M=9.25), and explain results (M=9.42).

Research Question 4

What is the relationship of student achievement, as measured on the Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) in mathematics and reading of third-, fourth-, and fifth-grade students, and teachers' beliefs about inquiry teaching during the 2012-2013 school year?

As indicated in Table 4, student achievement data were not normally distributed. In mathematics, 97% of the students achieved a level 3 or above. In reading, 91% of the students achieved a level 3 or above. The indicators on the McGill Strategic Demands of Inquiry Questionnaire indicated a strong belief in the various 14 factors and three domains on inquiry teaching strategies. Although there was no statistically significant relationship between teacher beliefs about inquiry based teaching strategies and student achievement, there did exist both high student achievement and high means on the MSDIQ instrument in this study.

The results from all three of the domains were closely related to the findings of Puntambekar et al. (2007), who studied sixth-grade students who were exposed to two different teaching styles. The students who experienced inquiry teaching in which they were engaged in questioning, connected prior and new knowledge, experimented with their own designs, communicated with others about their learning and reflected on both

the process and new knowledge, performed better on open ended and concept map questions than students who did not have these experiences (2007).

It is important to note the correlation between the mean ranks of students who earned a level 4 in mathematics and the teachers' beliefs about inquiry teaching strategies in both the enactment and reflection domains (Kendall's tau enactment= $-.556$, $p=.060$; Kendall's tau reflection = $-.550$, $p=.070$). These findings indicated that teachers may support the implementation of more inquiry teaching strategies in mathematics.

Supported by Shymansky et al. (1990), much research has been conducted in science and mathematics as to the effectiveness of inquiry based teaching strategies. Weaker Kendall's tau values in reading would require further study to determine the amount of inquiry based teaching strategies used in the reading classroom.

Implications for Practice

In the movement towards continued accountability in education with an emphasis on improving teacher quality so that student achievement can be increased, the way teachers instruct students is of utmost concern for all school districts.

This study should be useful to Florida school districts that are under the direction of the Student Success Act of 2011 which mandated Local Education Agencies to create new teacher evaluation systems. These systems include national models from prominent researchers such as Marzano and Danielson as well as district created systems in 10 school districts (Florida Department of Education, 2014). All of the teacher evaluation systems examined for this study included at least one element associated with the use of

inquiry in the classroom. Though other studies have been conducted to examine inquiry-based teaching strategies and student achievement, this study investigated the origin of teacher knowledge of inquiry-based strategies. The understanding as to how universities are preparing future teachers and what pedagogical knowledge they are using in their curricula should be of special interest to any district professional development department.

Additionally, the results of the present study should be useful to persons involved in the International Baccalaureate Primary Years Programme (IBPYP) in that the program supports inquiry-based teaching methodologies. It is interesting to note the number of participants (N=5) who believed their origin of knowledge of inquiry teaching strategies was from an IBPYP workshop. IBPYP practitioners who are interested in growth in the scope of the IBPYP may want to consider the impact both district and IBPYP workshops have on teacher knowledge of inquiry-based teaching strategies. The number of participants who believed their knowledge was from district provided workshops could be due to the nature of an IBPYP school committed to providing in-house professional development which may have been interpreted to be a district workshop.

Recommendations for Further Research

The goal of the study was to examine a widely discussed pedagogical strategy that has been proven to impact learning. Inquiry as a method of acquiring knowledge has multiple definitions by a myriad of scholars. However, the expectation that teachers use

inquiry-based teaching strategies has infiltrated teacher evaluation systems in the state of Florida. Furthermore, schools that have selected the path to become International Baccalaureate Primary Years Programme schools adopt a pedagogical philosophy rooted in inquiry teaching.

Further research into the methodologies which universities are using to instruct pre-service teachers would yield more information to assist districts in their professional development practices. Approximately 57% of the respondents felt their inquiry knowledge came from the workshop model; either from a district workshop or an International Baccalaureate workshop. The expectation and acceptance of school districts' value in inquiry-based instruction, as evidenced by the teacher evaluation systems, would indicate an interest to universities who are educating future educators.

The limitations of this study included primarily a lack of participants. The 17% response rate did not yield full responses to the student achievement level items and limited the scope of three of the research questions. Further studies should be conducted using a different method and variable representing student achievement. Henry (2003) used school grades to measure student achievement. The elimination of teacher reported data for student achievement levels should be considered to increase response rates.

Marshall et al. (2007) suggested elementary teachers have a better understanding of inquiry based teaching strategies as well as a better understanding for science and mathematics teachers (2007). This study focused on elementary teachers and their perceptions of inquiry-based teaching strategies with a specific response from IBPYP teachers. From the selected sample, IBPYP teachers may have been more responsive due

to the very nature of the International Baccalaureate Programme. The foundation of the Primary Years Programme is to develop an internationally-minded learner who is able to construct knowledge through inquiry (International Baccalaureate, 2009). Therefore, further qualitative research into the nature of an inquiry-based classroom in an elementary setting would benefit the inquiry teaching body of knowledge.

Furthermore, research in regard to inquiry based teaching and student motivation in achievement and self-efficacy would help support the growing knowledge base of best practices. Similar to the findings of Henry (2003) who found the use of constructivist teaching methods to have a positive result in the number of discipline referrals, further research into the connections between inquiry teaching methods and discipline would also be beneficial to pedagogy.

Additional research in the use of the McGill Strategic Demands of Inquiry Questionnaire (MSDIQ) would be beneficial to school districts as they prepare for the professional development needs of their teachers. Specifically, analysis of the 14 factors would be beneficial. Shore et al. (2012) recommended using the instrument's factors and domains rather than each item to facilitate professional development alignment and planning.

Summary

The findings of this study contribute to the growing body of knowledge of inquiry-based teaching. The use of the McGill Strategic Demands of Inquiry Questionnaire (MSDIQ) demonstrated strong beliefs of the participants in regard to 14

factors of inquiry-based teaching (Shore et al., 2012). In addition, participants believed they received more knowledge of inquiry-based teaching from workshops provided by the district or International Baccalaureate Organization or from other sources such as professional reading rather than in their formal undergraduate or graduate education.

The state and federal education legislation of the 21st century have moved the teaching profession toward more accountability through increased student achievement and improved teaching strategies. The changes have been reflected in teacher evaluation systems in school districts across the state of Florida. The legislation has suggested a need for continued alignment of best teaching practices and student achievement in order to maximize the potential of all students. The literature has increasingly stressed successful learning through inquiry, as students continually construct their own knowledge.

APPENDIX A
McGILL STRATEGIC DEMANDS OF INQUIRY QUESTIONNAIRE (MSDIQ)

McGill Student Demands of Inquiry Questionnaire Teacher Version

Strategic Demands of Engaging in An Inquiry Task

Engaging in an inquiry task has several possible elements. We would like to know how you rate the importance of the following 79 items. Each item is prefaced by the question,

“how important is it in inquiry based learning and teaching. . . ?”

Please rate the importance of the following questions from 0 (low or "not at all") to 10 (high or "very much so") by placing an X on the corresponding number.

1- for the student and teacher to have co-ownership of the question

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

2- for the student and teacher to share construction of the curriculum

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

3- for the student and teacher to share decision-making

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

4- for the teacher to listen as much as he or she speaks

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

5- for the student to work in a nurturing and creative environment

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

6- for the student to extend inquiry beyond the classroom

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

7- for the teacher to tap into the student's and his or her own interests

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

8- for the teacher to explore his or her interest

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

9- for the teacher to address his or her needs and student's needs

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

“how important is it in inquiry based learning and teaching. . . ?”

10- for the teacher to provide a mentor

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

11- for the teacher to model skills needed for the inquiry

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

12- for the teacher to give the amount of time needed, be flexible with time

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

13- for the student to organize time and space

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

14- for the student to understand the goal of the task

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

15- for the student to divide the task into a coherent sequence of do-able steps

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

16- for the student to make a concept map or web or cluster

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

17- for the student to foresee possible outcomes of the activity

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

18- for the student to understand key concepts

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

19- for the student to understand instructions

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

20- for the student to describe his or her own problem-solving strategies

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

21- for the student to have previous experience with similar activities

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

22- for the teacher to encourage honest criticism of ideas

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

“how important is it in inquiry based learning and teaching. . . ?”

23- for the teacher to encourage creative risk-taking

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

24- for the student to connect old and new knowledge

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

25- for the student to set aside preparation time

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

26- for the student to brainstorm his or her ideas

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

27- for the student to make a plan

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

28- for the student to have different plans in advance to accomplish the task

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

29- for the student to have back up plans at the end should the project stall

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

30- for the student to feel free to use imagination

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

31- for the student to keep motivated

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

32- for the student to have self-motivation

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

33- for the student to get a high grade

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

34- for the student to win a prize

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

“how important is it in inquiry based learning and teaching. . . ?”

35- for the teacher to give sensitive feedback, positive reinforcement, praise for persistence

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

36- for the student to ask questions

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

37- for the student to restate or reformat the problem

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

38- for the student to make suggestions

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

39- for the student to share emotions, feelings, ideas, and opinions

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

40- for the student to develop expectations of what will happen next

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

41- for the student to offer hypotheses about outcomes

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

42- for the student to make careful observations

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

43- for the student to identify where to obtain data

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

44- for the student to recognize hidden meanings in data

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

45- for the student to record data

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

46- for the student to classify data

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

“how important is it in inquiry based learning and teaching. . . ?”

47- for the student to search for resources beyond textbooks

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

48- for the student to search the Internet and World Wide Web

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

49- for the student to separate relevant and irrelevant information

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

50- for the student to apply previous knowledge to new concepts

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

51- for the student to understand how preconceptions affect learning

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

52- for the student to be aware of how the inquiry event affects him or her personally

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

53- for the student to keep an open mind to change

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

54- for the student to address doubts directly

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

55- for the student to assist others to make observations

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

56- for the student to find patterns in data

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

57- for the student to value personal judgment

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

58- for the student to verify data or information

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

59- for the student to compare and contrast data with someone else's

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

“how important is it in inquiry based learning and teaching. . . ?”

60- for the student to anticipate and respond to arguments in opposition to one's view

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

61- for the student to seek different viewpoints

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

62- for the student to test ideas and hypotheses

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

63- for the student to have a mental representation of the task

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

64- for the student to construct new knowledge

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

65- for the student to interact with or manipulate his or her surroundings

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

66- for the student to communicate one's learning with others

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

67- for the student to consider diverse means of communication

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

68- for the student to organize the presentation of the project

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

69- for the student to present data in tables and graphs

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

70- for the student to use vocabulary appropriate to the audience and topic

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

71- for the student to accept that more than one solution might be appropriate

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

72- for the student to apply new knowledge to future experiences

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

“how important is it in inquiry based learning and teaching. . . ?”

73- for the student to record methods, results, and conclusions

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

74- for the student to explain the results

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

75- for the student to question the findings

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

76- for the student to reflect upon his or her inquiry experience

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

77- for the student to discuss what has been learned compared to what was known before

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

78- for the student to evaluate the inquiry experience

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

79- for the student to follow-up the project with a new set of questions

① ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

APPENDIX B
INSTITUTIONAL REVIEW BOARD APPROVAL



University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1
FWA00000351, IRB00001138**

To: **Lucy Haddock**

Date: **September 24, 2013**

Dear Researcher:

On 9/24/2013, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	A COMPARISON OF TEACHERS' BELIEFS OF THE USE OF INQUIRY TEACHING, ORIGIN OF KNOWLEDGE OF INQUIRY TEACHING AND STUDENT ACHIEVEMENT BETWEEN INTERNATIONAL BACCALAUREATE AND NON-INTERNATIONAL BACCALAUREATE PRIMARY YEARS PROGRAMME SCHOOLS
Investigator:	Lucy Haddock
IRB Number:	SBE-13-09556
Funding Agency:	
Grant Title:	
Research ID:	n/a

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 09/24/2013 11:19:10 AM EDT

IRB Coordinator

APPENDIX C
RESEARCHER COMMUNICATIONS
WITH SCHOOL DISTRICT REPRESENTATIVES

School Board of Brevard County

2700 Judge Fran Jamieson Way Viera, FL 32940-6699

Dr. Brian Binggeli, Superintendent



November 4, 2013

Dear Ms. Haddock,

Thank you for your application to conduct research in the Brevard Public Schools. This letter is official verification that your application has been accepted and approved through the Office of Accountability, Testing, & Evaluation. However, approval from this office does not obligate the principal of the schools you have selected to participate in the proposed research. Please contact the principals of the impacted schools in order to obtain their approval **BEFORE** you contact the teachers you want to complete your survey. You must have the principal's approval. Upon the completion of your research, submit your findings to our office. If we can be of further assistance, do not hesitate to contact our office.

Sincerely,

Vickie B. Hickey

Vickie B. Hickey, Resource Teacher
Office of Accountability, Testing, and Evaluation

Office of Accountability, Testing & Evaluation
Phone: (321) 633-1000 FAX: (321) 633-3465

THE SCHOOL DISTRICT OF OSCEOLA COUNTY, FLORIDA

817 Bill Beck Boulevard • Kissimmee • Florida 34744-4492
Phone: 407-870-4600 • Fax: 407-870-4010 • www.osceola.k12.fl.us

SCHOOL BOARD MEMBERS

District 1 – Jay Wheeler – Chair
407-973-4141
District 2 – Kelvin Soto
407-363-2462
District 3 – Tim Weisheyer
407-363-0235
District 4 – Barbara Horn – Vice Chair
407-462-5642
District 5 – Tom Long
407-462-5782



Superintendent of Schools
Melba Luciano

October 25, 2013

Lucy Haddock
116 Esther Drive
Cocoa Beach, FL 32931

Dear Ms. Haddock:

This letter is to inform you that we have received your request to conduct research in our School District. Based on the description of the research you intend to conduct, I am pleased to inform you that you may proceed with your work as you have outlined.

I will remind you that all information obtained for the purpose of your research must be dealt with in the strictest of confidentiality. At no time is it acceptable to release any student or staff identifiable information.

I wish you the best of luck in your future endeavors. If I can be further assistance, please do not hesitate to contact me.

Sincerely,

Janine Jarvis, Director
Research, Evaluation & Accountability

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District 5 – Tom Long
407-462-5782



Superintendent of Schools
Melba Luciano

Approval of Office of Research, Evaluation & Accountability*:


Signature

10-25-13
Date

*Approval of the study at the district level does not obligate principals to participate in the proposed research.

Approval of Principal*:

Signature

Date

*The principal's signature suggests that the research project has been reviewed and that the school will participate, subject to the researcher's compliance with District policies.

From: Sandra Wesson <sandra.wesson@palmbeachschools.org>
Sent: Thursday, November 21, 2013 9:08 PM
To: Haddock, Lucy@Freedom
Subject: Two schools

The Principal at Morikami Park and the Principal at a non-PYP school have agreed to participate in your research study. Here is their contact information:

Morikami Park
Stacey Quinones, Principal
stacey.quinones@palmbeachschools.org

Sunrise Park
Alicia Steiger, Principal
alicia.steiger@palmbeachschools.org

Sorry it took so long to get these to you.

Sandra Wesson
Manager--Choice Programs
District IB Coordinator
School District of Palm Beach County
Choice and Career Options Department
Phone: 561-357-7639 or PX 47639; FAX: 561-434-7300
E-Mail: sandra.wesson@palmbeachschools.org



Good Sports: *Covering the best in Palm Beach County School Sports, airing nightly at 7 p.m. on Comcast 234 and AT&T UVerse 99.*

Disclaimer: Under Florida law, e-mail addresses are public records. If you do not want your e-mail address released in response to a public records request, do not send electronic mail to this entity. Instead, contact this office by phone or in writing.

Due to Florida's broad public records law, most written communications to or from government employees regarding public education are public records. Therefore, this e-mail communication may be subject to public disclosure.

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