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Investigating Inquiry-based Learning: Teachers Perspectives at a K-12 School

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Investigating Inquiry-based Learning: Teachers' Perspectives at a K-12 School

By

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Dedication

I would like to dedicate this work to my parents, Mr. and Mrs. Mojibul Chowdhury, for showering me with unconditional love; my wife and best friend, Mahmuda Sultana, for the endless support and encouragement; and my children, Zahra, Zaheen, and Zubayr Chowdhury, for bringing a smile to my face every day.

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Abstract

Inquiry-based learning (IBL) is receiving a lot of attention and consideration as a modern instructional method. Teaching strategies that actively involve students in the learning process through inquiry instructions are more likely to increase conceptual understanding than of strategies that rely on more passive techniques. The purpose of this study is to better understand how a selected group of five teachers perceive and practice inquiry-based learning (IBL) as an instructional method in their classrooms across all disciplines at one K-12 school. This study employed a case study methodology to better understand teachers' perceptions, practices, and technology integration, while using IBL in a metropolitan classroom setting. Data was accumulated through semi-structured, open-ended interviews and classroom observations. A qualitative case study approach was used to collect and interpret the teachers' individual experiences. The following research questions guided this study: How do a selected group of teachers perceive, plan, implement, and integrate technology while utilizing Inquiry-Based Learning (IBL) as an instructional strategy in their classrooms?

This case study revealed four major themes: teachers understood and implemented IBL in different ways; teachers recognized that IBL is helpful for better knowledge construction; teachers expressed that planning an open inquiry learning environment is extraordinarily challenging, and technology is beneficial for an inquiry learning environment despite its own challenges. Finally, teachers liked IBL for its many learning benefits and acknowledged that it is difficult to plan an open-inquiry learning environment. Each of the teachers implemented IBL slightly differently though they all followed a comprehensive and complete learning cycle.

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Chapter 1: The Problem

Introduction

Globally, educators are working hard to develop instructions across multiple disciplines to embrace and promote twenty-first century skills, which ask students to develop problem-solving skills by mastering information literacy (Chu, Reynolds, Tavares, Notari, & Lee, 2017). Educating our students is not an easy task in this rapidly changing and complex environment; fast technological innovation and dramatically changing social and cultural environments require lifelong learners who can construct their own knowledge by going beyond traditional content learning. Chu et al. (2017) eloquently stated that, "The twenty-first century skills standards seems to demand inquiry-oriented approaches to learning without explicitly saying so." (p. v) Though the U.S. educational system is encouraging teachers to deliver meaningful learning by focusing on students' active participation, critical thinking, problem solving, knowledge construction, collaboration, and communication, our assessment approaches still tilled heavily on standardized testing (Chu et al., 2017). To break the trend of stagnation and place the United States among the top five performers on the international stage at the education level, U.S. needs inquiry-based learning (IBL) that promotes understanding over memorization and assessments, which are intentionally designed to measure student knowledge integration abilities over standardized tests (Liu, Lee, & Linn, 2010). The United States is not among the top five performers in either math or science. To break this trend, the students in the United States must learn complex problem-solving techniques instead of memorizing algorithms or definitions (Marshall & Horton, 2011). These below-average assessment results are the early warning signs of our nation's future economic welfare as the quality of labor force has a direct correlation with

the performance on the international math and science assessments (Hanushek, 2004). Hanushek (2004) stated that if the U.S. can be positioned at the average level of European achievement distribution, the U.S. economy will gain a half of one percent boost in per capita income, i.e., about an increase of $2,000 per capita income after 10 years. Schools, teachers, administrators, educators, policy makers, and legislators can and should work together to help our students develop higher-order cognitive thinking by introducing active, participative, and higher-order thinking inquiry-based instructions across all disciplines instead of simply transferring passive knowledge into rote memorization.

In the traditional learning setup, teachers actively pass the structured information to the students while the students passively consume the delivered information (Loyens, & Rikers, 2011). If teachers encourage and enforce knowledge exploration by students before explaining new concepts and lessons, students can construct a better learning of the concept (Marshall & Horton, 2011). According to Loyens and Rikers (2011), teachers play a central role in inquiry-based instructions by proving stimulating questions and allowing students to explore and formulate their answers instead of delivering students with questions and answers. Marshall and Horton (2011) concluded that students will demonstrate a higher level of cognitive skills when teachers allocate more time to student exploration. On the contrary, Kirschner, Sweller, and Clark (2006) criticized inquiry-based methods for its minimal guidance during the instruction while dealing with non-expert or novice students. They mentioned the limitations of working memory which will cause a high cognitive load during inquiry instruction. Due to high cognitive load, newly learned knowledge may not be passed to the long-term memory successfully. They were also concerned about developing misconceptions and disorganized knowledge among the students under minimally guided learning. As a result, they concluded that inquiry-based

methods are mostly ineffective. In response to Kirschner et al., Hmelo-Silver, Duncan, Chinn (2007) provided a solution to overcome the high cognitive load by utilizing scaffolding while implementing inquiry instruction.

Common Core State Standards (CCSS) requires educators to learn how to ask essential questions to their students to encourage critical thinking and innovation (Wilhelm, 2014). Despite the presence of a decade of rich literature promoting the need and importance of IBL, there is little evidence that IBL is widely used in the U.S. classrooms (Hermann & Miranda, 2010). Blanchard, Osborne, Wallwork, and Harris (2013) suggested that success in implementing inquiry learning in the classroom can be achieved; however, we first need to ensure that our teachers feel comfortable teaching inquiry instructions. Teachers need access to quality inquiry training and other supportive resources to boost their comfort level while teaching inquiry learning. Some of the best teachers are finding it difficult to implement inquiry learning in the classroom setting, which helps support reformed-based Common Core State Standards. Keys and Bryan (2001) emphasized that a teacher's voice and concerns should be included when designing and implementing inquiry-based curriculum, as teachers play a central role in the successful implementation of educational reform efforts. According to Tamim and Grant (2013), teachers have positive perceptions about inquiry-based instructions. Teachers expressed four sets of benefits while implementing inquiry-based instructions: teachers provide facilitation and support during the learning process, teachers can differentiate in their teaching and assessment among students, teachers can motivate students and keep them engaged by providing them a sense of ownership, and teachers can lead the students to learn important soft skills: collaboration, communication, cooperation, time management, and project management (Tamim & Grant, 2013).

Finally, Capps and Crawford (2013) concluded that teachers skipped the inquiry learning approach in half of the allocated classroom time due to their limited understanding of inquiry-based learning. Nevertheless, according to Hmelo-Silver et al. (2007), empirical evidences strongly support that inquiry learning can foster deep meaningful understanding among the students along with positive gains in students' standardized tests. Hmelo-Silver (2006) placed extensive emphasize on incorporating scaffolding in inquiry instruction to leverage optimum learning benefits for the students. Hmelo-Silver and Barrows (2006) acknowledged that teachers play a pivotal role in scaffolding by pushing the students to think deeply by asking critical thinking questions which students can utilize as model questions. In conclusion, this study primarily focused on understanding the teachers' perspectives, practices, and technology integration while they were delivering inquiry-based instructions.

Statement of the Problem

Teaching strategies that actively involve students in the learning process through inquiry instructions are more likely to increase conceptual understanding than strategies that rely on more passive techniques, which are often necessary in the current standardized-assessment laden educational environment (Minner, Levy, & Century, 2010). Brown (2012) suggested that teachers can provide genuine learning experiences by promoting active student discourse through inquiry learning approaches. Schroeder, Scott, Tolson, Huang, & Lee (2007) discovered that alternative teaching strategies are more effective than that of traditional classroom lectures. According to Ireland, Watters, Brownlee, and Lupton (2012), though teachers in U.S. schools do not have a well-defined singular concept of inquiry learning, their conception and attitude matter

significantly? in inquiry learning in the classroom. Their research claims that an individual teacher has his or her unique way of dealing with inquiry teaching and learning.

Purpose of the Study

The purpose of this study was to better understand how a selected group of five teachers perceive and practice inquiry-based learning (IBL) as an instructional method in their classrooms across all disciplines at one private K-12 school. This study employed a case study methodology to better understand teachers' perceptions, practices, and technology integration, while using IBL in a metropolitan classroom setting. Data were accumulated through semi structured, open-ended interviews and classroom observations. A qualitative interpretive approach was used to capture and interpret the teachers' experiences.

Research Questions

The following research questions helped guide this study:

1. How does a selected group of teachers perceive Inquiry-Based Learning (IBL) as an instructional strategy in their classrooms?
2. How does a selected group of teachers plan IBL as an instructional strategy in their classrooms?
3. How does a selected group of teachers implement IBL as an instructional strategy in their classrooms?
4. How does a selected group of teachers integrate technologies while utilizing IBL as an instructional strategy in their classrooms?

Importance of the Study

Studies have provided data to support the case that students in our schools perform better when teachers ask intriguing questions to the students without providing the answers (Marriott, 2014). Successful teachers initiate and involve the students in persuasive dialogue through essential questioning to challenge the students to discover, share, link, and apply what they are learning (Wilhelm, 2014). Technology plays an important role in the twenty-first century learning environment. Technology integration while performing inquiry-based instructions can help the students in multiple ways: access relevant information instantaneously, collect and record students' findings, collaborate with other students and experts across the world, present and share organized findings through multimedia, have authentic and meaningful assessments, and share newly constructed knowledge to the world for review and feedback (Coffman, 2017).

While technologies are merely supporting tools, teachers, who are the leaders in their classrooms, are responsible for implementing new educational approaches through instructions. Teachers' knowledge, ability, professional development, adaptability, attitude, and instructional delivery approach have a significant impact on making their classroom productive and successful for their students (Spencer & Vavra, 2015). To better learn and understand the influence of teachers in inquiry-based learning, more research should be dedicated in the areas of teachers' beliefs, knowledge, practices, competencies, professional development, and collaboration among themselves. Settlage (2007) suggested that it is unrealistic for teachers to implement the inquiry learning method daily, as he speculates that open inquiry is difficult to practice in the classroom.

Knowledge acquired through this study will help the board of directors, educators, and administrators of the participating school to better understand teachers' perceptions, practices, and technology integrations while practicing inquiry-based instructions in a small school setting.

This study may embolden the importance of some existing practices and technological integrations for successful IBL implementation. Lessons learned from this case study will help many educators design and implement IBL in K-12 classrooms by avoiding the pitfalls and by embracing the successful practices and technologies. Finally, this study may bring attention to new areas of opportunity or challenges in relation to IBL for future researchers and educators.

Organization of the Study

This research study attempted to better understand the participating teachers' perceptions, practices, and technology integrations while utilizing inquiry-based instructions in their classrooms. First, the researcher conducted a literature review of inquiry-based learning to understand its historical background, the current trends of utilizing inquiry-based learning in K-12 schools, the influencing factors for successful implementation of IBL, and finally, the benefits & challenges of inquiry-based learning as an instructional method.

A qualitative case study approach was utilized for this dissertation research project. Qualitative research approaches are especially suitable for capturing human actions that take place in natural settings and it is quite impossible to derive the meaning of these human actions without considering the space, context, culture, and participants' experiences, i.e., the participants' frame of references. One of the most important aspects of the qualitative approach is its ability to capture and recognize multiple perspectives (Marshall & Rossman, 2016).

This case study covered only one specific private K-12 school with less than 500 students. This research project dealt with human subjects which required preapproval from the University of Memphis' Institutional Review Board (IRB) before conducting the actual research. After acquiring approval from the University of Memphis' IRB, the researcher invited research participants who meet the following criteria to join the case study: teachers who practice inquiry-

based instructions in their classrooms and have at least two years of teaching experience. The principal of the school selected five participants based on their number of years of teaching experience, willingness to participate, and availability.

The researcher primarily utilized interview and observation methods for data collection. The researcher scheduled a one-hour interview with each of the participating teachers. During the interview, the researcher focused only on the pre-established research questions and spontaneous follow up questions or probes based on participants' responses. The researcher used an audio recorder to capture the full interview as raw data and used a transcription software to generate the interview transcript. Audio recorded data was transcribed and shared with the participating teachers to authenticate the accuracy of the transcribed data. If there was any confusion regarding any segment of the raw dataset, the researcher cross checked with the participating teachers to verify the accuracy of the dataset to accurately reflect the participants' view.

The researcher conducted classroom observations to learn about teachers' understanding, practices, and technology integration while utilizing IBL in the classroom setting. The researcher observed the participants in their natural settings to capture the thick description of verbal and non-verbal incidents to develop a better understanding of some of the research questions. The researcher stored raw data electronically to ensure security and 24/7 availability of the raw data.

The researcher utilized coding methods to uncover the patterns of perceptions, practices, and technology utilization surrounding inquiry-based instructions. Upon discovering the patterns, the researcher grouped the data set to construct major themes or concepts for this research study. Interpreting the developed theme constructed the final step of this research study which was

reflected in the final chapter. The final chapter discussed the researcher's significant findings, interpretation of the major themes, and recommendation for future research areas.

Definition of Terms

Having a sound understanding of the following terms will help the audience to better understand this research project.

Inquiry-based learning. Inquiry-based learning is a student-centered, active learning method in which teachers ask essential questions to the learners to encourage construction of their own knowledge through an inquiry cycle. According to Li, Moorman, and Dyjur (2010), the five key steps in an inquiry-based learning cycle are ask: investigate, create, discuss, and reflect. Asking essential questions, without giving the answers first, lies at the center of the inquiry-based teaching and learning environment where teachers encourage open and active participation of the students by asking meaningful and relevant questions (Wilhelm, 2014).

Engage. The engage stage is the initiating stage of an inquiry-based learning method. During this stage, a teacher initiates a relevant and interesting discussion on a topic to grab the students' attention. Teachers ask essential questions to generate curiosity and interest among the students. Students' curiosity and interest should lead to students' active participation through dialogue and creative thinking. A teachers' job is to ensure persuasive discourse instead of imposing discourse to encourage open discussion and mass participation of the students. This initial discussion on a topic allows the students to ask foundational questions to clarify any misconceptions. Teachers can discuss concepts to check the readiness of the students in terms of pre-requisite skills on the relevant topic. Students should develop their own inquiry questions through involved dialogue and active participation by the end of engage stage.

Active learning. In a traditional learning setup, teachers actively pass the structured information to the students while students passively consume the delivered information. In an active learning environment, students actively participate in knowledge exploration and knowledge construction. If teachers encourage and enforce knowledge exploration by the students before explaining new concepts and lessons, students construct better learning of the concept (Marshall & Horton, 2011).

Constructivist approach to learning. The constructivist approach to learning emphasizes the construction of new knowledge among the learners based on their individual context, environment, and experiences. Constructivist designers view instruction as, "a process of supporting [knowledge] construction rather than communicating knowledge." (Cunningham & Duffy, 1996, p.171) The constructivist classroom is an environment where learners actively inquire and originate new knowledge and ideas through active participation, open dialogue, interaction, presentation, sharing, and negotiation. In this setup, the teachers' role is to guide and moderate the discussion rather than passively passing information to the learners.

Zone of proximal development (ZPD). The constructivist approach to learning emphasizes the learners to go beyond something given. Vygotsky (1978) revealed a gap between a child's, "actual developmental level as determined by independent problem solving" and the higher level of, "potential development as determined through problem solving under adult guidance or in collaboration with more capable peers." (p.86) Vygotsky coined this term as the "zone of proximal development".

21st century learners. AASL's (American Association of School Librarians) standards for the 21st-Century Learner provides vision for teaching and learning by promoting inquiry

framework of learning; i.e., to promote inquiry, critical thinking and eventually constructing new knowledge (Marriott, 2014).

21st century skills. "Our educational system needs to educate our students to be job and college ready by teaching them twenty-first century skills, which are comprised of three main knowledge domains: innovative thinking, information, media, and ICT (information, communication, and technology) skills, and life and career skills." (Chu et al., 2017, p. 8) Coffman (2017) recommended that "it is important to include twenty-first-century skills, such as communication, managing projects, and using technology, as well as the National Educational Technology Standards for Students (NETS.S) developed by the International Society for Technology in Education ISTE)." (p. 46)

Common Core State Standards (CCSS). The National Governors Association (NGA) and the Council of Chief State School Officers (CCSSO) jointly developed Common Core State Standards Initiative (CCSSI) to address the need of twenty first century skills in the U.S. "The Common Core State Standards (CCSS) framework reflects the national level core curriculum in the U.S. in the subject domains of English Language Arts/Literacy (ELAL) and mathematics." (Chu et al., 2017, pp. 28-29) Common Core State Standards (CCSS) require educators to learn and teach how to ask essential questions to their students to encourage critical thinking and innovation (Wilhelm, 2014).

International assessment programs. Two of the distinct and leading international assessment programs are: The Program for International Student Assessment (PISA), which is under the umbrella of the Organization for Economic Co-operation and Development (OECD), and the Trends in International Mathematics and Science Study (TIMSS). These assessments are

the benchmark for comparing the outcome of the standardized tests of math, science, and reading for 15-year-old participating students representing different countries.

Educational technology. The primary role of any educational technology is to optimize the learning output. There are numerous educational technologies utilized by teachers including interactive white boards, projectors, video conferencing and virtual field trips, podcasts, augmented reality, Google Educational Suit, concept maps and diagrams, mind maps, internet and mobile technologies, web 2.0, wiki, blogs, and learning management systems (LMS). The primary goal of any technology integration as a cognitive tool is to encourage active participations of students by igniting curiosity and higher order reflective thinking through knowledge exploration and discovery (Chu et al., 2017; Coffman, 2017; Kuhlthau, Maniotes, & Caspari, 2015; Boss & Krauss, 2014).

Chapter 2: Review of the Literature

Background

"Most students today attend classes day after day and experience rote learning and top-down instruction, without a clear understanding of how their in-school engagement connects to the world outside their classrooms and their future life and livelihood possibilities." (Chu et al., 2017, p. 5) Educators and policy makers, across the states, are not happy with our educational framework for K-12 schools and have continuously made substantial policy changes over the last two decades to ensure ongoing progress. The No Child Left Behind (NCLB) Act of 2001 asks for accountability among school administrators and teachers that is primarily based on their students' performance in standardized tests within the core subjects of math, science, English/language arts, and social studies. President Barack Obama signed Every Student Succeeds Act (ESSA) in 2015, which replaced NCLB. ESSA granted flexibility to states in designing curriculum and assessment criteria tailored to the localized population to close the achievement gaps, improve quality of instructions, increase equity, and increase outcome for all students (Chu et al., 2017).

Technology is continuously and rapidly disrupting the way we teach, learn, perform our jobs, communicate with each other, and share our ethical and social responsibilities (Chu et al., 2017). Survey data from 2013 Pew Research confirms that 94% of U.S. jobholders use internet at work regardless of type, size, or location of industries (Purcell & Rainie 2014). Globalization is bringing new competition to U.S. job markets, while automation is drastically replacing U.S. workers with machines and intelligent information systems. Consequently, according to Levy and Murnane (2012), our students should have sound digital, analytical, and communicational skills to compete and excel in the U.S. labor market. In other words, our schools need to educate

our students to be job and college ready by teaching them twenty-first century skills, which are comprised of three main knowledge domains: innovative thinking; information, media, and ICT (information, communication, and technology) skills; and life and career skills (Chu et al., 2017, p. 8). The National Governors Association (NGA) and the Council of Chief State School Officers (CCSSO) jointly developed Common Core State Standards Initiative (CCSSI) to address the need of twenty first century skills in the U.S. "The Common Core State Standards (CCSS) framework reflects the national level core curriculum in the U.S. in the subject domains of English Language Arts/Literacy (ELAL) and mathematics." (Chu et al., 2017, pp. 28-29)

Despite all these great policy and educational framework initiatives, based on the historical reports published by the Organization for Economic Co-operation and Development (OECD), fifteen-year-old U.S. students have participated in international testing since the 1960s but historically they are not performing well and consistently rank in the bottom half of the participating countries. Two of the distinct and leading international assessment programs are: The Program for International Student Assessment (PISA), which is under the umbrella of the Organization for Economic Co-operation and Development (OECD), and the Trends in International Mathematics and Science Study (TIMSS). These assessments are the benchmark for comparing the outcome of the standardized test of math, science, and reading for 15-year-old participating students representing different countries. Although over the last four decades the United States has participated in each of the last fifteen international assessments, U.S. students neither performed well nor showed any signs of improvement over that time. In 2015, among the thirty-five OECD countries, the United States ranked 31st in mathematics, 20th in reading, and 19th in Science (OECD, 2015). Although U.S. students demonstrated strengths in lower-order cognitive mathematical skills and abilities, they showed tremendous weaknesses in modeling and

solving higher-ordered cognitive activities related to mathematical models. The U.S. has substantial economic advantages over most of the participating countries, spending the 5th highest amount of money per student, and U.S. parents are better educated than parents from most other participating countries (OECD, 2015). Considering its economic advantage and parental education levels, the U.S. can and should do a much better job in preparing its students to break through this stagnation and place its fifteen-year-olds among the top preforming nations.

After all, it is teachers who are responsible for the execution of any instruction in the classroom. Teachers determine through building curriculum and the delivery process whether an instruction will produce meaningful learning to acquire twenty-first century skills or not (Spencer & Vavra, 2015). In a study conducted by Lebak and Tinsley (2010), teachers videotaped their teaching, participated in weekly peer group collaborative reflection sessions, collaborated with students, and consulted with other sources to identify goals for improving their teaching practices, developing action plans, and analyzing the results of their actions. After going through this exercise, teachers changed their pedagogical approach from a teacher-centered, textbook-driven approach to a student-centered, inquiry-based approach.

At its core, an inquiry-based teaching and learning environment encourages teachers to ask essential questions that foster creative thinking and active discussion among students (Wilhelm, 2014). Students in the United States need to learn how to think critically both in the classroom and beyond the classroom setting. Though many commissions, studies, and reports continue to call for the adoption of inquiry-based learning approaches in our classrooms (Marshall & Horton, 2011), there is little evidence that IBL is widely used in our classrooms (Hermann & Miranda, 2010).

What is Inquiry-based Learning (IBL)?

Inquiry-based learning evolved over time where multiple educational researchers made slow and gradual contributions over an extended period of time to establish this notion in education. Inquiry-based learning came into existence through a series of involved dialogue regarding different approaches of learning and teaching, in particular from the work of Jean Piaget, Lev Vygotsky, and David Ausubel. The work of these theorists was blended into the philosophy of learning known as constructivism (Cakir, 2008), which was then used to shape instructional materials.

Inquiry-based learning is rooted in learning by discovery. Jerome S. Bruner, an American psychologist, made significant contributions in defining discovery learning. Bruner's works focused on three distinct components while dealing with cognitive learning theory. Three key tenets are: the role of culture and structure in learning, the spiral curriculum, and discovery learning (Jiang & Perkins, 2013).

Bruner described culture as the toolkit for sense-making and communication (Takaya, 2008). Learners make sense of the words, images, and concepts according to their own culture, beliefs, and shared views. Cultural values are not constant themselves, but rather diverse and evolving in nature. Cultural aspects of the education direct the learners to think about alternative views and encourages the learners to explore multiple perspectives before coming to a conclusion (Takaya, 2008). The structural component demands that the learners understand the new concept by linking it with existing knowledge instead of simply memorizing in the vacuum to reproduce (Jiang & Perkins, 2013). The structure component further emphasizes disciplined understanding by expanding and deepening a learner's existing knowledge.

The spiral curriculum concept encourages revisiting foundational concepts repeatedly until learners display mastery on those basic concepts. The third component, discovery learning, promises that learners utilize past knowledge and current experience to explore facts and relationships to develop new knowledge and understanding within themselves. The key idea here is to construct new knowledge by going beyond the presented facts and concepts.

The constructivist approach to learning emphasizes that the learners need to go beyond something given. Vygotsky revealed a gap between a child's, "actual developmental level as determined by independent problem solving" and the higher level of, "potential development as determined through problem solving under adult guidance or in collaboration with more capable peers." (1978, p.86) Vygotsky coined this term as the "zone of proximal development". The concept of scaffolding is grounded in the theory of zone of proximal development (ZPD) (Vygotsky, 1978). Scaffolding is a process of providing learners with a bare minimum of support in the form of encouraging, explaining, modeling, or questioning to cross the ZPD to construct new knowledge or skills (Richey, Klein, & Tracey, 2011).

According to Bruner, there are two distinct advantages of discovery learning. First, learners can construct new knowledge within themselves, and secondly, this new knowledge will reshape the culture of the learners. Bruner criticizes John Dewey's experience-based education concept as it fails to encourage the learners to expand their perspectives beyond their familiar territory. Bruner defined discovery as, "all forms of obtaining knowledge for oneself by the use of one's own mind." (1961, p.22) In essence, this is a matter of "rearranging or transforming evidence in such a way that one is enabled to go beyond the evidence so assembled to additional new insight." (Bruner, 1961, p.22)

Fundamentally, constructivist designers view instruction as, "a process of supporting [knowledge] construction rather than communicating knowledge." (Cunningham & Duffy, 1996, p.171) The constructivist classroom is an environment where learners actively inquire and originate new knowledge and ideas through interactive dialogue, presentation, sharing, and negotiation. In this setup, teachers' role is to guide and moderate the discussion rather than passively passing information to the learners.

Constructivist teachers provide direction to the learners by engaging them in inquiry activities and by stimulating student centered active discussion and knowledge sharing, i.e., promoting active learning in a social setup where learners construct new knowledge according to their prior knowledge, social realities, peers' perspectives, and new findings (Bruner, 1986). The constructivist teachers introduce tasks which will ignite active thinking in the mind of the students to conceptualize new learning by reorganizing learners' existing knowledge and past socio-cultural perceptions (Clements & Battista, 1990).

Cognitive theorists posed a question regarding the role of the mind in constructing new knowledge, i.e., either a mind constructs unique meaning based on its individual perceptions of reality or a mind is simply a tool for reproducing the real world. Bruner (1990) appreciated this new discourse and supported strongly that the mind helps in the process of unique meaning making based on individual conceptions of reality.

Bruner (1986) believed that constructivism began with Kant who argued in his *Critique of Pure Reason* for "priori knowledge" that in absence of such knowledge no reasoning can evolve. In presence of a priori knowledge and past perceptions acquired from the environmental interactions (how the world appears to us), we reason, learn, and connect new knowledge onto a posterior knowledge.

Piaget, one of the most famous constructivist epistemological thinkers, argued that the learners' new knowledge construction portrays the real world in which the learners lived through (Bruner, 1986). According to Loyens and Rikers (2011), four elements play a pivotal role in constructivist inquiry-based instructions: prior knowledge, social negotiation, self-regulation, and meaningful tasks. Based on the principles identified by Smith and Ragan in 2005, a new design theory has evolved with three basic principles: "Learning results from a personal interpretation of experience, learning is an active process occurring in realistic and relevant situations, and results from an exploration of multiple perspectives." (Richey, Klein, & Tracey, 2011, p.130)

According to Driscoll (2005), Collins and Stevens worked with discovery learning and inductively derived a model of inquiry teaching around 1983. So, the essential question is: what are the key components of inquiry-based learning?

Key Components of Inquiry-based Learning Approach

It is a difficult task to unearth the origin of inquiry-based learning because of its evolving nature where multiple key contributors slowly and gradually establish this notion in education. Cakir (2008) recognized the significant contributions of Jean Piaget, Lev Vygotsky, and David Ausubel during the formative stages of inquiry-based learning. According to Keller (1987), inquiry is a process of knowledge-seeking behavior. "A deeper level of curiosity may be activated by creating a problem situation which can be resolved only by knowledge-seeking behavior." (Keller, 1987, p. 2)

Over the last sixty years, many models of inquiry-based instruction have been proposed and supported by leading educators, scholars, and researchers (Atkin & Karplus, 1962; Bybee et al., 2006; Marshall, Horton, & Smart, 2009; Marshall & Horton, 2011; NRC, 2000). Inquiry-

based learning is structured around different inquiry phases, which work as an articulate group to build an inquiry cycle. However, it is evident from the literature that no single definition can include every possible phase of an inquiry cycle (Pedaste et al., 2015). Callison and Baker (2014) discovered five foundational elements of information inquiry learning that surprisingly remain constant in this evolving environment. These five foundational elements are: questioning, exploration, assimilation, inference, and reflection.

Marshall and Horton (2011) gathered more than 100 sets of classroom observational data of middle school science and math teachers to assess different components of inquiry-based instruction. They identified four common components of inquiry cycle: engage, explore, explain, and extend. According to Marshall and Horton (2011) the engage phase is, "typically situated at the beginning of the lesson; assessing student prior knowledge and misconceptions; stimulating student interest." (p 96) During this initial phase, teachers encourage active participation from students by allowing them to ask intelligent questions to clarify relevant prior foundational knowledge to eliminate common misconceptions before introducing a new concept. This phase ends when students form their own questions for inquiry.

In the explore phase, students actively look for relevant information from diverse sources to answer their questions, which they developed through involved dialogues. Students check their assumptions and make necessary adjustments while gathering new information to answer their own questions. This phase ends when students are done with fact finding and information gathering. During the explain phase, students try to make sense of the new information in light of prior knowledge to resolve apparent contradictions and generate coherent new understanding. The explain phase helps students to develop a systematic interpretation of their answers by connecting gathered information from the explore phase. The explain phase ends when students

develop conceptual understanding of the problem that is under study. During the extend phase, students try to implement the newly learned knowledge and skills to solve new problems to validate the authenticity of the knowledge. Knowledge expansion is best accomplished by associating new knowledge with real-world applications. Teachers usually structure an inquiry-based learning task around the different inquiry phases. Different inquiry phases work as an articulated group to build an inquiry cycle. An inquiry cycle begins by encouraging students' active participation and ends with the expansion of their existing knowledge.

Based on the research conducted by Luera, Killu, and O'Hagan (2003), the five key components or stages of inquiry-based learning are: engage, explore, explain, expand, and evaluate. Pedaste et al. (2015) did a very thorough and detailed literature review of thirty peer reviewed journals to identify distinct phases in an inquiry-based learning process. An analysis of the articles resulted in the identification of five distinct general inquiry phases: orientation, conceptualization, investigation, conclusion, and discussion. According to this framework, inquiry-based learning begins with orientation and flows through conceptualization to investigation, where several cycles are possible. Inquiry-based learning usually ends with the conclusion phase. The discussion phase (which includes communication and reflection) is potentially present at every point during inquiry-based learning and connects to all the other phases. Discussion may potentially occur at any time during (discussion in-action) or after inquiry-based learning when looking back (discussion on-action) (Pedaste et al., 2015).

According to Callison and Baker (2014), there are five foundational elements of information inquiry learning that are surprisingly constant in this evolving environment.

Table 1

Key components of IBL as identified by different researchers.

Reference the researchers	Number of components	Name of the components
Pedaste et al. (2015)	Five derived phases	Orientation, conceptualization, investigation, conclusion, and discussion
Callison and Baker (2014)	Five foundational elements	Questioning, exploration, assimilation, inference, and reflection
Li, Moorman, and Dyjur (2010)	Five key steps	Ask, investigate, create, discuss, and reflect
Marshall and Horton (2011)	Four common components	Engage, explore, explain, and extend
Luera, Killu, and O'Hagan (2003)	Five key components	Engage, explore, explain, expand, and evaluate

Table 1 summarizes different key components of inquiry-based learning as identified by diverse researchers between 2003 and 2015.

Questioning triggers thinking, and thinking leads to a greater understanding in resolving the problem at hand. In the exploration phase, students search for answers to the questions. Exploration is a discriminating process to find and organize information in an effort to answer the question. In the inference phase, students make a conclusion based on findings which they acquired during the exploration phase and personal prior knowledge. In the reflection phase,

students contemplate the answer to a few questions to solidify the inquiry learning. Though the inquiry learning approach is evolving at a fast pace, the five core elements of inquiry learning remain fundamentally unchanged (Callison & Baker, 2014).

According to Li, Moorman, and Dyjur (2010), the five key steps in an inquiry-based learning model are: ask, investigate, create, discuss, and reflect. Li, Moorman, and Dyjur (2010) proposed an inquiry-based learning model with videoconferencing and e-mentoring for rural areas in Canada. According to this model, inquiry begins with student-inspired, natural questions and ends with new knowledge creation. After identifying the questions, learners investigate to acquire relevant facts and data. Based on the collected data, learners devise or create a solution to the problem or question at hand. Learners discuss and share their solutions and data with the other students. Finally, learners think and reflect by utilizing higher order thinking to construct new knowledge to apply in a creative way for future uses.

Based on the research conducted by Luera, Killu, and O'Hagan (2003), the five key components or stages of inquiry-based learning are: engage, explore, explain, expand, and evaluate. This section will illustrate the five different components of IBL framework as championed by Luera, Killu, and O'Hagan (2003).

Engage. According to Luera, Killu, and O'Hagan (2003), students learn most once they are engaged in the learning process. In the engage stage, the role of the teacher is to generate curiosity and interest in the topic. This phase is completed when a student forms a question for his or her inquiry. At its core, inquiry-based teaching and learning environment encourages the teachers to ask essential questions to foster creative thinking and active discussion among the students (Wilhelm, 2014).

The teacher first initiates the discussion with a discrepant event to grab the attention of the students. Students then get interested and involved by asking inquiry questions. Luera, Killu, and O'Hagan (2003) gave an example of an opening discussion by a teacher in a pilot lesson. The teacher announced to the class, "I went to the store the other day and saw three boxes of cereal in different sized boxes. I wanted to get the most amount of cereal for my money [hold up the three different size boxes]. Which box should I buy? How do you know that it is the box that holds the most cereal? Are you sure? How could we find out which box definitely holds the most cereal? How are you defining the word 'most'?" (p. 198) These types of activities should engage the students and help the students come up with his or her own inquiry question. Allowing time to initiate discussion between the students will help generate interesting inquiry questions. This kind of discussion should encourage persuasive discourse instead of imposing discourse. Teachers should initiate and involve the students in persuasive dialogue through essential questioning to challenge the students to discover, share, link, and apply what they are learning (Wilhelm, 2014).

Explore. In the exploration phase, students search for the answer to the questions. Exploration is a discriminating process to find and organize information in an effort to answer the question (Callison, & Baker, 2014). While exploring, the students work independently to gather evidence in the process of investigating the inquiry (Luera, Killu, & O'Hagan, 2003). At this point, students know their inquiry question and predictions. Students gather relevant information to better understand the inquiry at hand. Next, students verify their prediction by using available resources. If their assumption was incorrect, students list possible reasons for their incorrect assumption.

Explain. In the explain stage, students share their findings and methods while explaining their hypothesis and results. At this stage, students ask relevant questions to each other to understand each other's work. Callison and Baker (2014) suggested some of the critical questions for the students to ask: did I answer my question successfully? Did I utilize the best possible resources at my disposal? Finally, the teacher explains the student's questions and queries to link the information to the development of concepts (Luera, Killu, & O'Hagan, 2003).

Expand. During the extend/expand stage, students apply the concepts and skills to the new problem to validate their knowledge (Luera, Killu, & O'Hagan, 2003). Knowledge expansion is best accomplished by associating new knowledge with real-world applications. Teachers should encourage the students to think about individual home and social environments to find out an example or two where they should be able to apply these new concepts. Scaffolding could be a great tool to reinforce the new concepts to ensure knowledge expansion is permanent rather than short lived.

Evaluate. The evaluation stage refers to the ongoing practice throughout the process. "At this point in a traditional lesson, students would often be asked to demonstrate their new understandings by completing an activity sheet or some other activity that would be turned in, graded, and later returned to the students." (Luera, Killu, & O'Hagan, 2003, p. 7) Evaluation in the inquiry learning process is difficult but not impossible. One possible solution is a problem-solving approach in which students are challenged with problems based on newly learned concepts. In this process, immediate feedback is essential for quick identification of learning gaps and to reteach the concept (Luera, Killu, & O'Hagan, 2003).

Finally, based on this literature review, different groups of educational researchers and practitioners defined IBL by using many different phases of IBL. These different models are

complementary to each other instead of contradictory. While no single definition can include every possible phase of an inquiry cycle (Pedaste et al., 2015), there are a few common elements which are present in almost every proposed inquiry cycle. The main point of the inquiry cycle is to involve the students, ask essential questions, let the students explore, share, and construct new knowledge, and finally evaluate to determine if knowledge construction took place.

Types of Inquiry-based Learning

While there are different variations of inquiry-based teaching practiced by teachers in classrooms, Banchi and Bell (2008) provided a framework for four different kinds of inquiry teaching methods: confirmation, structured, guided, and open. Students at different grade levels need different kinds of inquiry learning activities. While elementary students need a lot of guidance and information from teachers in designing and carrying out their investigation from the beginning to end, high school students may need little to no support from their teachers in designing and conducting their investigation from scratch. All students need extensive and systematic practice to progress through different levels of inquiry.

"At the first level, confirmation inquiry, students are provided with the question and procedure (method), and the results are known in advance." (Banchi & Bell, 2008, p. 26) At this inquiry level, students learn how to follow the instructions, observe & collect data, and compare the observed data to known results. At the structured inquiry level, teachers provide the students with both questions and procedures, but students develop their own conclusions and supporting justification based on the collected data and other evidence. At the structured inquiry level, while students are following given inquiry methods, they are learning how to link the observed data and other evidence to derive conclusions. "At the third level, guided inquiry, the teacher provides

students with only the research question, and students design the procedure (method) to test their questions and the resulting explanations." (Banchi & Bell, 2008, p. 27) Students will be confident and successful in conducting guided inquiry only if they master themselves by learning and practicing confirmation and structured inquiry. Teachers play an active role at the guided inquiry level by closely observing and providing instant feedback on the procedures designed by students. Finally, at the open inquiry level, students have boundless opportunities to derive their own questions, develop their own methods, carry out their own investigation, draw their own conclusions, and communicate their findings. "Students at the fourth-and fifth-grade levels will be able to successfully conduct open inquires." (Banchi & Bell, 2008, p. 27)

Technology in Inquiry-based Learning

Technology integration can benefit the inquiry learning process in each of the inquiry phases; technology should be integrated seamlessly to optimize the inquiry learning experiences and to accomplish learning goals by actively engaging students instead of considering technology simply as an add-on. (Kuhlthau, Maniotes, & Caspari, 2015) Technology integration to promote pedagogy-based inquiry instructions is a challenging task for teachers who may encounter many barriers including technical and organizational support, and pedagogical beliefs (Ertmer, Lehman, Park, Cramer, & Grove, 2003).

Technology integration, in an inquiry-based instruction setup, should be student driven and technology tools should empower students to achieve the following goals: access relevant data in a timely manner, collect and record information, collaborate with experts and other students around the world, present information through multimedia, have meaningful and authentic assessments, and present new student knowledge to the world for review and feedback (Coffman, 2017, p. 34). There are numerous educational technology tools available in the market

including Google Educational Suit, internet and mobile technologies, web 2.0, wiki, blogs, and learning management system (LMS), as well as social media. The primary goal of any technology integration is to involve students by igniting curiosity and higher order reflective thinking through knowledge exploration and discovery (Chu et al., 2017; Coffman, 2017; Kuhlthau, Maniotes, & Caspari, 2015; Boss & Krauss, 2014).

While incorporating any technology in inquiry activities for students, Coffman (2017) recommended that "it is important to include twenty-first-century skills, such as communication, managing projects, and using technology, as well as the National Educational Technology Standards for Students (NETS.S) developed by the International Society for Technology in Education ISTE)." (p. 46) Although technology integration has numerous positive impacts in inquiry learning, teachers need to be mindful while planning technology integration to minimize the impact of potential disadvantages including information overload, online safety and privacy, cyber bullying, and distraction (Coffman, 2017). It is not an easy task to successfully integrate technology for teaching and learning, and many researchers have found that it is difficult to incorporate advanced information and communication technologies (ICT) in classrooms (Buckner & Kim, 2014). Ertmer et al. (2003) emphasized the importance of non-traditional professional development efforts which help teachers to develop technology-based authentic problems within student-centered pedagogies.

Current Trends of Utilizing Inquiry-based Learning

There is a common belief that few teachers are teaching science and math while utilizing an inquiry learning approach. Capps and Crawford (2013) found little to no practical evidence to support this claim. AASL's (American Association of School Librarians) standards for the 21st-Century Learner, provides vision for teaching and learning by promoting the inquiry framework

of learning; i.e., to promote inquiry, critical thinking and eventually constructing new knowledge (Marriott, 2014). Students in the United States need to learn how to think critically in the classroom and beyond the classroom setup. To promote critical student thinking, commissions, studies, and reports continue to call for the adoption of inquiry-based learning approaches in science and math (Marshall & Horton, 2011).

There are different kinds of inquiry teaching practiced by teachers in classrooms. Banchi and Bell (2008) provided a framework for three different kinds of inquiry teaching methods: structured, guided and open. Structured inquiry method, developed and managed by the instructors, is a controlled and planned approach. In this approach, students investigate a prescribed question using a method provided by the teacher. This approach does not allow the students to come out with their own questions; rather, teachers provide a set of relevant and critical questions for the students to think and ponder on it. Teachers also provide a structured method of thinking to solve the designated questions. This is the least creative and open thinking method for inquiry learning for the students. In a guided inquiry approach, teachers provide the structured inquiry questions, but students come up with their own creative methods to investigate these questions. In open inquiry, students investigate questions that they have posed using methods that they have designed (Banchi & Bell, 2008, p. 26 – p. 29). Though these three approaches offer different amounts of guidance for teachers and open thinking for learners, at the center, all these approaches inspire critical thinking among the students to promote active learning.

Developing critical thinking skills is taking center stage as a key objective in modern education. Past research has mostly examined the effectiveness of a single instructional approach in promoting critical thinking. Lately, researchers have begun discussing mixed teaching

approaches. Ku, Ho, Hau, and Lai (2014) suggested educators adopt more than one instructional approach of teaching critical thinking in order to optimize learning outcomes. Common Core State Standards (CCSS) requires educators to learn and teach about how to ask essential questions to their students to encourage critical thinking and innovation (Wilhelm, 2014). On the other hand, despite the presence of a decade of rich literature promoting the need and importance of IBL, there is little evidence that it is widely used in science classrooms (Hermann & Miranda, 2010).

Active learning. In traditional learning setup, teachers actively pass the structured information to the students while students passively consume the delivered information. If teachers encourage and enforce knowledge exploration by the students before explaining new concepts and lessons, students can construct better learning of the concept (Marshall & Horton, 2011). Table 2 summarizes Key current approaches of inquiry learning as identified by different researchers between 2008 and 2014.

Table 2

Key current approaches of inquiry learning as identified by different researchers

Researchers	Publication year	Key approaches
Banchi and Bell	2008	Teachers should provide a varied degree of guidance to the students: structured, guided and open inquiry
Ku, Ho, Hau, and Lai	2014	Educators must adopt more than one instructional approach of teaching critical thinking to optimize learning outcomes

Table 2 Continued

Researchers	Publication year	Key approaches
Wilhelm	2014	Teachers should learn and teach how to ask essential questions to their students to encourage critical think and innovation
Ireland, Watters, Brownlee, and Lupton	2012	Learners should be able to formulate their own answers through active participation by exploring new experiences
Buckner and Kim	2014	Though difficult, technologies should be incorporated to optimize inquiry learning outcome
Marriott	2014	Students are better influenced by the teachers who most frequently ask, rather than teachers who usually tell
Marshall and Horton	2011	Exploration by the students before receiving explanation from the teachers.
Brown	2012	Two important aspects of promoting inquiry teachings are asking essential questions and fostering focused conversation
Hermann and Miranda	2010	Open-inquiry question templates encourage students to actively participate in inquiry learning

Marshall and Horton (2011) mentioned that there is a positive correlation between the amount of time spent on active learning by the learners on the new concepts and the amount of new knowledge construction in the learners. According to eminent educators such as Pestalozzi, Dewey and Montessori, students involved in inquiry learning should be able to discover answers themselves through active engagement with new experiences (Ireland, Watters, Brownlee, & Lupton, 2012). Brown (2012) suggested that inquiry-based approaches to education provide unique opportunities to actively engage students in genuine learning experiences.

Technological integration in the learning environment. Many researchers have found that it is difficult to incorporate advanced information and communications technologies (ICT) in classrooms (Buckner & Kim, 2014). While considering technology as a support for project-based science learning, Blumenfeld et al. (1991) identified six contributions that technology can make to the learning process: enhancing interest and motivation, providing access to information, allowing active, manipulative representations, structuring the process with tactical and strategic support, diagnosing and correcting errors, and managing complexity and aiding production.

Slavin, Lake, Hanley, and Thurston (2014), after reviewing the achievement outcomes of different approaches to teaching science in elementary schools, suggested that programs that used science kits did not make any positive gains in student learning outcomes. On the other hand, programs which incorporate video and computer resources with teaching along with cooperative learning enjoyed limited but positive outcomes.

The Stanford Mobile Inquiry-based Learning Environment (SMILE) successfully inspired student questioning and changed student-teacher dynamics in class. Learners and learning environments influence students' initial abilities to adopt inquiry learning. SMILE, like

advanced technological integration in inquiry-learning, is more difficult to implement in learning environments where rote memorization is typical and deeply rooted (Buckner & Kim, 2014).

Asking without giving the answer. Children in schools are better influenced by the teachers who most frequently ask, rather than teachers who usually tell (Marriott, 2014). Marshall and Horton (2011) gathered more than 100 sets of classroom observational data and separated the data set into two groups—students who explored basic concepts before receiving explanations and contributed to the explanations, and students who received explanations before exploration and did not contribute to the explanations. When teachers make students explore concepts before explanations, students construct better learning of the concept. There is a positive correlation between the amount of time spent on exploration of the concepts and the amount of new knowledge construction in the learners. A negative correlation exists between the percentage of time spent explaining concepts by the teachers and the cognitive enrichment of the students. According to Brown (2012), two important aspects of promoting inquiry teachings are asking essential questions and fostering focused conversation.

Open-inquiry question templates encourage students to respond as a group on utilizing open-inquiry question templates to generate different scientifically oriented questions and identify different variables. Open-inquiry question templates help learners observe the impact of a single variable by keeping the remainder of the variables unchanged. Students develop explanations from the evidence and connect explanations to the existing knowledge to construct new knowledge (Hermann & Miranda, 2010). Asking essential questions lies at the center of the inquiry-based teaching and learning environment where teachers encourage open and active participation of the students by asking meaningful and relevant questions (Wilhelm, 2014).

Teachers should initiate and engage the students in persuasive dialogue through essential questioning to challenge the students to discover, share, link, and apply what they are learning (Wilhelm, 2014). Wilhelm (2014) explained seven characteristics of essential questions: "Questions should matter to students now and in the future, questions should connects to students' current lives, questions should force the students to make judgments, questions should get at the heart of the matter, questions should possess intellectual bite and challenges, questions should be open-ended in nature, questions should encourage the findings to link data, and questions should be concise and clearly stated." (p. 3) Finally, carefully designed essential questions are imperative in engaging learners in persuasive dialogue to encourage discovery of knowledge without simply delivering the answer via traditional classroom lectures.

Influencing Factors for Successful Implementation of Inquiry-based Learning

Liu, Lee, and Linn (2010) suggested an inquiry-based science unit to promote knowledge integration. They developed assessments that measure student knowledge integration abilities. This science assessment tool consisted of both proximal items that are related to the units and distal items that are published from standardized tests (e.g., Trends in International Mathematics and Science Study). They revealed that student, class, and teacher characteristics affect student inquiry science learning. Finally, several teacher-level characteristics, including professional development, showed a positive impact on science performance (Liu, Lee, & Linn, 2010). Teachers' training is one of the most common tools used to provide professional development for the teachers to boost their confidence in inquiry-based teaching practices.

Teachers' training. Teachers' readiness and confidence in teaching inquiry-based learning has a direct correlation with attaining effective training. Teachers who received more training in inquiry are more comfortable with inquiry methods. Three of the top concerns from

the teachers' prospective are: time, resources, and lack of teachers' preparation (Blanchard, Osborne, Wallwork, & Harris, 2013). Open-ended learning environments are especially challenging for teachers who do not have any training or exposure to inquiry-based learning and teaching challenges (Inoue & Buczynski, 2010). In the United States, teachers lack conformity while trying to implement inquiry instruction. Ireland, Watters, Brownlee, and Lupton (2012) revealed three conceptions of teaching for inquiry learning in science in the elementary years of schooling. The experience-centered conception involves teachers providing interesting sensory experiences to students. In the problem-centered conception, teachers focused on engaging students with challenging problems. Finally, the question-centered conception has teachers focused on helping students to ask and answer their own questions. Teacher training is essential to bring uniformity in inquiry-based learning in the classrooms. Teacher preparation programs make positive contributions in developing pedagogical stances towards inquiry-based teaching among the participating preservice teachers (PSTs). This program also helps boost confidence in PSTs with some variability across different groups (Truxaw, Casa, & Adelson, 2011).

Donnell and Harper (2005) suggested four major tensions related to the competing agendas that characterized and shaped the development of the inquiry process in the teacher education course: understanding and misunderstanding inquiry as an aspect of learning to teach, theory versus practice, various meanings of and commitments to social justice, and multiple requirements from stakeholders with different priorities in one outcome (p.156).

Teachers' attitude to inquiry learning. Teachers' view and their teaching practices play important roles in the successful implementation of any learning approach. According to Capps and Crawford (2013), teachers skipped inquiry-based learning approaches half of the allocated classroom time due to lack of pedagogical knowledge and understanding of inquiry learning

approach. While teachers mostly emphasized on following the inquiry learning process, they failed to foster the development of new knowledge among the students through open and involved student participation and collaboration. Inquiry-based learning was mostly teacher initiated instead of student-centered (Capps & Crawford, 2013). Ireland, Watters, Brownlee, and Lupton (2012) suggested that teachers in the elementary schools neither think nor express inquiry learning in a pedagogical way. Teachers express their inquiry teaching and curriculum in general laymen terms; this is not conducive in promoting inquiry instruction.

In a research study, teachers video tapped their teaching styles and analyzed the results of their actions. After going through this exercise, teachers changed their instructional delivery method from a teacher-centered, textbook-driven approach, to a student-centered, inquiry-based approach (Lebak & Tinsley, 2010). This research validates that well-structured professional development programs can help teachers to move from traditional lectures to inquiry instructions.

Ultimately, it is the job of the teachers to develop and implement inquiry learning plans (ILP). Though inquiry learning is student centered, it is the teachers who are responsible for defining all the parameters of inquiry learning classrooms for the participating students (Donhauser, Hersey, Stutzman, & Zane, 2014). Teachers' perceptions, along with their professional development, play a vital role in the successful implementation of inquiry-based teaching in the classroom (Ireland, Watters, Brownlee, & Lupton, 2012).

Teachers' knowledge. Teachers' understanding of inquiry-based instruction is pivotal to successful implementation of Inquiry-based learning. Capps and Crawford (2013) suggested that the majority of teachers do not have a solid understanding of inquiry-based instruction. In an open-ended learning environment, students are encouraged to ask and respond to questions

without being afraid to do so. When one teacher asked open-ended questions, the students gave different unexpected responses. These varied unfamiliar responses challenged the pre-service teachers to successfully respond and explain the responses in a pedagogically meaningful way to the students. As a result of that, the pre-service teachers frequently ignored the surprised responses. By doing so, the teacher failed to take advantage of teachable moments in inquiry learning to support the students' meaning-making attempts (Inoue & Buczynski, 2010).

Ireland, Watters, Brownlee, and Lupton (2012) discovered that the conceptions of inquiry teaching range from relatively naïve approaches to sophisticated strategies. This finding underpins the worry that despite a huge emphasis on professional development, mandated curriculum, and public evaluations that emphasize students' knowledge searching abilities over rote memorization, teachers' inquiry teaching knowledge remains a key area of weakness and deserves a lot more attention and improvement.

Culture of the school. Corder and Slykbuis (2011) suggested teachers to take the lead in the changing classroom culture of a school from a traditional cookbook lab into an inquiry driven science experience. Teachers can and should play a central role in a successful conversion process. This transformation is a difficult journey and the first attempt may fail. Teachers are encouraged to make multiple attempts to make it a success considering the enormous opportunities of learners' new knowledge construction through an inquiry learning approach. Chen and She (2015) suggested integrating scientific reasoning as a built-in component in inquiry learning. Scientific reasoning helps to enhance the desire of a student's scientific inquiry.

Administrative support. Implementing inquiry-based learning and changing the classroom culture is not an easy task. Though teachers play a central role in this important effort, their success largely depends on administrative support. School administration is in charge of

determining the school curriculum, instruction period, and assessment criteria. Teachers need more instruction time than a traditional instruction period to encourage active participation of every student in order to promote the inquiry learning approach. A supportive and knowledgeable school principal can play a vital role in guiding new teachers and in transforming classroom culture from the traditional lecture approach to an inquiry-learning approach (Towers, 2012).

Students' prior knowledge. Student prior knowledge and reading ability have a significant impact on the degree of conceptual knowledge development. Wang, Wang, Tai, and Chen (2010) made a perplexing discovery that, though inquiry-based learning confirmed significant gains in the conceptual knowledge development for all participating learners, students with low prior conceptual knowledge demonstrated greater gains than subgroups with more prior knowledge. Experiential studies from the recent past reliably suggest that a guided teaching approach has superiority over minimally guided instruction in the student learning process. This finding starts losing its ground only when students have unusually higher amounts of prior knowledge (Kirschner, Sweller, & Clark, 2006).

Supporting resources including educational technologies. Marshall, Smart, and Horton (2010) successfully developed a new protocol, the Electronic Quality of Inquiry Protocol (EQUIP), to assess the effectiveness of the quantity and quality of inquiry-based instruction in an inquiry learning environment. EQUIP can help teachers monitor and evaluate program success and provide teacher support in the transformation of teaching practices from a traditional approach to an inquiry-based one.

Based on the guidelines provided by NETS.S, technology integration in teaching and learning should help students develop the following skills: creativity & innovation,

communication & collaboration, research & information fluency, critical thinking, problem solving, and decision making, as well as digital citizenship, and technological operations and concepts (Coffman, 2017, p. 90). Technology is making it possible for students to access numerous and diverse information sources instantaneously. Internet connection, mobile devices, and different web tools are making learning diverse, interactive, collaborative, personalized, and socially responsive.

One the one hand, technology is enabling learners to access a tremendous amount of information in any given inquiry topic. On the other hand, according to Kuhlthau, Maniotes, and Caspari (2015), technology is making the exploration phase quite unmanageable for learners without sound guidance from teachers or subject matter experts. "While everyone has a voice, this also produces an abundance of misinformation and many misunderstandings. Questions arise about what is accurate, what is reliable, what is important, and what is wise." (Kuhlthau, Maniotes, & Caspari, 2015, p. 6)

Embedded librarian. In collaboration with the teachers, the school librarian can play a vital role in the implementation of inquiry-based learning and teaching to promote learning for life and knowledge sharing. School librarians should work with teachers to frame inquiry projects that do not have a straight forward answer that comes from a single source or reference. This kind of project should encourage open-ended inquiry learning with many possible alternatives instead of a single right or wrong answer. This should encourage students to reach an evidence-based conclusion after exploring many diverse and relevant resources. Teachers should ask essential questions to foster creative thinking among students in an open learning environment (Wilhelm, 2014) These questions should not have an easy and simple answer; rather, they should have the possibility of diverse and multiple potential correct answers. School

librarians can play a critical role in collaboration with the teachers in scaffolding the students in the art of inquiry learning.

Benefits and Challenges of Inquiry-based Learning

Zhao (2011) recommended inquiry-based learning approach to improve low test scores and behavioral problems. Wijnen et al. (2017) studied students' motivation while utilizing inquiry-based instructions; he discovered that students experienced more warmth and support from their fellow students and teachers. Tamim and Grant (2013) mentioned that teachers allowed the students to work on different projects while utilizing inquiry-based instructions; teachers observed a significant improvement in students' motivation and engagement. Teachers encourage and guide the students to develop their own questions, perform information search, develop hypotheses, test hypotheses, and share their findings in an inquiry-learning environment. In inquiry-based learning environment, students "plan and justify their ideas, examine the ideas of other students, and reflect upon the viability of their own ideas, as well as invite students to share control of designing and managing activities, assessments, and classroom norms." (Haney, Czerniak, & Lumpe, 2003, p. 366) IBL requires students' active participation through inquiry-based hands on activities and information search, as a result, learners are able to construct their own understanding and knowledge (Warner & Myers, 2008).

Inquiry-learning has its own challenges, however. The definition of inquiry-learning lacks conformity (Hmelo-Silver et al.,2007). Teachers, who have no training in inquiry instruction, are limited. Inquiry-learning curriculums are neither easily available nor well-structured. Teachers are not supported by complimentary inquiry-learning resources, and classroom time is too short to promote inquiry-based learning. Finally, it is rare to find

administrative support that promotes and supports inquiry-based teaching and learning. Overall, school and classroom cultures are not conducive to inquiry learning.

Benefits. Inquiry-based learning is essential for math and science learning as traditional lecture-based instruction is not producing the desired level of success. In addition, memorization-based math and science learning failed to produce workforce ready employees (Li, Moorman, & Dyjur, 2010). New knowledge construction should not be the end of the inquiry learning cycle. The inquiry cycle should include knowledge sharing and learning for life (Marriott, 2014).

Teaching strategies that actively engage students in the learning process through scientific investigations are more likely to increase conceptual understanding than are strategies that rely on more passive techniques, which are often necessary in the current standardized-assessment laden educational environment (Minner, Levy, & Century, 2010). Brown (2012) suggested that teachers can provide genuine learning experiences by engaging in active student discourse through an inquiry learning approach. Schroeder, Scott, Tolson, Huang, & Lee (2007) discovered that alternative teaching strategies are more effective than that of traditional classroom lectures. Eight categories of alternative teaching strategies are: questioning strategies, manipulation strategies, enhanced material strategies, assessment strategies, inquiry strategies, enhanced context strategies, instructional technology strategies, and collaborative learning strategies. Minner, Levy, and Century (2010) concluded that there is a positive impact in the student learning outcome when an inquiry-based learning method is used instead of traditional lecture-based learning. They praised instruction that emphasizes student active thinking instead of passive consumption of traditional lectures.

Understanding over memorization. An inquiry-based learning method accompanied by open-inquiry question templates, encourages students to respond as a group while utilizing open-

inquiry questioning templates to generate different scientifically oriented questions and identify different variables. Learners can observe the impact of a single variable by keeping the remainder of the variables unchanged. Students develop explanations from the evidence and connect explanations to existing knowledge to construct new knowledge (Hermann & Miranda, 2010).

Higher accomplishment in standardized tests. Inquiry-based teaching did not dramatically alter a student's overall achievement, as measured by North Carolina's standardized test in physical science (Tretter & Jones, 2003). Nevertheless, "Inquiry-based instruction had other positive effects, such as a dramatic improvement in student participation and higher classroom grades earned by students. In addition, Inquiry-based instruction resulted in more uniform achievement than did traditional instruction, both in classroom measures and in more objective standardized test measures." (Tretter & Jones, 2003, p. 350)

Challenges. Inquiry-based learning provides boundless opportunities for students to explore, explain, construct, and utilize science and math knowledge. Nevertheless, implementing inquiry learning in a classroom is not an easy task and often encounters a good number of challenges (Edelson, Gordin, & Pea, 1999). Settlage (2007) suggested that it is unrealistic for teachers to engage in inquiry learning on a day-to-day basis. He speculates that open inquiry is difficult to utilize in the classroom. Edelson, Gordin, and Pea (1999) explored five significant challenges to implementing inquiry-based learning: lack of motivation, accessibility of investigating techniques, background knowledge, management of extended activities, and practical constrain of the learning context (p. 391).

Scarcity of qualified teachers. Teachers find it extremely time consuming to make preparation for unknown and boundless peripheral open-ended questions by the students

(Hermann & Miranda, 2010). If teachers lack understanding of inquiry-based learning, they will have little to no interest in introducing inquiry learning approach in their classrooms; these teachers who are not prepared to teach IBL may shy the inquiry learning approach in half of the allocated classroom time (Capps & Crawford, 2013).

Inadequate quality pre-service training. Open-ended learning environments are specially challenging for the teachers who do not have any training or exposure to inquiry-based learning and teaching challenges (Inoue & Buczynski, 2010). In an active learning environment, students ask creative questions without having any fear of repercussions. Students also come out with varied and exotic responses in an open learning environment. Pre-service teachers are often challenged to successfully respond and explain the responses in a simple, coherent, and meaningful way to the students. As a result, these teachers failed to take advantage of teachable moments in inquiry learning to support the students' meaning-making attempts (Inoue & Buczynski, 2010). Soprano and Yang (2013) confirmed that the pre-service teachers' understanding of inquiry-based science teaching and learning along with their self-efficacy beliefs was developed and enhanced through the planning and teaching phases of the field experience. They recommended the use of cooperative inquiry-based field experiences and pre-service teacher action research by teacher education programs to prepare the teachers who would be able to play positive roles in promoting inquiry instruction.

Fazio, Melville, and Bartley (2010) suggested that teacher development courses help to improve teachers' perceptions related to inquiry teaching, but the role of practicum was problematic. Some of the key reasons, which work as a stumbling block for creating an inquiry-based environment, are: lack of resources, time constraints, and the need to address curriculum standards.

Unfavorable teachers' attitude. A teacher's conceptions and attitude matter in inquiry learning in the class. Teachers in U.S. schools do not have a well-defined singular concept of inquiry learning. Instead, each teacher has his or her own unique way of dealing with inquiry teaching and learning (Ireland, Watters, Brownlee, & Lupton, 2012).

School and classroom cultures. Anderson (2002) recommended that teachers seeking an inquiry orientation should focus on the nature of students' work, the students' role, and their own role. Anderson (2002) further suggested that teachers and others in positions of leadership should focus on promoting collaboration among teachers and promote an environment within which teachers can reflect on their values and beliefs.

Fouché (2013) suggested that teachers promote failure-based inquiry learning, where learners experience productive failure while exploring inquiry driven conceptual change and teachers ensure a learning environment where the students feel safe risking failure in front of their peers. Haug (2014) suggested teachers take advantage of teachable moments by turning them into learnable moments in the classrooms. Two types of teachable moments are planned moments and spontaneous moments. Planned teachable moments emerge when students strengthen new knowledge by linking explored findings to theory. Spontaneous teachable moments emerge from teachers' conscious efforts to adjust the pace of the class or curriculum. Meyer et al. (2012) suggested taxonomy of eight common teaching strategies for promoting inquiry-based education in K-12 science classrooms. These eight activities are: protocols, design challenge, product testing, black boxes, intrinsic data space, taxonomy, discrepant event, and modeling.

School environmental context factors have little to no impact on a teacher's ability to teach science using inquiry-based methods. Empirical data suggests that the three broad

categories of school environmental factors (human, sociocultural, design) have limited impact on inquiry-based teaching (Pea, 2012).

Baxter, Ruzicka, and Blackwell (2012) asserted that a diverse set of engaging activities to encourage students to perform inquiry investigations are required to help promote inquiry teaching, which will encourage the young learners to explore the world around them. Practice of inquiry activities should continue for a prolonged time, at least for a year, to produce sustainable change among the student inquiry learning and classroom environment.

Inadequate supporting resources including educational technologies. Teachers find it extremely time consuming to prepare for unknown and boundless peripheral open-ended questions from students. According to Hermann and Miranda, utilizing open inquiry question templates can facilitate student developed research questions that encourage and support inquiry in Earth and space science. In this structured inquiry-based approach, students are guided through a pre-formatted open-inquiry guideline to maneuver through the inquiry without getting lost in the process. This approach also reduces the burden on teachers since students have a standard format to maneuver through without asking a lot of questions (Hermann & Miranda, 2010). While inquiry-based learning and instruction is promoted for K-12 education by both the administration and educators, the educational industry lacks reliable assessment tools to measure the quality and quantity of the effective and efficient blending of inquiry-based instruction (Marshall, Smart, & Horton, 2010).

Student readiness. Students' prior knowledge is the building block for new knowledge construction through an inquiry learning process. Staging activities are a great tool to bridge the gap between entry skill requirements and current state of knowledge. In this process, teachers can initiate activities to construct lower level knowledge before stepping into the higher-level

knowledge. This process helps to motivate students and avoid student frustration. Bridging activities help close the gap between practices of students and scientists; i.e., bridging activities introduces scientific activities that are familiar to students before introducing unfamiliar scientific concepts (Edelson, Gordin, & Pea, 1999). All students are not equally ready to learn a specific topic at the same level. In tiered lessons, teachers try to attain the same learning objectives for all students by offering activities of different degrees of complexity to match the individual student's current level of knowledge and readiness. "Tiered inquiry activity, can be an effective way to differentiate instruction based on variations in students' scientific-practices and readiness in the science classroom." (Whitworth, Maeng, & Bell, 2013, p. 17)

In summary, inquiry-based learning is facing a lot of challenges as more and more educators are trying to adopt this evolving learning approach. The successful identification of challenges is the first step in developing successful solutions. Edelson, Gordin, and Pea (1999) identified five significant challenges to implementing inquiry-based learning and presented strategies for addressing them through the design of technology and curriculum. These challenges and proposed solutions are elaborated in the next section.

Summary of the Review of the Literature

One group of students was instructed through an inquiry-based learning method (5E instructional model) whereas another group was instructed through traditional methods. The 5E instructional model is composed of five distinct components: engagement, exploration, explanation, elaboration, and evaluation. The results showed that students who were instructed through inquiry-based learning achieved higher scores than the ones instructed through the traditional method (Abdi, 2014).

Luera, Killu, and O'Hagan (2003) designed an example of an inquiry-based mini unit for students to learn the concept of volume and how to measure the volume of a rectangular prism. The concept of volume has elements of lessons from both science and math. Their study confirmed that a carefully designed inquiry-based learning unit is a successful tool in promoting student knowledge construction. This well-designed inquiry-based unit ensured minimum teacher's intervention and promoted higher student engagement and learning achievement.

Marriott (2014) suggested that school librarians should work hand in hand with teachers to develop complex assignment projects, which do not have a straight forward answer found in a single source or reference. The author also mentioned that children in schools are better influenced by teachers who most frequently ask questions to promote active learners' participation, rather than teachers who usually passively pass the knowledge (Marriott, 2014). The open-inquiry question template is a structured approach to practicing and promoting open inquiry that typically results in a rich and satisfying research experience for both students and teachers (Hermann & Miranda, 2010).

In inquiry learning, teachers ask open-ended questions to ignite active discussion and participation among the students, and students' responses usually include different unexpected responses besides the usual one. Pre-service teachers are often intellectually and pedagogically challenged to successfully explain these diverse unusual responses in an instructionally eloquent and meaningful way to the students. Instead, most of the time, pre-service teachers overlook and ignore these unusual responses. In this process, by ignoring unfamiliar diverse responses, teachers fail to recognize and take advantage of teachable moments in an active inquiry learning approach, which enables the students to attempt to construct new meaning and knowledge (Inoue & Buczynski, 2010).

In conclusion, traditional lecture-based science instruction is not working to achieve optimal learning outcome in our schools. Traditional current textbooks are designed to teach segmented science concepts one at a time and fail to make connections for students and encourage thinking. This traditional approach promotes memorizing over understanding and open thinking. Liu, Lee, and Linn (2010) designed a science assessment consisting of both proximal items that are related to the units and distal items that are published from standardized tests (e.g., Trends in International Mathematics and Science Study). Their study compared the psychometric properties and instructional sensitivity of the proximal and distal items. The authors examined how student, class, and teacher characteristics affect student inquiry science learning. This study validated that an inquiry-based science unit is more successful in developing student knowledge integration. Teachers who have more than five years of experience teaching science have a positive impact while using inquiry-based teaching. Teachers who have access to colleagues in the school who are implementing the same inquiry-based unit have a higher success rate in implementing inquiry-based learning themselves. Teachers who participated in a workshop on designing inquiry-based units enjoyed a higher rate of success in deploying inquiry-based learning. Finally, through inquiry-based instruction, "students make meaningful and thoughtful connections to the world around them by asking questions, conducting research, and formulating informed decisions using technology tools that are as authentic as the problem they are tackling." (Coffman, 2017) Analyzed data from 138 studies support a strong and positive trend favoring inquiry-based learning practices, especially instruction that promotes active thinking and decision-making capabilities among the students based on explored data (Minner, Levy, & Century, 2010).

Implications of the literature. Over the past few decades, much has been written about what inquiry is and is not. Inquiry should not be considered as a singular construct, but rather, a range of approaches that form a continuum (Hermann & Miranda, 2010). The National Research Council (NRC) provides one example; this continuum ranges from less to more learners' self-direction with respect to different features of inquiry: confirmation inquiry, structured inquiry, guided inquiry, and open inquiry (NRC, 2000). Teachers, who do not have any training or exposure to inquiry-based learning, are especially challenged by the open-ended inquiry learning environment (Inoue & Buczynski, 2010). Inoue and Buczynski (2010) recommended teacher preparation training in three areas to overcome teachers' hurdles in implementing inquiry teaching and learning environment. These three focus areas are: anticipating possibilities in students' diverse responses, giving pedagogically meaningful explanations that bridge mathematical content to students' thinking, and in-depth, structured reflection of teacher performance and teacher response to students' thinking.

This literature review raised a few questions associated with inquiry-based learning. The first question is, what is inquiry-based learning? This literature review failed to come up with a single definition of inquiry-based learning. The reviewed literature mentioned multiple definitions of inquiry-based learning. In recent years, educators and administrators have been highly advocating the need for inquiry learning in science education. This encouragement for inquiry-based learning is based on the realization that science is eventually a question-driven, open-ended process where students need to have active participation to acquire personal experience through scientific inquiry and construct new scientific knowledge (Edelson, Gordin, & Pea, 1999). Inquiry-based learning can best be defined by describing its different phases or by asking, what are the key components of inquiry-based learning?

Pedaste et al. (2015) conducted a literature review using 32 articles from the EBSCO host library. The articles were selected based on specific search criteria describing inquiry phases or whole inquiry cycles. This analysis of the articles resulted in the identification of five distinct general inquiry phases: orientation, conceptualization, investigation, conclusion, and discussion. No single literature proposed all of these five phases; rather, each proposed a different number of phases with many different descriptions and names. The authors synthesized the collected data and proposed a framework for inquiry-based learning processes with five distinct phases. In this framework, inquiry-based learning begins with orientation and flows through conceptualization to investigation, where several cycles are possible. Inquiry-based learning usually ends with the conclusion phase (Pedaste et al., 2015).

The next question is: what are the key challenges and proposed solutions of inquiry-based learning? Many challenges are identified along with proposed solutions. It is a challenging task to implement inquiry-based learning in any learning environment, especially in the classrooms. Edelson, Gordin, and Pea (1999) have been exploring these challenges through a program of research on the use of scientific visualization technologies to support inquiry-based learning in the geosciences. They identified five significant challenges to implementing inquiry-based learning and present strategies for addressing them through the design of technology and curriculum. The five challenges are: motivation, accessibility of investigation techniques, background knowledge, management of extended activities, and the practical constraints of the learning context. The proposed solutions are: having meaningful problems with implications that matter to learners such as staging activities that can be used to set the stage for open-ended inquiry activities and introduce

learners to investigation techniques, bridging activities introducing practices that are familiar to students as a means of introducing unfamiliar scientific practices, embedding information sources that is a knowledge base directly connected to an inquiry tool, and record-keeping tools to facilitate management and organization of inquiry activities (Edelson, Gordin, & Pea, 1999).

The final question is: is inquiry-based learning actually working for our learners? Almost all the articles presented some evidence directly or indirectly supporting the positive impact of inquiry-based learning. Luera, Killu, and O'Hagan (2003) claimed that a carefully designed inquiry-based learning unit is a successful tool to promote student knowledge construction. In addition, a well-designed inquiry-based unit will ensure minimum teacher intervention and will promote higher student engagement and learning achievement (Luera, Killu, & O'Hagan, 2003). Minner, Levy, and Century (2010) conducted an inquiry synthesis project to synthesize findings from research conducted between 1984 and 2002 to address the research question, what is the impact of inquiry science instruction on K–12 students? Fifty-one percent of the 138 studies in the synthesis showed positive impacts of some level of inquiry science instruction on student content learning and retention. On the contrary, Wijnen et al. (2017) mentioned that there are no significant differences in autonomous and controlled motivation among the students between inquiry-based instructions and non-inquiry-based instructions.

In conclusion, while there are barriers to implementing inquiry-based instruction in the K-12 classroom, educators and administrators are aware of the countless benefits of inquiry-based learning. Quality and creative inquiry-based learning instruction, reliable inquiry learning assessment protocols and tools, trained instructors, mature technology, and involved students can

optimize the benefits of inquiry learning. Successful implementation of inquiry-based learning will have a huge impact on our national pride by acquiring higher rankings in math and science tests at the international level. Inquiry-based learning positively impacts our learners, which could be further enhanced by establishing a globally accepted definition and framework. Blanchard, Osborne, Wallwork, and Harris (2013) suggested that to achieve success in implementing inquiry learning in the classroom, first we need to ensure that our teachers feel comfortable with teaching inquiry science. Teachers need access to quality inquiry training and other supportive resources to boost their comfort level in teaching inquiry learning. Some of the best teachers are finding it difficult to implement inquiry learning in the classroom, and therefore, they setup to help support reformed-based Common Core State Standards. Keys and Bryan (2001) emphasized that a teacher's voice should be included when designing and implementing inquiry-based curriculum as teachers play a central role in the successful implementation of educational reform efforts. There is a tremendous opportunity to improve the teachers' understanding of inquiry-based learning. Capps and Crawford (2013) mentioned that teachers skipped the inquiry learning approach in half of the allocated classroom time due to their limited understanding of inquiry-based learning. The assessment aspect of inquiry-based learning needs improvement to generate enormous interest around inquiry learning. Overall, more investment is required to develop a successful and universal model for inquiry-based learning.

Discussion and recommendation for future research. Lee (2011) suggested that existing literature is limited in providing clarity while defining inquiry-guided learning. Since the publication of The Boyer Commission Report (1998), inquiry-guided learning has acquired tremendous attention as a preferred solution for a teaching and learning method to overcome any

learning ills. The Boyer Commission Report (1998) defined the inquiry-guided learning only generally or chiefly by anecdote (Lee, 2011). Although many years have passed, confusion still exists about what inquiry-guided learning really is and how to do it, such as whether you should implement it in a single course or across the curriculum (Lee, 2011).

Kirschner, Sweller, and Clark (2006) criticized inquiry-based methods for its inability to recognize the limitations of working memory and hence concluded that inquiry-based methods are mostly ineffective. They claimed that an inquiry-based method generates a high cognitive load in working memory, causing it to fail in capturing and retaining critical information to successfully pass on to the long-term memory which is essential for knowledge construction. They concluded that direct instructional method is more effective as it can optimally utilize working memory to store and transfer necessary information to the long-term memory to construct new knowledge. They mentioned that providing guidance during delivering instruction is essential for the novice and intermediate students. The importance of guidance diminishes when students have a high prior knowledge to provide self-guidance. Otherwise, under minimally guided instruction, students may develop misconceptions and unorganized knowledge.

In response to Kirschner et al. (2006), Hmelo-Silver, Duncan, Chinn (2007) identified two major flaws. First, Kirschner et al. lumped together several distinct pedagogical learning methods under the banner of minimally guided instruction. Hmelo-Silver et al. argued that "at least some of these approaches, in particular, problem-based learning (PBL) and inquiry learning (IL), are not minimally guided instructional approaches but rather provide extensive scaffolding and guidance to facilitate student learning." (Hmelo-Silver, Duncan, & Chinn, 2007, p. 99) The other flaw is Kirschner et al.'s claim that PBL and IL are inefficient which is, "contrary to

empirical evidence that indeed does support the efficacy of PBL and IL as instructional approaches." (Hmelo-Silver, Duncan, & Chinn, 2007, p. 99) Hmelo-Silver et al. concluded that "both PBL and IL employ scaffolding extensively thereby reducing the cognitive load and allowing students to learn in complex domains." (Hmelo-Silver, Duncan, & Chinn, 2007, p. 99)

While pondering about the debate among Kirschner et al. and Hmelo-Silver et al., Hung (2011) mentioned that researchers focused on the theoretical conception aspects and learning outcomes without considering the implementation processes while evaluating the effectiveness of the inquiry instructions. Hung (2011) studied recent implementation practices surrounding inquiry instructions and discovered a set of confounding variables which may explain the conflicting research outcomes in inquiry instructions. He recognized that inquiry instruction models are not consistent in terms of self-directed learning and the nature of problem solving. Additionally, he mentioned about human factors (students' behaviors, facilitators' behaviors, resources and workload, small group learning), a set of vital confounding variables, which play an important role in the successful implementations of inquiry instruction and its learning outcomes.

While many scholars are either advocating or criticizing inquiry learning, "there appears to be no consistent definition of inquiry learning." (Lazonder & Harmsen, 2016, p. 682) Lazonder and Harmsen (2016) identified that past researchers only focused on one type of learner and one type of guidance; past researchers failed to account for different ways of implementation. They concluded that "the effectiveness of inquiry learning depends almost entirely on the appropriate guidance." (Lazonder & Harmsen, 2016, p. 684) Despite the alluring nature of inquiry learning, controversy persists about whether and when inquiry-based instruction successfully promotes students' knowledge construction. In the light of the above-

mentioned inquiry-based learning debate, the goal of this study is to understand and describe how a selected group of established IBL teachers perceive and implement inquiry learning in their classrooms in a private school in an urban Midsouth city.

Chapter 3: Methodology

Introduction

A qualitative case study approach was utilized for this dissertation research project. Quantitative research approaches are grounded on the result sets, which may fail to capture and explain socially intricate multi-variants, including teachers' attitude, especially in explaining the self-constructed experiences of the research participants. Recently, qualitative research approaches have made significant contributions and earned recognition and prestige in the domain of social research (Marshall & Rossman, 2016). Per Denzin and Lincoln (1994), "The extent to which the 'qualitative revolution' is taking over the social sciences and related professional fields is nothing short of amazing." (p. ix)

Qualitative research approaches are especially suitable for capturing human actions which take place in natural settings and it is quite impossible to derive the meaning from these human actions without considering the space, context, culture, and participants' experiences, i.e., the participants' frame of references. One of the most important aspects of the qualitative approach is its ability to capture and recognize multiple perspectives (Marshall & Rossman, 2016). Qualitative research, from the epistemological perspective, better aligns with three of the major epistemological domains: critical emancipatory, constructivism/interpretivism, and postmodernism & poststructuralism (Grbich, 2007, p. 7). In constructivism, "the reality is fluid and changing and knowledge is constructed jointly in interaction by the researcher and the researched through consensus." (Grbich, 2007, p. 8)

The constructivist approach emerged from the works of Berger and Luekmann's (1967) *The Social Construction of Reality* and Lincoln and Guba's (1985) *Naturalistic Inquiry* (Creswell, 2014, p 8). Constructivists, or social constructivists, believe that individuals develop

subjective meaning on any matter according to their social, political, economic, and work life experiences (Creswell, 2014). That means, individuals may have a diverse understanding of the same issue according to their individual reality where they interact with other individuals in a specific social context. A researcher, while using a constructivist approach, should try to understand the participants' multiple and complex views by understanding the participants' contexts and backgrounds. A researcher can successfully implement the constructivist approach by asking open ended questions to the research participants. Open ended questions allow the research participants to talk about situations in their life settings in order to explain concepts broadly instead of being restricted by the guided research questions. Eventually, a researcher is going to interpret the participants' views through the researcher's own experience and background (Creswell, 2014). According to Lichtman (2013), "Knowledge is constructed by the researcher and is affected by his or her context." (p 13) Finally, the researcher and participants jointly construct the meaning of the researched object through engaged interactions amongst themselves (Guba & Lincoln, 1994).

This research project utilized a case-study methodology. Per Yin (2003), a case study design should be considered while trying to answer how and why questions without interfering with the behavior of the research participants; he also emphasized a detailed study of the contextual state coherent to the case. A case is a unit of analysis that may include one or more individuals, an activity, a process, an event, or a program (Creswell, 2014). According to Lichtman (2013), a case can be restricted to a specific entity, which could include only one specific individual to an entire school, or a case could be limited to a specific trait, characteristic, or behavior (p. 91). Miles and Huberman (1994) defined a case as, "a phenomenon of some sort occurring in a bounded context. The case is, in effect, your unit of analysis." (p. 25) In this case

study, the researcher interviewed five teachers to capture multiple perspectives which was utilized to develop the final research report.

Baxter and Jack (2008) warned against scope creep in a case study research. They recommended the researcher to bind a case by providing the guidelines for 'what to include' and 'what not to include' in a case study. Based on the collected data, this case study analyzed the teachers' perceptions, practices, and technology integration in the classroom setting while utilizing inquiry-based instruction. The researcher bound the case by only studying one specific private K-12 school with less than 500 students. Five teachers who met the sample selection criteria were interviewed. A total of eleven classroom observations were conducted by the researcher to cover all courses taught by these teachers.

To further bind this study, this case study excluded all other factors except the teachers' perceptions, practices, and technology integration in the classroom setting while utilizing inquiry-based instruction. There are many other factors (students' ability and readiness, school administration, academic curriculum, school and classroom cultures, types of standardized test, socio-economic background of the parents, etc.) that can influence either positively or negatively the successful implementation of inquiry-based instructions.

Baxter and Jack (2008) recommended that after defining the boundaries of a case, researchers should select a specific case study type to guide the entire study. Well-thought out research questions are also a great tool to bind a case study's research. In this case study, the researcher focused only on the pre-established research questions to analyze the teachers' perceptions, practices, and technology integration in the classroom setting while utilizing inquiry-based instruction. These questions fall under what Yin (2003) called a descriptive case

study. The descriptive case study is a great tool to describe a phenomenon under a natural setting without injecting any intervention (Yin, 2003).

Statement of the Problem

Teaching strategies that actively involve students in the learning process through inquiry instructions are more likely to increase conceptual understanding than that of strategies that rely on more passive techniques, which are often necessary in the current standardized-assessment laden educational environment (Minner, Levy, & Century, 2010). Brown (2012) suggested that teachers can provide genuine learning experiences by engaging active student discourse through inquiry learning approaches. Schroeder, Scott, Tolson, Huang, & Lee (2007) discovered that alternative teaching strategies are more effective than that of traditional classroom lectures. According to Ireland, Watters, Brownlee, and Lupton (2012), though teachers in U.S. schools do not have a well-defined singular concept of inquiry learning, teachers' conceptions and attitudes matter in inquiry learning in the classroom. Their research claims that an individual teacher has his or her own unique way of dealing with inquiry teaching and learning.

Purpose of the Study

The purpose of this qualitative case study was to better understand how a selected group of five teachers perceived and practiced inquiry-based learning (IBL) as an instructional method in their classrooms across all disciplines at one K-12 school. This study employed a case study methodology to better understand teachers' perceptions, practices, and technology integration, while using IBL in a metropolitan classroom setting. Data were accumulated through semi structured, open-ended interviews, and classroom observations. This approach allowed the researcher to capture and interpret the teachers' experiences.

Research Questions

The following research questions helped guide this study:

1. How do a selected group of teachers perceive Inquiry-Based Learning (IBL) as an instructional strategy in their classrooms?
2. How do a selected group of teachers plan IBL as an instructional strategy in their classrooms?
3. How do a selected group of teachers implement IBL as an instructional strategy in their classrooms?
4. How do a selected group of teachers integrate technologies while utilizing IBL as an instructional strategy in their classrooms?

Assumptions

It is a global trend that all educators are working hard to move away from a traditional lecture-based, direct instructional method of passing on knowledge. Current instructional methods encourage the development of multiple disciplines instructions to embrace and promote twenty-first century skills, which ask students to develop problem solving skills by mastering information literacy (Chu, Reynolds, Tavares, Notari, & Lee, 2017). One of the primary assumptions of this study is that this global trend of student-centered active learning will persist over an extended period.

In this modern approach of helping the students construct their own knowledge, teachers play a central role by providing guidance and tools instead of transferring their own views on a specific topic. Another central assumption of this study was that teachers' perceptions and practices was one of the most significant factors in understanding inquiry-based learning as an instructional method. It is paramount to understand the teachers' perceptions, and practices in the

classroom setting while utilizing inquiry-based instruction. Without having a sound understanding of the teachers' perceptions and practices, it is impossible to understand this modern trend of active learning. Teachers' practices relating to instructions, like many other aspects of our daily life, are continuously evolving to optimize learning outcome by embracing technological innovation.

Another core assumption was that technological disruption and in-classroom utilization of technologies had a significant impact on how teachers implement inquiry-based learning in their classrooms. Technological innovation is unceasingly and hastily disrupting the way educators deliver instructions, learn, perform their jobs, communicate with each other, and share their ethical and social responsibilities (Chu et al., 2017). Today, teachers are utilizing a glut of educational technology tools including interactive white boards, projectors, video conferencing and virtual field trips, internet and mobile technologies, web 2.0, wiki, blogs, and learning management systems (LMS), as well as social media. The primary goal of any technology integration as a cognitive tool is to involve students by igniting their curiosity and higher order reflective thinking through knowledge exploration and discovery (Chu et al., 2017; Coffman, 2017; Kuhlthau, Maniotes, & Caspari, 2015; Boss & Krauss, 2014). As a result, teachers' perceptions, practices, and technology integration in the classroom setting will remain the dominating forces to define the success and outlook of inquiry-based instruction.

Limitations

The scope of this case study was to analyze the teachers' perceptions, practices, and technology integration in the classroom setting while utilizing inquiry-based instruction. One of the primary limitations of this study was covering only one specific private K-12 school with less than 500 students. Another limitation was the small sample size of between four and six

participating teachers. However, according to DeMarrais (2004), a small sample size is desired for any qualitative research study in order to perform in-depth interviews with the research participants for capturing thick description and retaining a deep understanding of an issue.

As a single case study, the researcher's findings were limited by the participating school's culture, maturity, understanding of IBL, and administrative support for the teachers to practice and promote IBL in the classrooms. The principal and the vice-principal of the participating school were very supportive of the IBL method and promoted the IBL approach of teaching through ongoing training for all teaching staff. Yet another limiting factor was the limited pedagogical knowledge of IBL among the participating teachers. The sample selection criteria allowed those teachers who had at least two years of teaching experience to participate in this research study. This research project asked the qualified teacher for voluntary participation. The researcher also had no control on the diversity of grades and subject areas that were taught by the participating teachers. The principal of the school mentioned that he would try to ensure as much diversity as possible if there is a big pool of interested volunteer participants. Yet another limitation is the private school setup. In a private school setup, teachers have a total control on the type and volume of the curriculum. Private schools do not have to follow any State mandated curriculum or standardized tests.

Participants

Sample selection criteria. The sample selection criteria were as follows

- Teachers who practice inquiry-based instructions in their classrooms
- Have at least two years of teaching experience

This is a criterion-based participant selection as the researcher provided a list of characteristics for qualifying research participants (DeMarrais, 2004). Per the principal, there were between eight and twelve teachers who were interested in joining this research study.

DeMarrais (2004) once stated that “fewer participants interviewed in greater depth usually generates the kinds of understandings qualitative researchers seek.” (p. 61) This study collected data from five of the selected teachers. These teachers collectively have a total of 56-year of teaching experiences, six-year of minimum teaching experience, and 32-year of maximum teaching experience. Three of the participating teachers are male and two of the participating teachers are female. Teachers at this private school have complete control on their curriculum and do not have to follow any state standards for curriculum planning. Participating teachers are teaching between fourth-grade and tenth-grade. Participating teachers are teaching Math, Science, English Language and Arts, Advance Arabic, Social Studies, and US History. The following descriptions offer insight into the participants. The names are all pseudonyms.

Kate

Kate has 10 years of teaching experience. Her highest degree is a bachelor's. She teaches fourth grade students.

Michael

Michael has seven years of teaching experience. His highest degree is a bachelor's. He teaches various social studies classes from sixth to twelfth grade.

Matthew

Matthew has over 32 years of teaching experience. His highest degree is a doctoral. He teaches Advanced Arabic for middle and high school.

Julie

Julie has 11 years of teaching experience. Her highest degree is a masters. She teaches English, Language Arts for elementary and middle school.

Chris

Chris has six years of teaching experience. His highest degree is a bachelor's. He teaches social studies classes for elementary school.

Site selection. In this case study, the researcher interviewed five of the selected teachers of a local private school from an urban large Mid-South city to better understand how participating teachers perceive and practice inquiry-based learning (IBL) as an instructional method in their classrooms. This was a small, private K-12 school with an enrollment size of about 450 students. There were thirty-two well-qualified teachers, and four of them had a doctoral degree in their respective field. Ten of the teachers were male and rest were female. There were ten administrators, three of which were male, and rest were female. There was only one librarian to help all 450 students. There was no full-time employee to support the computer lab and other technology related services including network and Wi-Fi connections. One of the teachers took care of the technology needs in addition to his full-time teaching load.

Ethics

"Ethical considerations are much more than just ensuring informed consent and protecting participants' anonymity." (Marshall & Rossman, 2016, p. 126) The researcher anticipated the potential ethical dilemmas and consulted with his advisors in order to get expert opinion to avoid any ethical pitfalls. Formal permission was acquired from the participating school to conduct this study. The researcher did his first voluntary work for this school in 1999. This is a non-profit organization, and he was a regular donor since 2000. For a good number of years, he took care of their computer labs and network services on a voluntary basis. In 2006, his daughters joined this school at their day care center. The researcher led their network upgrade project in 2010. During this project he came to know most of the teachers and administrators very intimately. Teachers used to call him directly with their computer and network related

issues. This helped to connect with individual teachers at a personal level. In 2011, the researcher joined the School Process Improvement Committee (SPIC). He continued his service to the SPIC until 2017, when he got elected as one of the school board members. Though he is a current board member, teachers have no hesitation to call him if they need any help, as they used to do in the past. The researcher met the principal while he came for his first interview about five years back. The school principal held a doctoral degree in history and was a wonderfully friendly person, who loved to talk about world history. The researcher's daughter was a regional champion of the National History Bee contest. The researcher traveled with the principal many times for National History Bee and National History Day contests. The researcher explained to the principal about his research study idea and the principal graciously agreed to grant him access to the teachers and classrooms. The researcher talked to the participating teachers and explained that as a board member he has no authority over teachers' performance evaluations, hiring, or firing. He also explained that their confidentiality will be protected at all time. The researcher also conveyed that, this case study report will not be utilized to either reprimand or reward any of the participating teachers.

This research involved human subjects that required preapproval from the University of Memphis Institutional Review Board (IRB) before conducting the actual data collection. The role of the IRB is to study the research proposal before approving, rejecting, or recommending changes for a specific research proposal to safe-guard the rights and wellbeing of the research subjects.

Instrumentation

This qualitative research study did not utilize any previously established instruments; rather, it followed the standard qualitative research method. The researcher developed the

interview protocol to conduct interviews and classroom observations. The researcher, while conducting semi-structured interviews, primarily focused on asking pre-determined interview questions from the interview guide (see Appendix A) and did follow up with spontaneous questions or probes according to the participants' responses.

Data Collection

Method. A research methodology usually dictates the types of information accumulation methods used by the researchers. This research study used a combination of interview and observation methods for data collection.

Interview. An interview is a data collection method in which the researcher engages with the research participants in a focused conversation to learn about the research topic (DeMarrais, 2004). In this qualitative research, the researcher attempted to construct a picture of the teachers' perceptions and practices in IBL by acquiring knowledge from the research participants while concentrating on asking pre-established interview questions and spontaneous follow up questions or probes based on participants' responses (DeMarrais, 2004). It was imperative for the researcher to develop rapport with the research participants to stimulate a detailed and honest discussion; this was achieved by adhering to the approach that guaranteed the research participants that their interpretations are important to the researcher (Marshall & Rossman, 2016).

The researcher developed an engaged relationship with the participants by showing respect, paying attention during the interview process, showing interest by asking follow-up questions, and practicing good manners through verbal and non-verbal communications, as per Seidman (2013). In this scenario, the researcher considered each of the participants as a subject-matter expert. The goal of the researcher, an informed learner, was to get involved in an engaged

discourse with the research participants to learn from them in detail about the multiple perspectives, views, experiences, and opinions through open-ended interviews. By following the recommendations of DeMarrais (2004), the researcher conducted an informal, open-ended, and conversational style of interview to involve the research participants at a deeper level by encouraging them to answer and explain beyond the researcher's generated questions.

The researcher utilized open-ended elaboration and open-ended clarification to capture detailed descriptions and to avoid confusion rooted in assumptions. Towards this goal, the researcher developed an interview guide (see Appendix A) prior to the interview process. The researcher scheduled and conducted a one-hour interview with each of the participating teachers. Though all the interviews were scheduled for 60 minutes, actual interview time varied between fifty minutes to 85 minutes. Some participants answered some of the questions with great excitement and detail. The researcher utilized an audio recorder to capture the full interview as raw data. Audio files were transcribed by utilizing a transcription software called Temi.com. The researcher compared the auto generated transcripts with the source audio file multiple time to correct the transcripts. If there was any confusion regarding any segment of the raw dataset, the researcher crosschecked with the participating teachers to verify the accuracy of the dataset in order to reflect the accurate participants' view. Finally, the researcher performed member checking by sharing the corrected transcripts with the participating teachers. The researcher asked the participating teachers to read their interview transcripts and send back the corrections. Member checking improved the reliability and validity of the research study (Saldaña, 2009).

Observation. In addition to interviews, the researcher conducted classroom observations to learn about teachers' understanding, practices, and technology integration while utilizing IBL in the classroom setting. The researcher observed the participants in their natural settings to

capture the thick description of verbal and non-verbal incidents to develop a better understanding of some of the research questions. Lichtman (2013) stated that "observations usually occur in settings that already exist, rather than in contrived settings. You can observe naturally occurring groups either at work or in formal settings." (p. 222) The researcher observed four of the participating teachers, each of the teachers was teaching two distinct subjects, twice while they taught in the classroom setting for two 50-minute sessions. One of participants was teaching three different subjects, and the researcher observed all three of his classes. While observing the participating teachers, the researcher took field notes of the words, tone of voice, body language, and other paralinguistic messages (Marshall & Rossman, 2016).

Per Marshall and Rossman (2016), field notes entail systematic observation and recording of context, and interactions in the natural setting. One of the core tenants of IBL is to promote asking questions without providing the answers. The researcher observed and took note of the teachers' interactions with the students, and the teachers' ability to introduce a topic by promoting an inquiry learning environment, which allows and encourages the students to ask questions. The researcher also observed the teachers' responses and attitude while answering students' open-ended questions. The researcher observed and took notes on each of the steps of the inquiry cycle as followed by each of the participating teachers. The researcher took field notes on technologies utilized in the classrooms by the teachers in order to optimize inquiry learning experiences. Data gathered through observation helped the researcher to develop a better understanding of the research questions.

Data Analysis Method

After the researcher selected the research methodology, research site, criterion-based research participants, and data collection methods, he elaborated on analyzing and interpreting

the collected data (Marshall & Rossman, 2016). The researcher stored raw data in multiple sites electronically for ease of data organization, retrieval, and manipulation (Marshall & Rossman, 2016). "The process of bringing order, structure, and interpretation to a mass of collected data is messy, ambiguous, time-consuming, creative, and fascinating." (Marshall & Rossman, 2016, p. 214) Patton (2002) described that it is an unbearable task to study pages of interviews and field notes to make meaning out of it.

The researcher utilized coding to make initial meaning out of collected data. "A code in qualitative inquiry is most often a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion language-based or visual data." (Saldaña, 2009, p. 3) During the first cycle of coding, the researcher followed Descriptive Coding for observation notes and In Vivo Coding for interview transcripts. The researcher used Descriptive Coding for observation notes as these notes are written using the researcher's own words instead of participants' words. Additionally, observation notes included a lot of nonverbal clues and physical actions as observed by the researcher. On the other hand, the researcher used In Vivo Coding for interview transcripts as interview transcripts were comprised of participants' own words. According to Saldaña (2013), Descriptive Coding allows the researchers to "assign labels to data to summarize in a word or short phrase – most often as a noun – the basic topic of a passage of qualitative data." (p. 262)

The researcher studied all eleven classroom observation notes and assigned labels to data; these labels came from the literature review. Luera, Killu, and O'Hagan (2003) mentioned that teachers should grab the attention of students at the beginning of any inquiry-based learning sessions by discussing a discrepant event. The researcher observed this particular action as performed by participating teachers and labeled this action as grabbing students' attention.

Callison and Baker (2014) emphasized the importance of teachers asking intriguing questions in an IBL environment to activate thinking among students. The researcher witness that teachers asked numerous questions to encourage students' active participation. As a result, students asked relevant and critical thinking questions. The researcher recorded three labels by witnessing this event: teacher asked questions, involved students, and students asked clarifying questions.

Wilhelm (2014) mentioned that, while using inquiry-based teaching, teachers should foster creative thinking and group discussion by asking essential questions. The researcher noted that teachers promoted interactive group discussions by engaging all students during any inquiry-learning session. The researcher labeled these events as: group discussions, classroom discussion, and students' active participation. According to Haney, Czerniak, and Lumpe (2003), while utilizing IBL, students present their findings to the entire class and classmates are allowed to ask any kind of questions; this empowers students to be a part of the assessment process for other students. Participating teachers allowed students to present their project findings, other students asked critical and clarifying questions to the presenter. The researcher labeled this incident as students asking questions to other students. These are some examples of labels the researcher recorded as codes while performing the first cycle of coding on classroom observation data using Descriptive Coding.

According to Saldaña (2013), In Vivo Coding "uses words or short phrases from the participant's own language in the data record as codes." (p. 264) The researcher studied five interview transcripts multiple times, highlighted the key ideas or expressions and identified key words or short phrases to record those ideas or expressions. Most of the In Vivo codes, identified by the researcher, were grounded in the IBL literature. Marshall and Horton (2011) recommended that teachers should, at the beginning of an IBL session, assess students' prior

knowledge and address misconceptions by asking interesting and stimulating questions. Participating teachers conducted prior knowledge check before introducing any new concept. The researcher found that teachers used the following terminologies while assessing or activating students' prior knowledge: fluency check, bell work, prior knowledge activation, and foundational knowledge. Marriott (2014) claimed that students are positively influenced by teachers who ask questions instead of giving answers. According to Marshall and Horton (2011), students construct a better understanding of a new concept when they are allowed to explore knowledge before teachers provide an explanation. Teachers described that they let the students think, discuss, explore, and ask questions before explaining a new concept. Teachers used the following In Vivo codes to express the importance of knowledge explorations before providing explanations: let students figure it out, discuss and learn, ask questions without giving answers, discuss and negotiate meaning, hands-on activities, and learning by doing.

Asking relevant and critical thinking questions is central to the success of inquiry-based teaching and learning (Brown, 2012). Wilhelm (2014) emphasized the importance of asking open-ended, meaningful, and relevant questions during inquiry-based instruction. Teachers expressed that they allowed and encouraged students to ask open-ended questions. The researcher observed that teachers used the following In Vivo codes to show their encouragement to ask questions by students: students ask a lot of questions, students are not afraid to ask questions, students asked open-ended questions, students asked critical thinking questions, students asked questions to other students, interesting vs. relevant question, and students asked hypothetical questions. If teachers can successfully encourage and implement students' active participation during IBL, students will develop a better conceptual understanding (Minner, Levy, & Century, 2010). According to Brown (2012), teachers should encourage active students'

participation through open discourse to provide genuine learning experiences in an inquiry learning environment. Teachers used following In Vivo codes to explain how they promoted students' active participation: students were allowed to ask any number of questions, students worked in small group, performed hands on activities, conducted information search, carried out knowledge search, classroom presentation, worked on project, and discussed among themselves. These are some examples of In Vivo codes while performing the first cycle of coding on interview transcripts.

During the second cycle of coding, the researcher followed Eclectic Coding. According to Saldaña (2013), Eclectic Coding "employs a purposeful and compatible combination of two or more first cycle coding methods, with the understanding that analytic memo writing, and Second Cycle of recoding will synthesize the variety and number of codes into a more unified scheme." (p. 262 – p. 263) To optimize this process of synthesizing the huge number of codes, the researcher utilized a visualization tool called Webspirationpro. This tool helped the researcher visualize all the codes in a single diagram. This tool allowed the researcher to drag and drop similar codes into organized clusters and synthesize them to fit in a unified IBL concept. It took several attempts to synthesize the In Vivo codes.

The researcher learned about IBL by conducting a detail literature review. Knowledge acquired through IBL literature review helped the researcher to synthesize the In Vivo codes. During the synthesis step of coding, the researcher observed that teachers encouraged students to ask questions by using multiple In Vivo codes. Teachers mentioned that students were encouraged to 'ask critical thinking questions'. Sometimes, teachers encouraged students to 'ask relevant questions'. Teachers claimed that some students 'ask interesting questions'. Teachers allowed students to 'ask questions to other students'. Teachers reported that sometimes students

'ask hypothetical questions'. The researcher identified this cluster of similar codes. Then the researcher synthesized all the above-mentioned codes into a single scheme: 'students were allowed to ask questions'. This is an example of the second cycle of Eclectic Coding.

After conducting the second cycle of coding, the researcher analyzed codes to determine patterns by grouping themes together or forming categories based on their commonalities (Saldaña, 2009). Lincoln and Guba (1985) highlighted the importance of the researcher's intuitive senses to gather 'look and feel alike' data to determine data grouping. The researcher became overwhelmed with the huge number of codes. Additionally, these codes were interconnected and overlapping. The researcher utilized the Webspirationpro, a mind-mapping and visualization tool, software to visualize the big picture and connections among different groups. This visualization tool helped the researcher tremendously while grouping the codes into multiple categories.

Saldaña (2009) recommended researchers to revisit their codes multiple times before finalizing their codes. The researcher had to think through the codes multiple times before finalizing the major categories. The researcher identified the following major categories of codes: IBL Characteristics, IBL Benefits, IBL Challenges, Teachers' perceptions, IBL Planning, IBL Implementation, Learning Assessments, Instructional Materials, Technology Utilizations (TU), Challenges of TU, Encourage Active Participations, Characteristics of Non-IBL Methods, How Participants' Learned IBL, Different Names for IBL, and Things to Consider for Future IBL Planning.

The researcher compared among major categories to construct major themes or concepts for the study; "a theme is an outcome of coding, categorization, and analytic reflection." (Saldaña, 2009, p. 13) The researcher identified four major themes after carefully analyzing all

the major categories of codes: teachers understood and implemented IBL in different ways; teachers recognized that IBL is helpful for better knowledge construction; teachers expressed that planning an open inquiry learning environment is extraordinarily challenging; and technology is beneficial for an inquiry learning environment despite its own challenges. The researcher analyzed the major themes in chapter four and discussed their relationships with the research questions in chapter five.

Trustworthiness

Reliability of data collection was enhanced by adding multiple data sources. Data were collected through interviews and multiple classroom observations. Accuracy of the interview data was achieved through member checking. The researcher shared the corrected interview transcripts with the participating teachers to validate the accuracy of the interview data. Finally, the researcher maintained a research log to keep up with the research progress and development.

Summary of the Methodology

The researcher employed a descriptive case study methodology in a single case study to understand and interpret how participating teachers are implementing inquiry-based instructions in their classrooms. The researcher utilized interview and observation methods for data collection in this qualitative case study. A case study-based qualitative research opens enormous opportunities for the researcher to capture the rich and in-depth descriptions of a specific case along with its context (Flyvbjerg, 2011). During the data analysis phase of this case study, this researcher explored multifaceted phenomena using the data, which represents multiple viewpoints, to construct an analyzed understanding within the selected context (Baxter & Jack, 2008, p. 544). Robert Stake and Robert Yin, two of the primary proponents of case study theories, placed emphasis on constructivist paradigm of meaning making through a case study

research (Baxter & Jack, 2008, p. 545). A strong alliance between the researcher and the participant empowers the researcher, in a case study research, to construct his or her own meaning of the data under study (Crabtree & Miller, 1999). After coding, grouping the codes, and analyzing the intricate relationship among the different groups of codes, the researcher identified four major themes: teachers understood and implemented IBL in different ways; teachers recognized that IBL is helpful for better knowledge construction; teachers expressed that planning an open inquiry learning environment is extraordinarily challenging; and technology is beneficial for an inquiry learning environment despite its own challenges. The next chapter describes the four major themes along with their sub-themes.

Chapter 4: Findings

Introduction

The purpose of this study was to better understand how a selected group of five experienced teachers perceived and practiced inquiry-based learning (IBL) in a small private school setup. Four major themes emerged after analyzing the interviews and classroom observations data. Four research questions are: how do a selected group of teachers perceive Inquiry-Based Learning (IBL) as an instructional strategy in their classrooms? (RQ1); how do a selected group of teachers plan IBL as an instructional strategy in their classrooms? (RQ2); how do a selected group of teachers implement IBL as an instructional strategy in their classrooms? (RQ3); how do a selected group of teachers integrate technologies while utilizing IBL as an instructional strategy in their classrooms? (RQ4). The first theme is related to research questions one (RQ1) and three (RQ3); the second theme is related to research questions one (RQ1), two (RQ2), and three (RQ3); the third theme is related to research questions two (RQ2) and three (RQ3); and the fourth theme is related to research questions two (RQ2), three (RQ3), and four (RQ4).

This chapter summarizes the four major themes that emerged from analyzed interviews and classroom observations data. The four major themes are: teachers understood and implemented IBL in different ways; teachers recognized that IBL is helpful for better knowledge construction; teachers expressed that planning an open inquiry learning environment is extraordinarily challenging; and technology is beneficial for an inquiry learning environment despite its own challenges.

These major themes are interrelated and highly contextual. These themes emerged from the interviews and classroom observations of five experienced teachers with a minimum of six-

years of experience. This case study covered only a single small private school where teachers don't have to follow any state-imposed curriculum or standardized tests. Each section of this chapter describes a major theme in detail by further breaking it down into subthemes and explains its relationship with two or more of the research questions. These major and sub-themes are best understood by rich and detailed excerpts from the interview transcripts. Though all the interviews were scheduled for 60 minutes, actual interview time varied between fifty minutes to 85 minutes. Some participants answered some of the questions with great excitement and detail. The researcher remained focused in developing major themes and sub-themes in the context of the research questions.

Major Theme One

Teachers understood and implemented IBL in different ways. Research question one was designed to capture teachers' perception regarding IBL as an instructional strategy in their classrooms. Teachers learned about inquiry-based learning primarily through teaching experiences and self-learning. Because of that, each of the participating teachers had a slightly different understanding of the IBL method. Research question three was designed to learn about the IBL implementation methods. Each of the participating teachers implemented IBL slightly differently in his or her classrooms. One of the teachers implemented two different methods: one for her Science classes and the other for her Math classes. Three sub-themes emerged on how teachers understood and implemented IBL method which are: teachers learned IBL methods from teaching experience and self-learning; teachers primarily understood inquiry learning through its characteristics and benefits; each of the teachers implemented IBL by using a unique learning cycle.

Teachers learned IBL method from teaching experience and self-learning. All the participating teachers, except one, learned about inquiry learning through teaching experience and self-learning. Teachers used different names to express inquiry learning. Most of them practiced some versions of inquiry learning methods before they had mastered the theoretical framework of the inquiry learning. Kate is the only teacher who received some formal online web-based training on inquiry learning as a part of her professional development or continuing education. Her school gave her access to eduGAIN (e-learning platform for teachers' professional development and resource-sharing) to learn about inquiry learning method. Participating teachers described their initial exposure to IBL:

> **Kate**: I worked in Ontario, we actually had to use an anchor …. teachers get assessed by the board, so when they (new teachers) come in, they (School board members) showed us how to do it. They gave us the guidelines to follow the website called eduGAIN. So, every time they (School board) come up with any new concepts or any kind of continuing education for teachers, those are posted up. We are required to go there and kind of looked through the videos and see the new strategies that are being applied.

> **Michael**: My degree is not actually in teaching … to get my license as a teacher, I went a program called the Memphis Teaching Fellows. Apart from a lot of classroom management, a lot of discussion about what would be helpful for students, … what would benefit them most in terms of learning. There was a lot of discussion about activities that you put learning in the hands of the students and the concept that they would get more out of it when they're the ones like doing the research, like you still engage their curiosity.

Mathew: It's about 30 years plus in the journey of knowledge, training, degrees and formal education. … worked as a language inspector in Libya, English language inspector, and a teacher trainer in the United States. … I participated in many, many, many conferences regarding a communicative language teaching any new approaches and the focus on developing students' communicative competence through communicative practices.

Julie: I got into teaching nine years ago and at that time I was pretty much a very traditional teacher, but after doing some workshops and teaching English as a second language, I found that the best way to promote the English Language Learning is through the communicative approach. And that's how I was introduced to inquiry-based learning.

Chris: A learned through self-learning, studying, looking things up on the Internet. I kind of say I fell into it from teaching every day and growing with teachers and I watch my mom teach. When l started to teach, I just wanted to make the subjects that I taught more interesting. So, I always try to attach an activity .. small group activity into my teaching method. Without knowing it, I was actually doing the IBL methods. Afterwards I researched it, I realized that this was an authentic Method. And I just started to try to follow the steps of the IBL method.

Teachers primarily understood inquiry learning through its characteristics and benefits. Teachers explained IBL through a set of characteristics. Some of the most common characteristics of inquiry learning methods are student-centered learning, interactive learning,

active learning, self-directed learning, asking open-ended questions without giving the answer, learning by doing, problem-based learning, and project-based learning. Though there are some common characteristics, each of the participating teachers mentioned and emphasized a different set of IBL characteristics based on his or her own IBL practices.

> **Kate**: When you actually ask them open ended question, you'll get a better result than a close ended question. So, I give them the basic step on ideas that they probably already have, I know that they know it and then once I come to a new concept, I let them figure it out. …Mostly in math, I notice that whenever I give them open ended problem and I let them figure it out, it works better for them to understand. I don't give out the math concept right away because I figured whenever I give them the concept first, it's a very hard for them to comprehend. .. I noticed whenever one (of the students) helps the others, they (students) understand it better and they ask more question and it actually helps me (the teacher) to understand which are the parts that they're weak on and which are the parts that I need to cover more on.
>
> **Michael**: There are things that I do in my classroom that I would consider to be inquiry-based teaching strategy, I don't think I've been formally introduced to it as such. So, there are things where, …. student driven learning, meaning you're basically putting learning in the hands of the students. You pose problems to them or you set tasks in front of them and you see what they get out of it, but we're not so much directing it, you're just guiding them in the learning process.
>
> **Mathew**: Communicative language teaching …is based on student-oriented type of learning. So, we give more room for the students to participate in the learning process. They acquire knowledge through what we call meaning negotiation and discussion and

elicitations. So, it's very much relevant to second language acquisition and second language learning that the shift was taken from the teacher as the main source of knowledge to the students. It is a kind of interactive class when we involve the students through what we call communicative practices and communicative language teaching. The end product of a long process of research done in the field, starting from the behaviorist approach, an audio linguist and all the way down to cognitive approach.

Julie: Inquiry based instruction to me is giving the students the lead to guide their own learning and be responsible for it. Um, it promotes independent learning. So, in my experience, inquiry learning sometimes helps students figure out what they want to learn or what they know already. And … I find that it's very helpful in engaging students and providing them with a classroom where they are in control.

Chris: In general, I learned that inquiry instruction is really helpful in the classroom. It gets students thinking, it allows them to talk more, and share their own ideas, allows for more collaboration and it's less boring for the students. … So, for me, an inquiry-based learning, it's just a way to keep the students engaged with it, to make them have a hold on their own learning gradually. A lot of self- learning, self-taught, and self-knowledge.

Though all teachers mentioned numerous benefits of inquiry learning, each of the teachers highlighted different learning and teaching benefits based on his or her own IBL practices. Some of the most common benefits are engaged students, active students' participation, relevance to students' learning interest, creative solutions from the students, students can ask unlimited questions, teachers can have a better understanding of students' need, students learn to ask critical questions, teachers spend less time for classroom management, and

students can comprehend material better. Some of the benefits as expressed by the participating teachers are:

> **Kate**: IBL is beneficial because they're actually using it in their daily life. Every single concept that we do, it's always something to do. They can take it back at home and do it. … I was even surprised that they were able to figure out the equation without me telling them, because they know the concept, but they don't know how to put them together, but they did it. .... It makes a lot easier for me to teach because then I know they're understanding it and I can move on to the next step. Or if somebody's struggling, I could figure that out and I changed my instruction according to their pace.
>
> **Michael**: …. for me it's about taking ownership, because then they (students) do seem to be more engaged when they develop these questions. And I think they try to make more of a connection to themselves when they develop these questions. … students are getting an opportunity to ask question based on their need instead of you (the teacher) are trying to anticipate what their need is and try to explain it.
>
> **Mathew**: The number one advantage of that approach is it gives the students self-confidence. So that's what we need. Second motivation, they're motivated to learn, okay. Because they are their part. They feel they are part of the learning process and the important one in the class, also it is not teacher dominated. … It limits my (the teacher's) role in the class. I'm not speaking all the time and I'm kind of relaxed. I am kind of managing the class.
>
> **Julie**: I think a big part of it is engagement and the students are, in my opinion, yes, there they're always improving. If you're in the classroom, there's always going to be some level of improvement on their part. But I'm with inquiry-based instruction. I think the

most beneficial part of it is that motivation and engagement. I think they're motivated to ask questions. They're motivated to take part. The questions that they're asking are already of interest to them. So, it makes it relevant to their learning. Sometimes it could be if you're in a classroom environment where students are very comfortable and confident in asking questions. In such a case, then you know that they will ask the questions that they feel they want to know, they want to find answers to. It's a good way for me (the teacher) to monitor their (students') learning. It's also nice because I get to see their creativity.

Chris: I always tell my kids, I love creative people, so be creative as much as possible. I give you a concept and this is what I want from the concept. I don't give them a rubric and say, do exactly these steps. … You know when you got a room full of 20, 30 kids and they all got 10 different learning styles, you, you don't know how to teach them. But if you allow the students to show you, then all you must do now is just, Guide them. It is kind of get here. I will just keep you on task, stay on task, stay within the parameters of the concept.

Each of the teachers implemented IBL by using a unique learning cycle. Each of the participating teachers developed and practiced his or her own unique way of implementing an inquiry lesson. All of them started with an attempt to actively involve the students and end with an assessment and feedback loop. The teaching/learning activities in the middle varied tremendously. Some of the learning activities, as practiced by the participating teachers, are open discussion with the students to establish main learning objectives, reinforcing prior knowledge by asking "why" questions, letting the students ask questions, grouping/regrouping students in

three groups based on their learning readiness on a specific topic, letting the students choose a topic of their own interest, letting the students explore relevant information, assigning hands on activities, letting the students present and share their findings, assigning projects, and evaluating and providing instant feedback throughout the learning cycle. Kate utilized two different learning cycles; one for her Math classes and the other one for her Science classes.

Kate's IBL learning cycle for Science classes:

Step 1 - Grabbing attention by asking questions

Step 2 - Initiate discussion using textbook tips

Step 3 - Students and teachers work together to develop questions

Step 4- Students perform research on the listed questions

Step 5- Hands on activities

Step 6 - Project Assignment

Step 7- Formative and summative evaluation and Feedback

Kate's IBL learning cycle for Math

Step 1 - Grabbing attention by asking questions

Step 2 – Fluency or practices for refreshing basic concepts

Step 3 – Introduce new concepts through discussion

Step 4- Open discussions and open-ended questions

Step 5- Exit plan in the form of individual practice

Step 6 – Based on the performance of the individual practice, students are grouped into three groups – strong, medium, and weak

Michael's IBL learning cycle

Step 1 - Grabbing attention by displaying video, images, or other fun activities

Step 2 – Open discuss with students to set learning goals and objectives

Step 3 – Let the students think and discuss about main topic

Step 4- Assign individual/ group activities

Step 5- The teacher asks guiding questions to each of the groups to ensure students are working and on track

Step 6 – Students summarize learning through comparison and differentiation (among the groups)

Step 7- Students present and share their findings

Step 8- Group reflection through group discussions

Step 9 – Assessment and ongoing feedback

Mathew's IBL learning cycle

Step 1 – Share end-of-day learning objectives

Step 2 – Read a passage from the text book

Step 3 – Students Identify and highlight known words from the text book passage

Step 4 – Meaning negotiation of the text through group discussion by focusing on the main theme of the paragraph

Step 5- Comprehend new words – students enrich each other's knowledge

Step 6- Students express their understanding of the topic by writing a paragraph on the main idea

Step 7 – The teacher provides continuous and instant feedback

Julie's IBL learning cycle

Step 1 – Grab the attention by showing video

Step 2 – Ask questions and let the students ask questions

Step 3 – Discuss and communicate the learning objectives

Step 4- Set the scene; explain or illustrate

Step 5- Students choose their own topics

Step 6 – Students work on their projects

Step 7- The teacher helps the students by asking guiding questions and giving instant feedback. If require, the teacher will assign a student

- Controlled practices (structured practices) or
- Free practices (unstructured practices)

Step 8- Students share their products/ artifacts with the class

Step 9 – Assessment and feedback by the peers and the teacher

Chris' IBL learning cycle

Step 1 – The teacher sparks interest by asking questions

Step 2 – Conduct brainstorming session to develop main idea

Step 3 – Detail out the main idea using KWL (Know, want to know, and want to learn) method

Step 4- Class discussion in the form of "Asking Why Questions"

Step 5- Small hands-on activities

Step 6 – Assign projects

Step 7- Students present and share their findings

Step 8 – Assessment and ongoing feedback

Major Theme Two

Teachers recognized that IBL is helpful for better knowledge construction.

Participating teachers described many benefits of the IBL method. All the teachers expressed that they have positive experiences (RQ1) while using the IBL method to attain higher learning outcomes. Successful planning (RQ2) and implementation (RQ3) of IBL is essential to accomplish these higher learning outcomes. This major theme emerged from three sub-themes: students' active participation makes learning memorable; students enjoy learning most when they choose topics of their own interest; students make new meaning through discussion and experiences.

Students' active participation makes learning memorable. Students are at the driver's seat in the inquiry learning method. A teacher's job, in an inquiry learning method, is to encourage students' active participation through discussion, debate, hands-on activities, projects, and role play. Active students' participation makes learning fun and memorable. In Ms. Kate's science class, each of the students developed a model to compare the lung capacity between a fourth-grade student and an adult. Ms. Kate said that "We usually do all of these experiments in the class, this time I let them do it with their parents and they had a lot of fun." Learning through this kind of hands on activity is going to stick with learners for a long time.

In Mr. Michael's class, students work on National History Day (NHD) projects. These research-based projects help develop quasi-experts in different history topics. Mr. Michael utilizes these students (quasi-experts) as reference resources when any discussion takes place on that specific history topic. Mr. Michael described that "We participate in a National History Day project and basically this is research, students are researching on their own. When students do it properly, I can, on many occasions, I literally have, ….. a quasi-expert in my room on different

topics. ….. when a student has gone through the process of working on a national history day project, I can easily reference that child with a point of reference in my room." Mr. Michael explained that IBL helps him to instill transferable skill sets among his students. Some of the transferable skills are critical reading, critical writing, and critical thinking. According to Mr. Michael, "I recognize that there are certain contents that will stick and some that will not. But there are certain skill sets that once they are learned it's basically transferable to more rigorous environments." Students should be able to utilize these learned skills at any time in the future.

Mr. Chris assigned role-play projects on the American Revolution. Students enjoyed these projects so much that they can vividly describe their roles even after multiple years. Mr. Chris said, "I think the best example is doing the American Revolution because the students really get involved in it and it goes for such a long period of time and the students still to this day or tell me some of my sixth graders who did it in fourth grade and tell me, Mr. Chris, remember when I was Sam Adams, or remember when I was George Washington or ….. but I just remember that we did so many projects with it and it just having ideas and the way they came back with questions for me, that really threw me off. That they had more questions than I could even answer. I saw a lot of students researching and they will come to me and tell me what happened on this day or they told me how many people died in the Boston massacre and they knew it. They knew it, they knew it better than me."

Students enjoy learning most when they choose topics of their own interest. In inquiry learning, teachers allow the students to pick topics based on their own interests to make the learning experience interesting and relevant. When students choose their own topics, they consider themselves responsible for the learning outcomes. If a student likes a topic, he or she will go the extra mile to learn about it in detail. Motivated students have unlimited access to

online information to learn and share knowledge. Ms. Kate asked her students "... what type of career would you have if you are doing certain energy lesson?" Students were allowed to learn about different energy related careers based on their own interests. Ms. Kate mentioned that "…they actually read these people who has different type of career, they are very interested."

Mr. Michael spoke extensively about NHD projects. Students choose their own projects and work individually or as a team. According to Mr. Michael, "In project-based learning students seems to get them going, because you know, them taking ownership over their learning. ….. students seem to become a lot more engaged when they are the ones in control of the learning process." When students are allowed to develop their own research question, they are willing to give more. Mr. Michael said "... it is about taking ownership, because students seem to be more engaged when they developed these questions and I think they try to make more of a connection to themselves …"

Mr. Mathew spoke about the importance of automaticity and autonomy in inquiry learning. Mr. Mathew said "Student-oriented learning is automaticity and autonomy. Students can be themselves and they can do this to make sure that they are independent learners, they are not depending on the teacher all the time, you're there as a facilitator. …. I had the chance last year because we had the computer lab in the same place, so twice a week I usually let my students to work on it in different topics. I'll ask them, for example, you go to this website and there are a lot of topics: fashion languages, whatever, pick up your topic. So, I'm not imposing students a certain topic, this is what we call autonomy. They have the autonomy to choose their topics of interest, …. I found out that … students learned more when they are focusing on their favorite topics, … they asked lots of questions and answers and they created a lot of discussions."

Ms. Julie focused on making learning interesting for her students. Ms. Julie described that "the questions that students are asking are already of interest to them. So, it makes it relevant to their learning. … if there's interest then it's relevant to them, then they feel like they are motivated and more engaged to learn. Whereas if I am giving them something is just, you are basically at an uphill battle, just trying to force this, you know, other subject or topic or something that they probably have no interest in." According to Ms. Julie, she does not have to worry about diverse instructional material anymore as technology is making it possible for the students to explore knowledge based on their own interest. Ms. Julie gave an example: "We did this with the third graders have maybe two months ago, I handed out tablets. They worked in pairs. The students had to find a technological device or something that is going to be used in the future. So, they went through all these images on Google of different cars and watches and phones and all kinds of different things. They had to choose one that they particularly liked and talk about what they think it will do, how it will help society, how it will help people. And why they think it is important. …. So, you know, I didn't say, …. in 10 years, you might find a smart home. No, they were looking and whatever they found interesting, that is what they wrote about."

Mr. Chris summarized the difference between a teacher's-imposed topic and a student's self-selected topic by using the following example: "I'm realizing it is like force feeding somebody something that they don't want to eat. It is lot better if they go ahead and make it their-selves, fix it their-selves and make what they want to eat and that way they are retained for long. They actually enjoy it."

Students create new meaning through discussion and experiences. Without students' active participation, there is no inquiry learning. The participating teachers' primary focus was to

involve students in classroom discussions by fostering a welcoming environment where students are comfortable to ask any question. When students participate in group discussions and share their knowledge and experiences with each other's, they enrich their learning experiences. Ms. Kate was amazed when she found out that her fourth-grade students wrote a particular equation because she did not teach them how to write the equation. In her words: "I never taught them the equation, how to write it down. I was even surprised that they were able to figure out the equation without me telling them, because they know the concept, but they don't know how to put them together, but they did it." Ms. Kate emphasized that, for better knowledge construction, a teacher should encourage a student to find out the answer instead of handing the student a straight answer. In Ms. Kate's words: "I do not like to give them straight up answer sometime. Do ask them, go ahead and find out and then tell me what it is. So, it is kind of helped them to explain through their own words than me just giving them a straight answer." When Students explain something in their own words, their experiences play a vital role. We see, understand, explain, and construct meaning based on our prior knowledge and experiences.

Mr. Michael described that "… basically, I am asking them (students) questions, trying to leave them in the direction where they can make connections. So, a big part of it …… them being able to connect ideas or information over time, over space. So, helping them make connections." According to Mr. Mathew "…. people will take away what they understand. So, what they understand is part of their experience and what they don't understand is not part of their learning experience." Mr. Mathew recognizes the importance of students' active involvement and experiences in the knowledge making process. Mr. Mathew said that "… the more we involve students in the interaction, the more we have a student-oriented activity, the more we have given them the chance to negotiate meaning to talk about their experience, to

elicit, to find out for themselves, to discover, to compare, to use clues, to be an independent learner." Meaning is not a predefined proposition, students make meaning through discussion, negotiation, and lived experiences. Mr. Mathew said, "whatever we gave them (students), they reformulate that. So, don't expect that you're giving them this piece of information. It's going to be producing the same way the book or you wanted to be. They are going to add their own color on it."

Major Theme Three

Teachers expressed that planning an open inquiry learning environment is extraordinarily challenging. This theme is related to the planning (RQ2) and implementation (RQ3) of IBL instructions. At the center of inquiry-based learning is students' active participation. While students enjoy discussing challenging topics, they do not take part in discussions covering too easy or too difficult topics. According to Mr. Mathew, "Inquiry based learning is useful at all times except when you have level of difficulty that students' participation is absent." Knowing students' current knowledge level is essential for designing inquiry instructions. During the planning phase, teachers do not have the students' profile to know the average level of the students' knowledge. Besides that, a learning group may have students with varied knowledge levels.

Ms. Kate continuously grouped and re-grouped her students into three groups to provide different levels of instructions and practices. This is how Ms. Kate explained her three-group method of inquiry-based teaching approach: "The three groups method I use, they will be getting all the same concept, ….. Now they will be getting it in different ways. So, my upper group will get beyond the concept. They'll get challenged questions, they will get enrichment questions, they have more advanced complicated questions and my middle group will get exactly what I'm

going to be doing in the class in general. My lower group will get extra fluency (practices), those one that I know they are probably missing. I will give them more practice and their question will be same as the average, but they will have more fluency practice and I work more with them." It is challenging for the teachers to develop multiple sets of instructional materials and practice materials to support students with varied needs and levels of knowledge. Textbooks are usually not suitable for inquiry-based teaching and learning methods.

Mr. Mathew mentioned that while inquiry instruction calls for open discussion and creative thinking, textbooks provide limited and structured materials only. Mr. Mathew said, "… the main problem in any teaching is there is no perfect textbook. That is a given in teaching, but again, it is a structured kind of content that will provide structured material." Mr. Michael said that "Now, I am learning that, in many cases the material provided in a textbook is fairly shallow, right?" According to Mr. Michael, planned hands-on activities may or may not work as intended. Mr. Michael said that, "…. basically, what I have to do is, I take the activities (from TeachTCI, Read like a historian, etc.) ……. sometimes they work, sometimes they don't. So, if I try to implement or utilize an activity one year and it does not get to the issues that I wanted to get to; for the next year, I know that I have to adjust it."

Teachers encourage the students to choose topics based on their own interests to make the learning experience interesting and relevant. It is difficult for the teachers to plan instructional materials if they do not know the topics in advance. Additionally, inquiry-based instructional materials are not readily available in abundance. Teachers mentioned only a few reliable sources (TeachTCI, Read like a historian by Stanford University, Teachers pay Teachers, etc.) from where they can borrow and modify inquiry instructions to make it their own. Ms. Julie said: "Sometimes the materials could be things that other teachers have created. Teachers Pay

Teachers or from websites and sometimes it is stuff that I create myself, because I feel like this is something that they (students) need and it is very specific (to the needs of my students)."

Inquiry learning is designed to involve students in open discussions where students are encouraged to ask any number of questions. Teachers expressed several concerns such as that there is not enough time to discuss all the questions asked by the students, the asking of relevant vs. interesting questions, and students sometimes ask difficult questions that teachers may not know the answers to. Mr. Michael said: "… if you are a teacher who is in a position where there is material that needs to be covered, do you have time to facilitate a discussion which is not exactly on topic, but it's relevant? I will give you an example … it was a geography class. It started about land conflict use and the conversation went off into the use of interest in terms of various things. So, we started off in the Amazon rain forest and we ended up talking about credit card debt, interest and so forth." In summary, in IBL implementation, discussions rather than lesson plans may determine the learning path.

Major Theme Four

Technology is beneficial for inquiry learning environment despite its own challenges. All teachers utilized technology (RQ4) during IBL planning (RQ2) and IBL implementation (RQ3) phases. Teachers are utilizing multiple technological tools inside their classrooms. Teachers are also leveraging the technological tools for interactive learning outside the boundaries of the classrooms. Though there are numerous benefits of utilizing technology in inquiry learning methods, incorporating technology has a few challenges. Teachers are borrowing a lot of IBL instructional materials for curriculum development, instructional materials, and hands-on activities from the internet. Ms. Julie mentioned borrowing instructional materials from the Teachers Pay Teachers site. Mr. Michael mentioned that he borrows

curriculum, instructional materials, and hands-on activities from teachTCI and Read Like a Historian project by Stanford University. Mr. Michael said: “In terms of planning, I use a curriculum that is provided by an institute called the Teacher's Curriculum Institute, TeachTCI. They provide a lot of activities. I also use stuff from Stanford University. They have a program called "Read Like a Historian". They have stuff from all over the places. So, basically what I have to do is, I take those activities…. I, I have to adjust it, … basically make it my own.”

Teachers utilized technology to grab students’ attention during the first step of the inquiry learning cycle. Mr. Michael projected an interactive map on the white board from a website to grab the attention of his students. When Mr. Chris said, “scavenger hunt”, all the students utilized their electronic devices to search for information from the internet. Mr. Chris described: “One real way I use IBL with technology is if I ask a question and nobody knows the answer to which is going to happen, I just say scavenger hunt. And the scavenger hunt means it allows students to go use whatever they can use …… it looks crazy because they almost jumping on top of each other to see who gets to find out this answer and you will hear them yelling - is it this, is it that? etc. So that's one way we use technology.”

Mr. Mathew utilizes technology to accomplish learners’ automaticity and autonomy during inquiry learning process. Mr. Mathew: “If technology can achieve two principals: automaticity of the students, they can do things automatically. Autonomy, they have their own independence and collaborative. They can collaborate without my being there online. That's the purpose of integrating technology.”

Ms. Julie utilizes technology to promote students’ comprehension development inside the classroom and at home. Ms. Julie: “I like to use various websites to help compliment the students' learning. So, one particular example is using readworks (www.readworks.org) …. I

have heard, parents say to me this year, my student loves to do read works because he can use the tablet to read and answer comprehension questions …"

Teachers utilized technology to encourage the use of research projects for their students. Ms. Kate: "I have computers there (in the classroom), so, they (students) always have access to those (computers) if they want to do research. If they do not have enough time to finish up during class, they are always welcome to come during their recess or lunchtime to use it for research purposes." Mr. Michael allowed his students to utilize technology for research-based projects like NHD. Mr. Michael: "Sometimes we will use the electronic devices in the class to do research, for instance, especially when we're doing stuff with project-based learning, like their databases and stuff that I provide to them that they can use to do research. We have tablets or in some cases, especially when we're planning something in advance, then I might ask them to bring their own electronic devices in the classroom." Mr. Chris allowed his students to do an information search using available technological tools. Mr. Chris: "I always have a laptop available, kids know. …. Can we use your laptop? Sometimes I pass a tablet around. I allowed days when kids can bring their own laptops and look up things."

Teachers utilized technology for learning assessments. Ms. Kate: "We have tablets. We sometimes have to book for them to use it for their assessment or their research." Ms. Kate utilized MasteryConnect and Edulastic for automated assessments. Mr. Michael utilizes Schoology (https://www.schoology.com), a Learning Management System (LMS), for assessment and analyses of learning outcomes. Mr. Michael: "One thing that I'm using as well… called schoology (https://www.schoology.com/). So, it's our LMS, our learning management system... So, through schoology I can post information relevant to a class. I can give assignments which are basically graded or depending on the type of assignments, I have to go and grade it. So

basically, it's live. If you set your notifications and everything, any changes you are making automatically updated … I can give tests which are timed."

One of the teachers utilized technology to accomplish interactive, online hands-on activities. Ms. Kate utilized Gizmo, an online interactive science lab, for her students to work on the lab assignments either inside the classroom or from anywhere at their own time. Ms. Kate: "Sometime when we used Gizmo, that is an interactive activity, it helped them to do the lab through the computer without moving in and out (of the classroom) … it is different, it is kind of help them to think outside the box."

Teachers utilized online videos as supplementary instructional resources. Ms. Kate's students watch videos as supplementary resources, to learn about interesting topics in more detail. Ms. Kate: "We have online videos we watch … I don't usually like to pull them during their other time. But students, some of them are very, very, into these concepts, maybe science, they like something they will actually ask me later during the day, during lunchtime or during the dismissal, if they could watch some of those videos." Mr. Michael said that watching videos takes a lot time, and that students may not pay attention to the video. Mr. Michael: "PauseIT is one of those things where you put a video and then add into intervals in the video, the questions that they will have to answer before they can move forward into the video."

Mr. Chris cautioned about watching videos without explaining the purpose of watching them in the first place and without preparing a set of questions to be asked at the end of the watching session. Mr. Chris: "One of the key things about watching videos is making sure that kids are actually retaining the information from the video. So, if you're going to watch videos then you should have questions for them to answer why they're watching it or at the very end

some type of question to make sure that they grasp what was on the video. They should not watch it like watching TV."

Teachers, across the board, utilized technological tools to promote collaboration among the students and the teacher. Mr. Michael: "Now we have it where if we're working on a website, we can have four people on the website working on the website at the same time, … whatever it is that we have to turn in class. We have one document open and several people can be working inside the same document. So, I've tried to push this aspect (collaboration) of technology to my students." Mr. Mathew: "If technology can achieve two principals … Autonomy, they have their own independence and collaborative. They can collaborate without my being there online. That's the purpose of integrating technology."

Teachers shared only a handful of challenges of utilizing technology in the inquiry learning environment. The most common challenges are the permissible age limit that is imposed by the parents, students do not stay on task, students may lose focus, lack of reliable technology infrastructure, losing productivity by visiting unrelated sites or playing games, and the need of monitoring all the students at all times by a single teacher. The teachers then talked about the challenges of utilizing technology:

Ms. Kate: "Some of the challenges will be, I'm not having internet connection or Wi-Fi connection. The other one probably, I always worry about the restrictions, … I don't want them to go on different sites that they're not supposed to... I can't go around to like 20 students at the same time to see which sites they're on. So sometimes some of the students will find a way to play games and not do the work."

Mr. Michael: "So my worry is always about how students can get off task using technology. …. just as much as you have productivity, there are so many ways to be off task and

if that is not accounted for, I think (technology) can be a nightmare… So over dependency on the internet comes with some issues as well. And power outage, not that bigger view, but it can happen."

Mr. Mathew: "Number one challenge is students' age, not all parents allow the students to have access to technology… The main important thing if technology is not well monitored by the teacher, there can be deviations. So, I mean the students may lose focus……. And teachers have to be consistent with their use of technology... so, it's ready for them, when they get back next time to use this kind of facilities."

Ms. Julie: "…students don't stay on task when you hand them the devices. They are playing games or they're watching the soccer game or trying to see who is winning or whatever."

Mr. Chris: "You have to be involved as a teacher. You have to be an active teacher, so even though students are on the internet, you have to set those parameters at the very beginning - what is expected of you and what is the punishment when students are not doing it or not on task and sitting idle."

Summary

This chapter summarized the four major themes that emerged from analyzing interviews and classroom observations data. The four major themes are that teachers understood and implemented IBL in different ways, teachers recognized that IBL is helpful for better knowledge construction, teachers expressed that planning an open inquiry learning environment is extraordinarily challenging, and technology is beneficial for an inquiry learning environment despite its own challenges.

Chapter 5: Discussion

Introduction

Chapter four discussed the four Major Themes (MT) that emerged from analyzed interviews and classroom observations data. The four major themes are: teachers understood and implemented IBL in different ways (MT1); teachers recognized that IBL is helpful for better knowledge construction (MT2); teachers expressed that planning an open inquiry learning environment is extraordinarily challenging (MT3); and technology is beneficial for an inquiry learning environment despite its own challenges (MT4). This chapter examines the four major themes in the light of four research questions: how do a selected group of teachers perceive Inquiry-Based Learning (IBL) as an instructional strategy in their classrooms? (RQ1); how do a selected group of teachers plan IBL as an instructional strategy in their classrooms? (RQ2); how do a selected group of teachers implement IBL as an instructional strategy in their classrooms? (RQ3); how do a selected group of teachers integrate technologies while utilizing IBL as an instructional strategy in their classrooms? (RQ4). Additionally, this chapter includes implications of this case study and future recommendations from the researcher.

Discussion

The discussion section unpacks the relationship among the research questions and the major themes. Observed and analyzed data confirms an intricate relationship among major themes. This section examines each of the research questions individually to have a better understanding of its relationship to the major themes.

Research question one: how do a selected group of teachers perceive IBL as an instructional strategy in their classrooms? A teacher's perception about IBL depends on a few factors. Some of the most significant factors are: how did someone learn about it? How does

someone describe and differentiate it? Is it beneficial or harmful? Is it challenging or easy to practice?

When asked about the first important question of, "How did you learn about inquiry-based instruction?", teachers provided varied responses. These teachers learned inquiry-based learning from their teaching experiences and out of their self-interest. Inoue and Buczynski (2010) identified that teachers did not receive training before teaching inquiry-based instructions and recommended teacher preparation training to optimize teaching and learning experiences. Since these teachers self-learned IBL from multiple sources, they do not have a uniform understanding of the IBL method. Leading educators, scholars, and researchers identified, proposed, and implemented many models of inquiry-based instruction (Atkin & Karplus, 1962; Bybee et al., 2006; Marshall, Horton, & Smart, 2009; Marshall & Horton, 2011; NRC, 2000). Major theme one partially emerged out of this important finding.

The second important question is, how do teachers describe and differentiate IBL? Teachers described IBL with a set of positive attributes: student-centered learning, learning by asking questions, self-directed learning, learning through discussion, learning through meaning negotiation, active learning, hands-on learning, learning by discovery, problem-based learning, project-based learning, et cetera. Tamim and Grant (2013) mentioned teachers had a positive perception about inquiry learning and they defined inquiry learning by describing the perceived learning benefits. IBL method can provide the following benefits: teachers' support during the learning process, differentiated teaching and assessment, motivation for students, sense of ownership, and soft skill development through collaboration, communication, and cooperation (Tamim & Grant, 2013).

While differentiating IBL from a non-IBL method, teachers described non-IBL methods as a boring classroom where teachers stand and deliver lectures. Instead of promoting open discussions, non-IBL methods demand one-way communication along with a strict set of classroom rules to control students' in-classroom behavior. In a non-IBL setup, students ask relatively fewer questions. Loyens and Rikers (2011) interpreted the traditional learning setup as a mechanical process where teachers actively pass the structured information to the students while the students passively consume the delivered information. On the contrary, Marshall and Horton (2011) confirmed that, in inquiry instructions, students can actively participate in knowledge exploration and demonstrate a higher level of cognitive skills development.

Teachers claimed Non-IBL methods do not allow students to think as critically as the IBL method; rather non-IBL methods promote rote memorization skills. Buckner and Kim (2014) mentioned it is difficult to implement inquiry-based instructions in traditional learning environments where rote memorization is typical and deeply rooted. Due to many limitations of traditional learning approach, teachers were excited to utilize inquiry learning method in their classrooms and confident this method is working for their students.

Based on the analyzed data, teachers liked the IBL teaching method and embraced it in their classrooms. This finding contributed in the development of the second major theme that teachers recognized IBL is helpful for better knowledge construction. Teachers stated IBL is a student-centered learning method where students are allowed to ask questions, participate in group discussion, do hands-on activities, work on projects, search for information, and share their findings in order to construct new knowledge. Marriot (2014) claimed that inquiry framework of learning promotes knowledge investigation, encourages critical thinking, and leads to construction of new knowledge. According to Warner and Myers (2008), IBL demands

students' active participation through knowledge search and hands on activities. These engaged and involved activities help students to construct their own understanding and knowledge.

When asked about the benefits of using IBL for the teachers and the students, teachers mentioned numerous benefits both for the students and for themselves. In an IBL setup, students are in the driving seat. For example, students can ask any question at any time during the learning sessions. Students can choose their own topics, making learning fun and relevant. Students express their opinion during discussion sessions sharing their experiences and creativity. Students enjoy hands-on activities and interactive learning environments. Students love working on projects and sharing their products or artifacts. Also, the entire inquiry learning process helps the students to comprehend and construct new knowledge. Tamim and Grant (2013) mentioned that students learned and shared multiple views and developed a better understanding of the topic when they were allowed to work on an inquiry-based project learning environment. Teachers observed that students developed many critical thinking and communication skills while working on projects utilizing inquiry instructions (Tamim & Grant, 2013).

For the teachers, they have the pleasure to witness the creativity of their students. Coffman (2017) described creativity and innovation can be promoted among students by infusing technology in inquiry instructions. Teachers, in an inquiry learning setup, are the guides who moderate the discussion instead of delivering traditional lectures. Teachers do not focus on discipling students, but instead focus on igniting students' inquisitiveness by asking provoking questions. Brown (2012) expressed that inquiry teaching is most effective when teachers ask essential questions and promote focused conversations. Overall, teachers were very satisfied they are benefiting tremendously by implementing the IBL method in their classroom. This finding

contributed in the development of the second major theme, i.e., teachers recognized IBL is helpful for better knowledge construction.

Is it easy or difficult to practice IBL? These are all experienced teachers who have used IBL for at least six years in their respective classrooms. Initially, teachers needed to learn about it through a lot of trial and error, but with experience it became easier. According to Blanchard et al. (2013), teachers who received more professional development and training in inquiry instructions, are more comfortable with using inquiry methods in their classroom. Teachers mentioned technology utilization make IBL implementation easy and fun. Coffman (2017) mentioned many learning benefits can be accomplished by adding technology in inquiry instructions.

While teachers enjoyed utilizing the IBL method, it has a few challenges. Sometimes students ask hypothetical or extraordinarily difficult questions, and teachers may not know the answers. If students ask too many questions, teachers have a difficult time staying on track to accomplish the learning objectives. Settlage (2007) warned practicing open inquiry is a challenging task for the teachers; answering unknown open-ended questions is not an easy task for any of the teachers. Nevertheless, experienced teachers expressed they are comfortable to practice the IBL method to promote active students' participation. These findings contributed in the development of the second and fourth major themes, i.e., IBL is helpful for better knowledge construction and technology is beneficial for IBL learning environment.

Research question two: how do a selected group of teachers plan IBL as an instructional strategy in their classrooms? Teachers were using text books as their primary guidance for their curriculum and learning objectives. Text books are very structured and shallow. Textbooks are not suitable for the inquiry learning approach that demands creative

thinking, hands-on activity, open discussion topics, and project-based learning. Liu et al. (2010) identified that textbooks are designed to teach segmented concepts, as a result, students fail to make connections and think critically. According to Lebak and Tinsley (2010), teachers changed their pedagogical approach from a teacher-centered, textbook-driven approach to a student-centered, inquiry-based approach after watching and reflecting on their recorded teaching sessions. Teachers mentioned that while inquiry instruction calls for open discussion and creative thinking, textbooks provide limited and structured materials only. Following curriculum or textbook is not sufficient for promoting successful inquiry instructions; Common Core State Standards (CCSS) require teachers to learn and teach the skillsets on how to ask essential questions of their students to encourage critical thinking and innovation (Wilhelm, 2014). Teachers borrowed a limited number of curriculums, instructional materials, hands-on activities, and projects from teachers' collaborative networks and Internet based open-sources. Teachers needed to modify those resources to make it work for their students.

In inquiry learning, to make the learning experience interesting and relevant, students chose topics based on their own interests. Tamim and Grant (2013) identified that effective IBL teachers allowed their students to choose learning styles according to their comfort level. It is difficult for the teachers to plan instructional materials as they are not aware of the learning styles of their future students. Inquiry-based instructional materials are high in demand and low in supply. Teachers mentioned only few reliable sources (TeachTCI, Read like a historian by Stanford University, Teachers pay Teachers, etc.) from which they can borrow and modify inquiry instructions. Another aspect of inquiry learning is to promote asking open questions. Teachers do not know in advance what questions students are going to ask, as result, it is difficult for the teachers to anticipate potential questions when developing an inquiry-based

instruction and relevant implementation strategies. Hermann and Miranda (2010) mentioned that it is extremely time consuming for the teachers to prepare for unknown and numerous borderline open-ended questions by the students. Additionally, all the students are not at the same level, which makes planning even more challenging for the teachers.

In general, though challenging, planning helped the teachers to develop instructional curriculums, instructional materials, hands-on activities, discussion topics, and projects to promote better knowledge construction through students' active participation in the learning process. These findings contributed in the development of the second and third major themes, i.e., IBL is helpful for better knowledge construction and planning an open inquiry learning environment is extraordinarily challenging.

Research question three: how do a selected group of teachers implement IBL as an instructional strategy in their classrooms? Teachers used distinct implementation methods in their classrooms. Teachers' primary focus was to engage and promote active students' participation throughout the learning cycle. Teachers began their learning cycle by encouraging active students' involvement and ended their learning cycle by giving individual feedback based on the learning assessment. The teaching/learning activities in the middle varied tremendously. The following are some of the learning activities, as practiced by the participating teachers: students participate in open discussion to set main learning objectives, teachers reinforce prior knowledge by asking "why" questions, students ask "why" questions to learn and know new concepts, teachers group/regroup students in different groups to address a topic at their level, teachers let the students choose a topic of their own interest, teachers provide resources for the students to explore relevant information, teachers assign hands-on activities to the students, students present and share their findings, teachers assign projects to the students, students present

their final product or artifacts to the class, and teachers and peer students evaluate and provide instant feedback throughout the learning cycle.

Luera, Killu, and O'Hagan (2003) explained the five key components of an inquiry learning cycle: engage, explore, explain, expand, and evaluate. Teachers covered all five components under different titles. Teachers were successfully utilizing their learning cycles to promote new knowledge construction within their respective classes. Though different, each of the teachers had a complete learning cycle. These findings contributed in the development of the first and second major themes: teachers understood and implemented IBL in different ways and IBL is helpful for better knowledge construction.

Research question four: how do a selected group of teachers integrate technology while utilizing IBL as an instructional strategy in their classrooms? Teachers used technological tools during IBL planning and IBL implementation. During the planning phase, teachers used open source instructional materials to complement their curriculum development. Teachers also utilized materials from the internet to develop learning objectives, hands-on activities, and projects.

During the implementation phase, teachers utilized technological tools for optimizing learning outcomes at each of the learning cycles. Some of the teachers utilized videos or images to grab students' attention at the beginning of the learning cycles. Teachers empowered their students' information search capacities by providing access to the Internet using laptops or tablets. Students and teachers utilized different collaborative technological tools for productivity and joint knowledge development. Teachers mentioned that students made their presentations more creative, appealing, and engaging by using technology. Teachers utilized clickers gaining instant feedback from the students, adjusting their instructions quickly. Teachers used various

technological tools for providing interactive learning experiences to the students. Kuhlthau et al. (2015) recommended technology integration in IBL environment to optimize learning outcome and experiences by actively engaging students in the learning process, they cautioned against adding technology simply as an add-on.

Though technology provides incredible benefits in an inquiry learning environment, it does bring a few challenges for the teachers and the students. Some of the most common challenges, as shared by the teachers, are the age limit as imposed by the parents and technology providers, students may lose focus and leave the assigned task, students may lose productivity by visiting unrelated sites or playing games, teachers need to monitor between 20 and 30 students, inadequate technology infrastructure, and slow internet speed. According to Ertmer et al. (2003), it is a difficult task for the teachers to integrate technology in inquiry instructions as well as they may encounter many barriers including technical and organizational support.

According to Coffman (2017), technology integration can enrich students' learning experiences and outcomes by providing timely access to relevant facts. Additionally, technology should provide virtual spaces for students to collect, store, collaborate, evaluate, present, and share their findings in an authentic and meaningful way (Coffman, 2017). Teachers provided all the above-mentioned services to their students. Teachers primarily integrated technological tools to engage students by igniting curiosity and higher order reflective thinking through knowledge exploration and discovery (Chu et al., 2017; Coffman, 2017; Kuhlthau et al. 2015; Boss & Krauss, 2014). These findings contributed in the development of the fourth major theme: technology is beneficial for an inquiry learning environment despite its own challenges.

Conclusion

This case study attempted to learn and share how a selected group of experienced teachers at a small private school perceive, plan, and implement technology enabled IBL as an instructional strategy in their classrooms. Though teachers used IBL method of instructions, they understood IBL differently based on their teaching experiences and self-learning of IBL methods. Existing IBL literature supports that there are many versions of IBL teaching and learning both in theory and in practice. Tamim and Grant (2013) mentioned that teachers did not receive professional development in inquiry learning, as a result, they practiced according to their own understandings and beliefs to optimize learning outcomes for students. According to Lazonder and Harmsen (2016), inquiry learning has many inconsistent definitions. They identified that past researchers focused on one type of guidance and one type of learners while defining and studying inquiry learning. Banchi and Bell (2008) mentioned about four different kinds of inquiry teaching methods depending on the amount of teachers' guidance and nature of inquiry learning activities.

Teachers did not follow the same implementation steps for inquiry instructions, each of them developed and practiced his or her own unique implementation method. Though they differed in the implementation steps, all of them started with an attempt to actively involve the students, allowed the students to ask questions, explore knowledge, share their findings, and concluded with an assessment and feedback loop. While Lazonder and Harmsen (2016) mentioned that past researchers failed to consider different ways of IBL implementation, Marshall and Horton (2011) gathered more than 100 sets of classroom observational data of middle schools, observed diversity in inquiry implementations, and identified four common components of inquiry cycle: engage, explore, explain, and extend. According to Luera, Killu,

and O'Hagan (2003), though teachers used many variations of inquiry learning cycles, there are five key components or stages of inquiry-based learning: engage, explore, explain, expand, and evaluate.

Teachers encountered multiple challenges during IBL implementation. The leading challenges were: lack of inquiry-based instructional materials, not enough time to discuss all the questions asked by students, dealing with open-ended and hypothetical questions, learners' prior-knowledge variability, dependable technological infrastructure and support, and reliable high-speed access to internet. According to Blanchard et al. (2013), three of the most pressing concerns as reported by teachers while implementing IBL were: time, resources, and lack of teachers' preparation. Hermann and Miranda (2010) explained that it takes a lot of time and preparation for the teachers to deal with boundless, surprising, and peripheral open-ended students' questions. Ertmer et al. (2003) mentioned that teachers, while trying to integrate technology in IBL environment, may encounter multiple barriers including technical and organizational support.

Teachers reported numerous benefits of technology integration in IBL environment and mentioned that keeping students on task was the major challenge. Coffman (2017) recommended to incorporate technology in IBL to optimize learning outcome and learning experiences. Technology integration in IBL can achieve the following goals: access relevant data in a timely manner, collect and record information, collaborate with experts and other students around the world, present information through multimedia, have meaningful and authentic assessments, and present new student knowledge to the world for review and feedback (Coffman, 2017, p. 34). Technology integration can enable students' active participations by igniting curiosity and higher

order reflective thinking through knowledge exploration and discovery (Boss & Krauss, 2014, Chu et al., 2017; Coffman, 2017; Kuhlthau, Maniotes, & Caspari, 2015).

Teachers praised and adopted IBL methods as they recognized that IBL is helpful for better knowledge construction among their students. Some of the key benefits of using IBL method as mentioned by teachers were: students' active participation, motivated and self-directed students, asking critical thinking questions, learning multiple perspectives, showing creativity, choosing topics of their own interest, and new knowledge construction through discussion and experiences. Tamim and Grant (2013) reported that teachers observed a significant improvement in students' motivation and engagement while utilizing one of the inquiry-based methods. Wijnen et al. (2017) discovered when teachers implemented inquiry-based instructions, students experienced more warmth and support from their fellow students and teachers. According to Tretter and Jones (2003), inquiry-based instruction has many positive impacts including a dramatic improvement in students' active participation and classroom grade. Marriott (2014) concluded that inquiry instruction is helpful for students' knowledge construction and lifelong learning. There is an overall positive impact in students' learning outcome and experiences when IBL is used by teachers (Brown, 2012; Li et al., 2010; Minner et al., 2010; Schroeder et al., 2007).

While teachers enjoyed using IBL instructions and mentioned many benefits of using IBL instructions, teachers had difficulties introducing complex new concepts by utilizing IBL method. This specific limitation of IBL is explained by Kirschner et al. (2006), they suggested that teachers should choose direct instructional guidance over minimally guided inquiry instructions for novice students, as direct instructional guidance helps novice students to develop solid conceptual understanding by reducing cognitive load and eliminating misconceptions.

According to Kirschner et al. (2006), while practicing a direct instructional guidance approach, teachers provide in-depth information that completely explains the concepts for the students. The researcher observed that teachers encountered this challenge of introducing complex new concepts by using two distinct methods. Firstly, teachers used direct instruction to introduce the new concepts and then quickly switched back to IBL method. Secondly, teachers broke down the complex concepts into smaller chunks and utilized scaffolding to optimize learning process. Hmelo-Silver et al. (2007) mentioned that teachers can utilize scaffolding in inquiry learning for the students to minimize cognitive load and facilitate learning in complex domains.

In summary, inquiry learning is practiced by many teachers, but it does not have a single model. Teachers liked IBL for its many learning benefits and acknowledged that it is difficult to plan an open-inquiry learning environment. Each of the teachers implemented IBL slightly differently though they all followed a comprehensive and complete learning cycle. Finally, four major themes emerged from this case study. First, teachers understood and implemented IBL in different ways. Teachers recognized that IBL is helpful for better knowledge construction and they emphasized that planning an open inquiry learning environment is extraordinarily challenging. Finally, teachers acknowledged that technology integration in IBL environment is beneficial for optimizing learning experiences and learning outcomes despite its own challenges.

Implications

The inquiry learning method is beneficial for students. Experienced teachers can optimize students' learning outcomes by using the inquiry learning method in their classrooms. Teachers engaged students in persuasive discussion by asking intriguing questions. Ms. Kate expressed that: "When you actually ask them open ended question, you'll get better result than a close

ended question." Students actively participated in the learning process through meaningful discussions, hands-on activities, and projects. Students negotiated meaning among themselves by sharing diverse views and lived experiences before constructing their own meaning. According to Ms. Kate "I noticed whenever one (of the students) helps the others', they (students) understand it better and they (students) ask more questions, and it actually helps me (the teacher) to understand which are the parts that they're weak on and which are the parts that I need to cover more on." Mr. Chris emphasized the importance of asking questions to make inquiry learning interesting and challenging. Mr. Chris: "Ask the question, sparks the students' interests first. The first thing is to figure out what, what question that applies to your lesson and can they relate to today. That's the very first. Once you, once you have that question, then it pretty much builds itself." Asking essential questions lies at the center of the successful implementation of inquiry learning. Marriott (2014) reached the same conclusion after analyzing data from several studies and found that students will perform better if teachers ask them thought provoking questions instead of providing answers.

Committed teachers are essential for successful IBL implementation. Teachers played a central role in successfully involving the students in persuasive discussions to share and learn diverse perspectives before constructing the new knowledge on any given topic. If teachers believe that inquiry learning is beneficial for the students, they will learn and implement inquiry learning in their classrooms. Teachers learned the inquiry learning method through their teaching experiences and self-learning. Experienced IBL teachers know how to guide, motivate, and encourage a student to be an independent learner. Mr. Mathew said: "So the more we (teachers) involve students in the interaction, the more we have a student -oriented activities, the more we give them the chance to negotiate meaning, to talk about their experience, to elicit, to find out for

themselves, to discover, to compare, to use clues, to be an independent learner." Though teachers allowed the students to choose topics based on their own interests, teachers provided guidance throughout the learning process by asking guiding questions. Teachers' involvement and adequate guidance are essential for successful implementation of inquiry learning. Teachers' attitude, knowledge, and delivery approach are significant factors in providing an impactful learning environment to promote student success (Spencer & Vavra, 2015).

Teachers agree that technology plays a positive and pivotal role in inquiry learning success. Teachers recognize that technology has the highest impact during the initial stage of the knowledge formation when students perform information searches to gather facts before organizing and sharing their findings with their peers. Teachers allowed students to visit the internet to do their research by utilizing either their personal electronic devices or in-classroom laptops or tablets. According to Mr. Michael, students can make their presentation more appealing and engaging by utilizing diverse technological tools. Ms. Julie said that "… my students went to storyjumper.com and that's a kind of like a publishing website where the students actually created the books in electronic form and it looks like a real story book and they can add the audio to it. They can add props and scenes and create characters from different faces and different clothing and things and so that it all made it their own. That's very creative." Coffman (2017) mentioned that students can benefited in multiple ways by utilizing technology in an inquiry learning environment: information search, gathering facts, collaboration, presentation through engaging multimedia, automated assessment, and sharing newly constructed knowledge with the global intellectual community.

It is not an easy task for teachers to successfully plan and implement the IBL method. Teachers do not have the students' profiles during the planning phase of IBL. Besides that, in

any classroom, there are students with varied knowledge levels. Essentially, teachers had to make a lot of assumptions while planning instructional materials, hands-on activities, role-plays, and projects for their future students. According to Mr. Mathew, textbooks are not a great resource for open inquiry learning as textbooks provide limited and structured materials only. According to Mr. Michael, "… in many cases the material provided in a textbook is fairly shallow." Mr. Michael mentioned that planned hands-on activities may or may not work as intended. He continued that "…. basically, what I have to do is, I take the activities (from TeachTCI, Read like a historian, etc.) ……. sometimes they work, sometimes they don't." Without students' participation and inquisitiveness there is no IBL. While teachers try to motivate and encourage students' participation, ultimate success depends on the students' attitude and willingness to be involved in active discussions.

Recommendations

The purpose of this study was to better understand how a selected group of five experienced teachers from a small private school perceive and practice inquiry-based learning (IBL) as an instructional method in their classrooms. Four major themes emerged from this case study: teachers understood and implemented IBL in different ways; teachers recognized that IBL is helpful for better knowledge construction; teachers expressed that planning an open inquiry learning environment is extraordinarily challenging; and technology is beneficial for inquiry learning environment despite its own challenges. According to the first major theme, teachers do not have a uniform understanding of inquiry learning. Teachers learned inquiry learning from their teaching experiences. Because of that, teachers have the practical knowledge of inquiry learning but they seriously lack the pedagogical knowledge. According to Lee (2011), current literature is inadequate for inquiry-guided learning with a high degree of clarity. To make real

progress in the field of inquiry learning, more research should be dedicated in defining inquiry learning with added clarity.

According to the first major theme, teachers implemented inquiry learning by following different models or learning cycles. Though all of them started with an attempt to actively involve the students and end with an assessment and feedback loop, intermediate steps are not same. It would be an interesting study to learn about the top ten popular inquiry learning cycles, take the best elements from each of the model and develop an ideal inquiry learning model for future teachers.

Without students' active participation, there is no inquiry learning. Mr. Michael mentioned that students are more inquisitive at lower-grade level, but they are less inquisitive at higher-grade level. This could be a very interesting topic to study, is there any correlation exists between students' curiosity level at different grade levels and students' participation in inquiry learning on the corresponding grade levels? If there is a correlation that will help the educators to take advantage on those grade levels where students can get best out of inquiry learning.

A final area for exploration is to master the art of asking medium questions to stimulate thinking among the learns. It is an easy task to either ask trivial questions to a learner or stimulate trivial questions in a learner's mind. It is also an easy task to ask impossibly difficult questions to a learner. The challenging task for the educator is to present challenging but medium questions to stimulate and encourage thinking in the learners' mind (Driscoll, 2005).

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Appendices

Appendix A: Interview Guide

Interview Guide

Research Question 1: How does a selected group of teachers perceive IBL as an instructional strategy in their classrooms?

Lead Question: *Tell me about your experience with inquiry-based instructions.*

Follow-up questions:

a) How did you learn about inquiry-based instruction?

b) How is inquiry-based instruction different from some of the other instructional methods you might use in your classroom?

c) How does inquiry-based instruction help your learners?

d) How does inquiry-based instruction help you as an instructor?

e) Tell me about a time when IBL worked particularly well in your classroom.

f) What are the challenges of using IBL in your classroom?

Research Question 2: How does a selected group of teachers use IBL as an instructional strategy in their classrooms?

Lead Question: *How do you practice inquiry-based instruction in your classrooms?*

Follow-up questions:

a) Talk me through how you plan and implement an IBL lesson.

b) How do you set learning goals and objectives while following inquiry-based instruction?

c) What instructional materials/resources do you utilize while using the IBL method as an instructional approach?

d) What instructional events or steps do you practice while teaching inquiry-based learning?

e) How would you deliver your instruction in IBL?

f) How do you encourage active student participation in an inquiry learning process?

g) How do you assess the learning outcome while using IBL approach?

Research Question 3: How does a selected group of teachers integrate technologies while utilizing IBL as an instructional strategy in their classrooms?

Lead Question: *How would you integrate technology in the classroom to support inquiry-based instruction?*

Follow-up questions:

a) What technological tools do you use in your classrooms to support inquiry-based instruction?

b) Take me through an inquiry instruction event in which you utilized technological tools.

c) How does technology utilization help your students and you as an instructor?

d) Which inquiry phase might benefit the most from technology integration?

e) Which technological tools are helpful when assessing learning outcomes in inquiry learning?

f) What are the challenges encountered by students and instructors while engaging in technology infused inquiry learning?

Appendix B: Observation Note

Classroom Observation Notes:

Research Participant	Grade Level	Subject	Date: Start time: End time:

Area of Observation	Observation Notes	Comments

Appendix C: IRB Approval Letter

Institutional Review Board
Office of Sponsored Programs
University of Memphis
315 Admin Bldg
Memphis, TN 38152-3370

April 6, 2018

PI Name: Md Rezaul Chowdhury
Co-Investigators:
Advisor and/or Co-PI: Lee Allen
Submission Type: Initial
Title: Investigating Inquiry-based Learning and the Teachers' Perspectives at a K-12 School
IRB ID **:** #PRO-FY2018-379

Expedited Approval: April 6, 2018
Expiration: April 6, 2019

Approval of this project is given with the following obligations:

1. This IRB approval has an expiration date, an approved renewal must be in effect to continue the project prior to that date. If approval is not obtained, the human consent form(s) and recruiting material(s) are no longer valid and any research activities involving human subjects must stop.

2. When the project is finished or terminated, a completion form must be submitted.

3. No change may be made in the approved protocol without prior board approval.

Thank you,
James P. Whelan, Ph.D.
Institutional Review Board Chair
The University of Memphis.

Appendix D: Consent Letter

THE UNIVERSITY OF MEMPHIS
Dreamers. Thinkers. Doers.

Institutional Review Board

315 Administration Bldg.
Memphis, TN 38152-3370
Office: 901.678.2705
Fax: 901.678.2199

Consent to Participate in a Research Study

Investigating Inquiry-based Learning and the Teachers' Perspectives at a K-12 School

WHY ARE YOU BEING INVITED TO TAKE PART IN THIS RESEARCH?

The purpose of this study is to better understand how a selected group of between four and six teachers perceive and practice inquiry-based learning (IBL) as an instructional method in their classrooms across all disciplines at one K-12 school. This study will employ a case study methodology to better understand teachers' perceptions, practices, and technology integration, while using IBL in a metropolitan classroom setting. So, you are being invited to take part in a research study about inquiry-based learning. You are being invited to take part in this research study because you meet the following criteria:

- Teachers who practice inquiry-based instructions in their classrooms and
- have at least two years of teaching experience

If you volunteer to take part in this study, you will be one of about six teachers to do so in your school.

WHO IS DOING THE STUDY?

The person in charge of this study is MdRezaul Chowdhury of University of Memphis Department of Instruction and Curriculum Leadership. He is being guided in this research by Dr. Lee Allen, an Associate Professor and Program Coordinator for the School Library Information Specialist program in the Department of Instruction and Curriculum Leadership. There may be other people on the research team assisting at different times during the study.

WHAT IS THE PURPOSE OF THIS STUDY?

The purpose of this study is to better understand how a selected group of between four and six teachers perceive and practice inquiry-based learning (IBL) as an instructional method in their classrooms across all disciplines at one K-12 school. This study will employ a case study methodology to better understand teachers' perceptions, practices, and technology integration, while using IBL in a metropolitan classroom setting.

Knowledge acquired through this study will help the board of directors, educators, and administrators of the participating school to better understand teachers' perceptions, practices, and technology integrations while practicing inquiry-based instructions in a small school setting. This study may embolden the importance of some existing practices and technological integrations for successful IBL implementation. Lessons learned from this case study will help many educators design and implement IBL in K-12 classrooms by avoiding the pitfalls and by embracing the successful practices and technologies. Finally, this study may bring attention to new areas of opportunity or challenges in relation to IBL for future researchers and educators.

WHERE IS THE STUDY GOING TO TAKE PLACE AND HOW LONG WILL IT LAST?

The researcher will interview the participating teachers on the Pleasant View School campus and also observe the participating teachers while teaching in the classrooms. This research will focus on obtaining information to better understand teachers' perceptions, practices, and technology integration, while using IBL (Inquiry-based learning) as an instructional approach. No information will be gathered about individuals other than the participating teachers. The researcher will schedule a one-hour interview with each of the participating teachers. Besides that, the researcher will observe each of the participating teachers while they teach in the classroom setting for at least one 50-minute session.

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Fax: 901.678.2199

WHAT WILL YOU BE ASKED TO DO?

You (participating teacher) will be interviewed by the researchers on your perceptions, practices, and technology integration, while using IBL (Inquiry-based learning) as an instructional approach. The goal is to share your understanding and experience regarding Inquiry-based learning. Additionally, the researcher will observe each of the participating teachers while they teach in the classroom setting for at least one 50-minute session.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?

To the best of our knowledge, the things you will be doing have no more risk of harm than you would experience in everyday life.

WILL YOU BENEFIT FROM TAKING PART IN THIS STUDY?

You will not get any personal benefit from taking part in this study. Your willingness to take part, however, may, in the future, help society as a whole better understand this research topic

DO YOU HAVE TO TAKE PART IN THE STUDY?

If you decide to take part in the study, it should be because you really want to volunteer. You will not lose any benefits or rights you would normally have if you choose not to volunteer. You can stop at any time during the study and still keep the benefits and rights you had before volunteering.

IF YOU DON'T WANT TO TAKE PART IN THE STUDY, ARE THERE OTHER CHOICES?

If you do not want to be in the study, there are no other choices except not to take part in the study.

WHAT WILL IT COST YOU TO PARTICIPATE?

There are no costs associated with taking part in the study.

WILL YOU RECEIVE ANY REWARDS FOR TAKING PART IN THIS STUDY?

You will not receive any rewards or payment for taking part in the study.

WHO WILL SEE THE INFORMATION THAT YOU GIVE?

We will make every effort to keep private all research records that identify you to the extent allowed by law.

Your information will be combined with information from other people taking part in the study. When we write about the study to share it with other researchers, we will write about the combined information we have gathered. You will not be personally identified in these written materials. We may publish the results of this study; however, we will keep your name and other identifying information private.

The researcher will store all data in umDrive, which is a secure web-based file storage and sharing service provided by the University of Memphis. The researcher and his adviser will share data through umDrive secure

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file sharing method. Data from umDrive, with right privilege, is accessible from any place at any time using the Internet.

We will keep private all research records that identify you to the extent allowed by law. However, there are some circumstances in which we may have to show your information to other people. For example, the law may require us to show your information to a court or to tell authorities if you report information about a child being abused or if you pose a danger to yourself or someone else. Also, we may be required to show information which identifies you to people who need to be sure we have done the research correctly; these would be people from such organizations as the University of Memphis.

CAN YOUR TAKING PART IN THE STUDY END EARLY?

If you decide to take part in the study you still have the right to decide at any time that you no longer want to continue. You will not be treated differently if you decide to stop taking part in the study.

WHAT IF YOU HAVE QUESTIONS, SUGGESTIONS, CONCERNS, OR COMPLAINTS?

Before you decide whether to accept this invitation to take part in the study, please ask any questions that might come to mind now. Later, if you have questions, suggestions, concerns, or complaints about the study, you can contact the investigator, MdRezaul Chowdhury at mchwdhry@memphis.edu. If you have any questions about your rights as a volunteer in this research, contact the Institutional Review Board staff at the University of Memphis at 901-678-2705. We will give you a signed copy of this consent form to take with you.

What happens to my privacy if I am interviewed?

For each of the research participants the researcher will assign a pseudonym, all your responses will be captured under that pseudonym. The researcher will not store any linking information between you and your pseudonym.

Advisor Name and Designation: Dr. Lee Allen, Associate Professor and Program Coordinator, Department of Instruction and Curriculum Leadership

Advisor's Contact Information: allenlee@memphis.edu or (901) 678-4073

_____ _____
Signature of person agreeing to take part in the study Date

_____
Printed name of person agreeing to take part in the study

_____ _____
Name of [authorized] person obtaining informed consent Date

IRB #:
Expiration Date:

Appendix E: Recruitment Flyer

University of Memphis

Volunteers Wanted for a Research Study

Investigating Inquiry-based Learning and the Teachers' Perspectives at a K-12 School

The purpose of this research is to better understand how a selected group of between four and six teachers perceive and practice inquiry-based learning (IBL) as an instructional method in their classrooms across all disciplines at one K-12 school. This study will employ a case study methodology to better understand teachers' perceptions, practices, and technology integration, while using IBL in a metropolitan classroom setting. Information will be accumulated through semi structured open-ended interviews and classroom observations. A qualitative interpretive approach will be used to capture and interpret the teachers' experiences.

You are encouraged to take part in this research study if you meet the following requirements:

I. A teacher who practice inquiry-based instructions in his/her classrooms and
II. A teacher who has at least two years of teaching experience

You will not be compensated for taking part in this research study. If you decide to take part in this research study, it should be because you really want to volunteer. Your willingness to take part, however, may, in the future, help society better understand this research topic.

The researcher will interview the participating teachers on their school campus and observe the participating teachers while teaching in their classrooms. This research is conducted under the direction of Dr. Lee Allen, an Associate Professor and Program Coordinator for the School Library Information Specialist program in the Department of Instruction and Curriculum Leadership.

To learn more about this research, contact Reza Chowdhury through email mchwdhry@memphis.edu or call at (901) 409 0637.

Reza Chowdhury mchwdhry@memphis.edu or call (901) 409 0637

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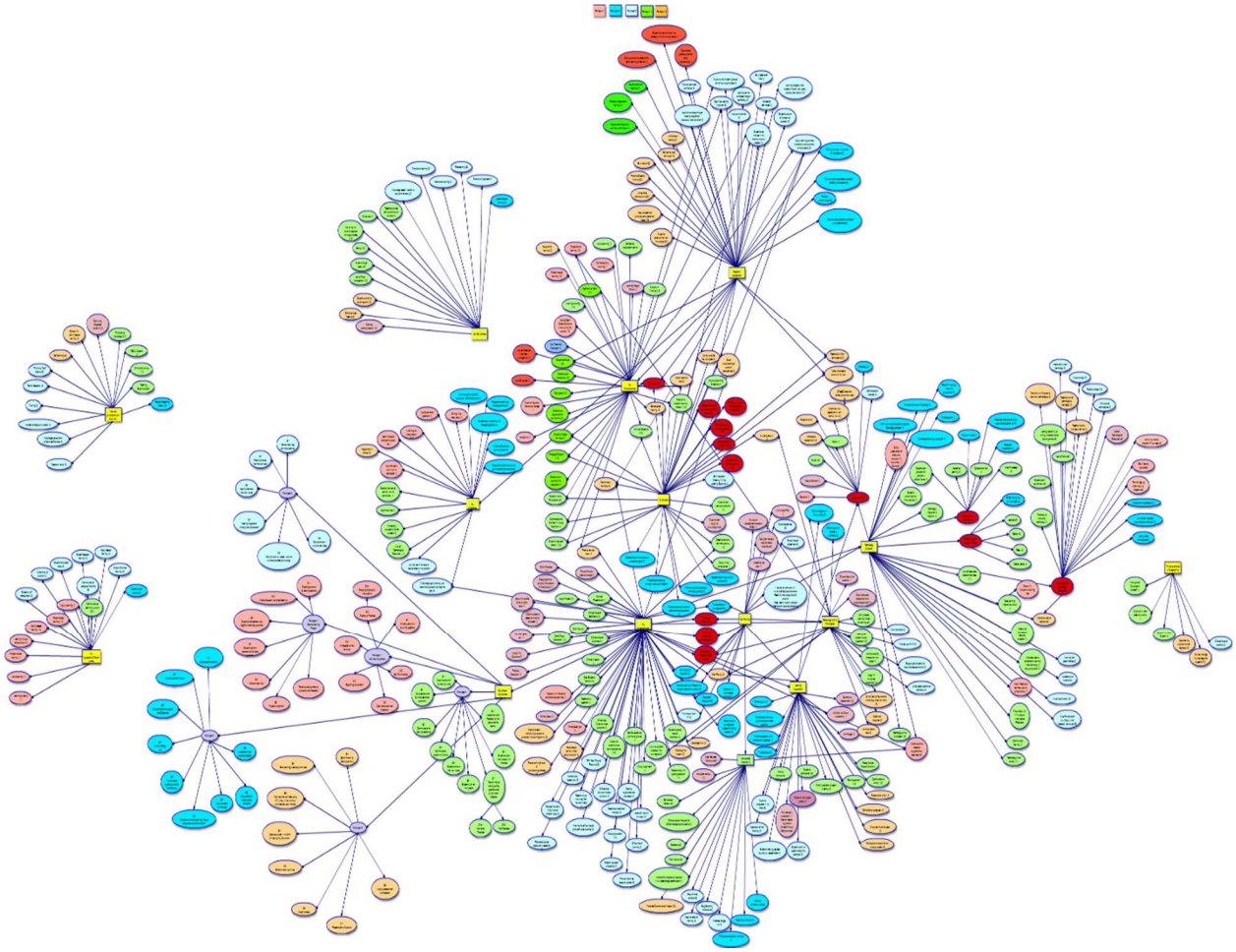
Reza Chowdhury mchwdhry@memphis.edu or call (901) 409 0637

Appendix F: Coding Mind Map Using the Webspirationpro

A Snapshot of IBL Coding Using the Webspirationpro Mind Mapping Tool



Appendix G: Research Log

Research Log

Date	Topic	Action/Reflection	Future Action plan and Comments
2/11/18	Consent from the principal	Acquired formal signed consent letter from the principal	Design and circulate recruitment flyers
3/15/18	Circulation of recruitment flyers	Circulated recruitment flyers – principal, vice principle, teachers' common areas	Check back with principal to know about interested participants
4/10/18	Contacted all research participant with interview and observation schedules	Worked with individual teacher to find out suitable time for one-on-one interview and classroom observations	Conduct interviews and classroom observation on scheduled date and time
4/25/18	Interview - participant one	Met the first research participant at her office room. Spent few minutes discussing her wellbeing's and Canada. She moved here from Canada though she graduated from a local university from Memphis. Let her go over the consent letter, sign the consent letter. Asked for her approval to record the entire interview. Thanked her for participating on this case study.	Explained to her that a copy of the interview transcript will be emailed to her for member checking.
4/26/18	Interview - participant two	Met the second research participant at his office room. Spent few minutes discussing his wellbeing's and sports. He loves soccer games and follow all the international soccer leagues. I know him for last 20 years and we go to the same church for congregational prayers. Let him go over the consent letter, sign the consent letter. Asked for his approval to record the entire interview.	Explained to him that a copy of the interview transcript will be emailed to him for member checking.

		Thanked him for participating on this case study.	
4/27/18	Interview - participant three	Met the third research participant at his office room. Spent few minutes discussing his wellbeing's and international politics and cultures. He loves to have intellectual discussion on educational theory development. Let him go over the consent letter, sign the consent letter. Asked for his approval to record the entire interview. Thanked him for participating on this case study.	Explained to him that a copy of the interview transcript will be emailed to him for member checking.
4/30/18	Interview - participant four	Met the fourth research participant at her office room. Spent few minutes discussing her wellbeing's and her progress in her doctoral program. She is working on her doctoral program and plan to graduate in a year. Let her go over the consent letter, sign the consent letter. Asked for her approval to record the entire interview. Thanked her for participating on this case study.	Explained to her that a copy of the interview transcript will be emailed to her for member checking.
5/1/18	Interview - participant five	Met the fifth research participant at his office room. Spent few minutes discussing his wellbeing's and sports. He loves basketball games and follow all the NBA games. Let him go over the consent letter, sign the consent letter. Asked for his approval to record the entire interview. Thanked him for participating on this case study.	Explained to him that a copy of the interview transcript will be emailed to him for member checking.
4/25/18	Classroom observation participant one, session one	Located on the second floor, has windows to enter day light. Each of the students has individual desk and chair. Teacher's desk is located at the front-center of the room. There is a small safe to	Compare classroom observation data with interview transcript to have a better understanding of the teacher's IBL

		store the laptops and tablets. There is a white board which is also used for the projection for the overhead projector. Though it is a decent size room, there is hardly any space left to perform hands on activities and small group discussion. Key Observations: -Started with prior knowledge activation -Students asked a lot of questions -Successfully involved all the students to participate -Students could discuss in the classroom before answering any question -Allowed the students to work in groups to solve application questions -One of the students was picked randomly to solve a problem on the whiteboard	perception, planning, and implementation.
4/25/18	Classroom observation participant one, session two	Located on the second floor, has windows to enter day light. Each of the students has individual desk and chair. Teacher's desk is located at the front-center of the room. There is a small safe to store the laptops and tablets. There is a white board which is also used for the projection for the overhead projector. Though it is a decent size room, there is hardly any space left to perform hands on activities and small group discussion. Key Observations: -Asked about the progress students are making on their assigned Lung Capacity Project -The teacher asked, "What do you think" question to initiate discussions	Compare classroom observation data with interview transcript to have a better understanding of the teacher's IBL perception, planning, and implementation.

		-Students shared their findings -Other students asked questions to the presenter -The teacher asked essential questions to cover all the concepts and contents -Allowed the students to work in small groups	
4/26/18	Classroom observation participant two, session one	-Allowed group learning -Bell work for prior knowledge activation -Encouraged students to ask open questions -Interactive class with a lot of discussions -Talked about learning goals and objectives -The teacher connected each of the concepts with real life applications -The teacher encouraged the students to learn from the primary sources and to share their findings with the entire class.	Compare classroom observation data with interview transcript to have a better understanding of the teacher's IBL perception, planning, and implementation.
4/26/18	Classroom observation participant two, session two	Located on the second floor, has two windows to enter day light. Each of the students has individual desk and chair. Teacher's desk is located at the back of the classroom. There is a small bookshelf with lots of encyclopedias and dictionaries. A small cart to store laptops. There are maps on the walls. There is a white board which is also used for the projection from the overhead projector. Though it is a decent size room, there is hardly any space left to perform hands on activities and small group discussion. Key Observations: -Started with Map Reading skill	Compare classroom observation data with interview transcript to have a better understanding of the teacher's IBL perception, planning, and implementation.

		-Bell work for prior knowledge activation -Encouraged students to work in small groups -Students shared their findings -The teacher mentioned the importance of alternate views -The teacher encouraged open questions and open thinking for continuous growth	
4/26/18	Classroom observation participant two, session three	Located on the second floor, has two windows to enter day light. Each of the students has individual desk and chair. Teacher's desk is located at the back of the classroom. There is a small bookshelf with lots of encyclopedias and dictionaries. A small cart to store laptops. There are maps on the walls. There is a white board which is also used for the projection from the overhead projector. Though it is a decent size room, there is hardly any space left to perform hands on activities and small group discussion. Key Observations: -Started by discussing learning goals -Encouraged students to ask open questions -Interactive class with a lot of discussions -The teacher picked students randomly to ensure equal opportunity for each student to participate	Compare classroom observation data with interview transcript to have a better understanding of the teacher's IBL perception, planning, and implementation.
4/26/18	Classroom observation participant three, session one	Located on the second floor, has no window. This is a small portion carved out of the computer lab and a temporary classroom. People are coming in and out while the class is going on. There are three rows of chairs with foldable desk. There	Compare classroom observation data with interview transcript to have a better understanding of the teacher's IBL perception, planning, and implementation.

		is hardly any space left between the chairs. Students can enter from only one side; the other side is blocked by the wall. There is no desk for the teacher. There is no storage area for the teacher. There are other classes taking place in the computer lab which is making lot of noises. The teacher was not happy about this classroom location. Key Observations: -The teacher distributed study materials to all the students -Students were divided into small group of two to three students -Students underlined all the known words -Students discussed among themselves to find out the main idea of the paragraph -Students discussed among themselves to learn the meaning of the unknown words -The teacher was involved throughout the learning process to help the students.	
4/27/18	Classroom observation participant three, session two	Located on the second floor, has no window. This is a small portion carved out of the hallway and next to the restroom area. There is a lot of traffic as students are going in and out of the restrooms. There are two rows of chairs with foldable desk. There is hardly any space left between the chairs. Students can enter only from the front side as other two sides are blocked by the wall. There is only a chair for the teacher. There is no storage area for the teacher. There is a small white board. The teacher was not	Compare classroom observation data with interview transcript to have a better understanding of the teacher's IBL perception, planning, and implementation.

		happy about this temporary classroom setup. Key Observations: -The teacher distributed study materials to all the students -Students were divided into small group of two to three students -Students underlined all the known words -Students discussed among themselves to find out the main idea of the paragraph -Students discussed among themselves to learn the meaning of the unknown words -The teacher was involved throughout the learning process to help the students	
4/27/18	Classroom observation participant four, session one	Located on the first floor, has windows to enter day light. Collaborative table setup for the students to work on small group. Teacher's desk is located at the back of the room. There is a small safe to store the laptops and tablets. There is a white board which is also used for the projection for the overhead projector. Key Observations: -Teacher wrote down learning objectives and classroom activities on the white board -Book-club meeting – students work on their assigned role/s, present their roles to the group members, and discussed the parts they read for that week. One of the students is assigned as the discussion leader to lead and manage his or her group for that day. Other roles are: word wizard, illustrator, summarizer, etc.	Compare classroom observation data with interview transcript to have a better understanding of the teacher's IBL perception, planning, and implementation.

		- Students come to the teacher with their questions -The teacher walked around the class to ensure all the students are involved and moving along -The teacher allowed the students to work on the tablets; students worked as a pair to work on the online story builder website	
4/27/18	Classroom observation participant four, session two	-The teacher discussed with the students to formulate and define the scope of the assigned project -Students asked a lot of questions relevant to the assigned project -The teacher helped the students to refine their research questions by asking guiding questions: what are you going to work on? What is important to you? Do you need to make any changes to the project? How are you going to present your project? -Students were allowed to work on small group -Students had permission to go online to perform information search before selecting a topic of their own choice for their assigned project	Compare classroom observation data with interview transcript to have a better understanding of the teacher's IBL perception, planning, and implementation.
4/30/18	Classroom observation participant five, session one and two	-The teacher grabbed the students' attention by projecting an image on the white board to activate discussion on prior knowledge -Teacher discussed with the students regarding learning goals for next two sessions -The teacher successfully involved the students to ask a lot of interesting questions related to the learning goals -The teacher discussed about the group project which was assigned previously; students	Compare classroom observation data with interview transcript to have a better understanding of the teacher's IBL perception, planning, and implementation.

		asked lots of questions to clarify their concerns regarding their group project -For every category of new knowledge learned, the teacher has a five-element application groups. Students must connect any concept or new knowledge with one or more of those categories -Students were having lots of fun with the teacher while learning diligently	
9/27/18	Meeting with all the committee members	Edits for Chapter 1,2, and 3 Received verbal feedback and written edits	Listen the verbal recommendation from the recorded audio file. Review the recommended written edits
9/28/18	Searching for the best transcription tool	Explored different software Compared among different transcription tools	Decide to pick the best possible tool
9/30/18	Working on recommended edits	Some of the edits and recommendations were easy to understand, some of the recommendations deserved additional thinking and clarification	Think, reflect, read few related articles Schedule one-on-one meeting with some of the advisors
10/01/18	Select the best Transcription tool	Temi.com was the best option. Great tool. Great customer support. Quick learning tool.	Learn about Temi.com Watch how to video on Temi
10/2/18 through 10/6/18	Read the auto generated transcripts	Reading transcript was very useful to refresh the memory and to comprehend the participants' view	Compare the transcripts with the source audio files
10/7/18 through 10/9/18	Compare transcripts with source audio files – multiple times	Comparing transcripts with the audio files helped me to make necessary correction on the auto generated transcripts. It also refreshed my memory to construct a better understanding of the participants' view	Send the corrected transcripts to the research participants for members checking

10/9/18	Send the corrected transcripts to the research participants for members checking	Followed up with the participants to get their feedback and confirmation that the transcripts are accurate	-These transcripts and observation notes will be utilized to develop codes
10/10/18	First attempt to code	-Highlighted the main ideas -Assigned name to key ideas	Need to revisit the codes
10/12/18	Meeting with Dr. Tawfik	Discuss about five journal articles to finetune my recommendation section under literature review	Read all five articles to extract the themes to finetune the recommendation section under literature review
10/13/18	Second attempts to code	-Try to consolidate some of the codes with similar ideas and contents	Start thinking about grouping the codes
10/14/18	First attempt to category the codes	-Too many codes all over the places, getting quite impossible to get a handle on it	Do some research to identify a tool to making thinking visible
10/14/18	Identify a Making thinking visible tool to categories the codes	http://www.webspirationpro.com is great tool for making thinking visible used by other researchers	Subscribe Webspirationpro.com to organize the codes with visual impact
10/15/18	Second attempt to category the codes	All the codes were entered in Webspirationpro software. Though there exist a very complex and intricate relationship among the codes, it was much easier to have a better comprehension of the codes due to visual representation in a summarized form.	Start thinking about major theme development
10/16/18	First attempt to develop major themes	Initially derived five themes	Think through the developed themes in the light to the research questions
10/17/18	Meeting with Dr. Nordstrom	Discuss about all the edits as recommended by Dr. Nordstrom	Added additional detail on the research participants Elaborated on my relationship with the research site
10/17/18	Second attempt to develop major themes	Refined five themes into four major themes	Think through each of the individual

			major theme to identify the supporting points, direct quotes, and sub-themes
10/17/18	For each of the major theme - identify the supporting points, direct quotes, and sub-themes	Everything/major themes are very interconnected. Three sub-themes were identified for the first major theme. Three sub-themes were identified for the second major theme.	Start thinking about writing chapter 4 (findings) and chapter 5 (Discussions and recommendations)
10/18/18 Through 10/24/18	Writing chapter 4 (Findings)	Writing findings in the light of the emerged major themes Findings were inconsistent with existing research findings Finding were emboldened by adding direct quotes from the participating teachers	How does these findings corelate with research questions?
10/25/18	Writing chapter 5 (Discussions and recommendations)	Discussed emerged major themes and their intricate relationship with the research questions	Email completed Dissertation to Dr. Allen
10/25/18	Email Dissertation to Dr. Allen	Email Dissertation to Dr. Allen	Look for edits and feedback, and work on the recommended edits

Appendix H: Observation Summary

Observation Summary

Participant Name and Observation Number	Observation date & time	Subject & Grade Level	Description of the classroom	Key notes from observation
Kate – Observation One	4/25/18 & 8:00 – 8:50 am	Math – 4th Grade	Located on the second floor, has windows to enter day light. Each of the students has individual desk and chair. Teacher's desk is located at the front-center of the room. There is a small safe to store the laptops and tablets. There is a white board which is also used for the projection for the overhead projector. Though it is a decent size room, there is hardly any space left	-Started with prior knowledge activation -Students asked a lot of questions -Successfully involved all the students to participate -Students could discuss in the classroom before answering any question -Allowed the students to work in groups to solve application questions -One of the students was picked randomly to solve a problem on the whiteboard

			to perform hands on activities and small group discussion.	
Kate – Observation Two	4/25/18 & 9:10 – 10:00 am	Science – 4th Grade	Located on the second floor, has windows to enter day light. Each of the students has individual desk and chair. Teacher's desk is located at the front-center of the room. There is a small safe to store the laptops and tablets. There is a white board which is also used for the projection for the overhead projector. Though it is a decent size room, there is hardly any space left to perform hands on activities and small group discussion.	-Asked about the progress students are making on their assigned Lung Capacity Project -The teacher asked, "What do you think" question to initiate discussions -Students shared their findings -Other students asked questions to the presenter -The teacher asked essential questions to cover all the concepts and contents -Allowed the students to work in small groups

Michael - Observation One	4/26/18 & 8:50 – 9:40 am	Social Studies – 6th Grade	Located on the second floor, has two windows to enter day light. Each of the students has individual desk and chair. Teacher's desk is located at the back of the classroom. There is a small bookshelf with lots of encyclopedias and dictionaries. A small cart to store laptops. There are maps on the walls. There is a white board which is also used for the projection from the overhead projector. Though it is a decent size room, there is hardly any space left to perform hands on	-Allowed group learning -Bell work for prior knowledge activation -Encouraged students to ask open questions -Interactive class with a lot of discussions -Talked about learning goals and objectives -The teacher connected each of the concepts with real life applications -The teacher encouraged the students to learn from the primary sources and to share their findings with the entire class

			activities and small group discussion.	
Michael - Observation Two	4/26/18 & 10:45 – 11:35 am	US History – 7th Grade	Located on the second floor, has two windows to enter day light. Each of the students has individual desk and chair. Teacher's desk is located at the back of the classroom. There is a small bookshelf with lots of encyclopedias and dictionaries. A small cart to store laptops. There are maps on the walls. There is a white board which is also used for the projection from the overhead projector. Though it is a decent size room, there is hardly any space left to	-Started with Map Reading skill -Bell work for prior knowledge activation -Encouraged students to work in small groups -Students shared their findings -The teacher mentioned the importance of alternate views -The teacher encouraged open questions and open thinking for continuous growth

			perform hands on activities and small group discussion.	
Michael – Observation Three	4/26/18 & 1:45 – 2:35 pm	Civics – 8th Grade	Located on the second floor, has two windows to enter day light. Each of the students has individual desk and chair. Teacher's desk is located at the back of the classroom. There is a small bookshelf with lots of encyclopedias and dictionaries. A small cart to store laptops. There are maps on the walls. There is a white board which is also used for the projection from the overhead projector. Though it is a decent size room, there is	-Started by discussing learning goals -Encouraged students to ask open questions -Interactive class with a lot of discussions -The teacher picked students randomly to ensure equal opportunity for each student to participate

			hardly any space left to perform hands on activities and small group discussion.	
Matthew - Observation One	4/26/18 & 2:50 – 3:40 pm	Arabic Language – 8th grade	Located on the second floor, has no window. This is a small portion carved out of the computer lab and a temporary classroom. People are coming in and out while the class is going on. There are three rows of chairs with foldable desk. There is hardly any space left between the chairs. Students can enter from only one side; the other side is blocked by the wall. There is no desk for the teacher. There is no	-The teacher distributed study materials to all the students -Students were divided into small group of two to three students -Students underlined all the known words -Students discussed among themselves to find out the main idea of the paragraph -Students discussed among themselves to learn the meaning of the unknown words -The teacher was involved throughout the learning process to help the students

			storage area for the teacher. There are other classes taking place in the computer lab which is making lot of noises. The teacher was not happy about this classroom location.	
Matthew - Observation Two	4/27/18 & 10:50 – 11:40 am	Arabic Language – 10th grade	Located on the second floor, has no window. This is a small portion carved out of the hallway and next to the restroom area. There is a lot of traffic as students are going in and out of the restrooms. There are two rows of chairs with foldable desk. There is hardly any space left between the chairs. Students can enter only	-The teacher distributed study materials to all the students -Students were divided into small group of two to three students -Students underlined all the known words -Students discussed among themselves to find out the main idea of the paragraph -Students discussed among themselves to learn the meaning of the unknown words -The teacher was involved throughout the learning process to help the students

			from the front side as other two sides are blocked by the wall. There is only a chair for the teacher. There is no storage area for the teacher. There is a small white board. The teacher was not happy about this temporary classroom setup.	
Julie-Observation One	4/27/18 & 12:15 – 1:05 pm	English Language Arts – 3rd grade	Located on the first floor, has windows to enter day light. Collaborative table setup for the students to work on small group. Teacher's desk is located at the back of the room. There is a small safe to store the laptops and tablets. There is a white board	-Teacher wrote down learning objectives and classroom activities on the white board -Book-club meeting – students work on their assigned role/s, present their roles to the group members, and discussed the parts they read for that week. One of the students is assigned as the discussion leader to lead and manage his or her group for that

			which is also used for the projection for the overhead projector.	day. Other roles are: word wizard, illustrator, summarizer, etc. - Students come to the teacher with their questions -The teacher walked around the class to ensure all the students are involved and moving along -The teacher allowed the students to work on the tablets; students worked as a pair to work on the online story builder website
Julie - Observation Two	4/27/18 & 10:50 – 11:40 am	English Language Arts – 7th grade	Located on the first floor, has windows to enter day light. Collaborative table setup for the students to work on small group. Teacher's desk is located at the back of the room. There is a small safe to store the laptops and tablets. There is a white board	-The teacher discussed with the students to formulate and define the scope of the assigned project -Students asked a lot of questions relevant to the assigned project -The teacher helped the students to refine their research questions by asking guiding questions: what are you going to work on? What is important to you? Do you need to make any changes to the project?

			which is also used for the projection for the overhead projector.	How are you going to present your project? -Students were allowed to work on small group -Students had permission to go online to perform information search before selecting a topic of their own choice for their assigned project
Chris - Observation One	4/30/18 & 2:00 – 2:50 am	Social Studies – 4th grade	Located on the second floor, has windows to enter day light. Each of the students has individual desk and chair. Teacher's desk is located at the front-center of the room. There is a small safe to store the laptops and tablets. There is a white board which is also used for the projection for the overhead	-The teacher grabbed the students' attention by projecting an image on the white board to activate discussion on prior knowledge -Teacher discussed with the students regarding learning goals for next two sessions -The teacher successfully involved the students to ask a lot of interesting questions related to the learning goals -The teacher discussed about the group project which was assigned previously; students asked lots of

			projector. There are two internet drops; one is used by the teacher for his laptop. The other internet drop connects with a small switch hub for the students to connect with their electronic devices.	questions to clarify their concerns regarding their group project -For every category of new knowledge learned, the teacher has a five-element application groups. Students must connect any concept or new knowledge with one or more of those categories -Students were having lots of fun with the teacher while learning diligently
Chris - Observation Two	4/30/18 & 2:50 –3:40 pm	Social Studies – 4th grade	Located on the second floor, has windows to enter day light. Each of the students has individual desk and chair. Teacher's desk is located at the front-center of the room. There is a small safe to store the laptops and tablets. There is a white	-The teacher grabbed the students' attention by projecting an image on the white board to activate discussion on prior knowledge -Teacher discussed with the students regarding learning goals for next two sessions -The teacher successfully involved the students to ask a lot of interesting questions related to the learning goals

			board which is also used for the projection for the overhead projector. There are two internet drops; one is used by the teacher for his laptop. The other internet drop connects with a small switch hub for the students to connect with their electronic devices.	-The teacher discussed about the group project which was assigned previously; students asked lots of questions to clarify their concerns regarding their group project -For every category of new knowledge learned, the teacher has a five-element application groups. Students must connect any concept or new knowledge with one or more of those categories -Students were having lots of fun with the teacher while learning diligently