# EXPLORING THE DEVELOPMENT OF TEACHER UNDERSTANDING AND USE OF INQUIRY-BASED INSTRUCTION IN CANADIAN AND WORLD STUDIES

by

Marina Sadik

A thesis submitted in conformity with the requirements

for the degree of Master of Arts, Educational Leadership and Policy

Department of Leadership, Higher, and Adult Education

Ontario Institute for Studies in Education

University of Toronto

**Exploring the development of teacher understanding and use of inquiry-based instruction in Canadian and world studies**

**Marina Sadik**
**Master of Arts, Educational Leadership and Policy**
**Department of Leadership, Higher, and Adult Education**
**University of Toronto**
**2018**

## Abstract

Inquiry-based learning (IBL) has begun to be emphasized in the Canadian and World Studies (CWS) curriculum. Teacher understanding and usage of inquiry, however, is understudied and unclear. The present qualitative case study explores how teachers understand and use inquiry in CWS while taking part in two-part workshop on IBL administered through the board. Seven teachers were interviewed after each workshop and observations were conducted during the workshops. Using a developmental framework of professional development, findings show that teachers have a novice understanding of inquiry. Specifically, they have understood inquiry as a task or assignment rather than a process of learning. A prescriptive understanding of inquiry, exacerbated by systemic barriers for teachers and students, has led to pseudo-inquiry (practice that contains elements of inquiry but is not connected by the essence of inquiry).

**Acknowledgments**

I would like to thank all the teachers who agreed to participate in my research, whom without, this study would not exist. I am especially grateful to Madeline, the student achievement consultant, who was unceasingly concerned about my studies and helped find a new group of teachers to work with when my first project fell apart.

I would also like to thank my friends and colleagues. Amanda, thank you for listening to my rants and validating my worries, sadness, anger, and confusion, for answering all my questions, for talking out ideas with me, and for being an excellent critical friend for my thesis. Said, thank you for your friendship and your advice about conceptual and theoretical frameworks. Your experience and thesis have been instrumental in helping me finish mine. Lastly, Michelle, I wouldn't be the same without you. Thank you for being my best friend, my editor, and my rock.

I would not have been able to finish this thesis without my mentors and supervisors. Dr. Bascia, Dr. Rodway, and Dr. Childs, thank you for your constant advice, mentorship, compassion, and understanding on this journey. Thank you for the opportunities you have provided me, and the guidance you have given.

Finally, I would like to thank my family. Your patience and kindness has not gone unnoticed. Although I have been holed up in my room, reading and writing for months, thank you for giving me the space and support to finish this thesis. Thank you for loving me, raising me, guiding me, and feeding me for 24 years. I would literally be nothing as a human without you.

## Table of Contents

## List of Figures

## List of Tables

## List of Appendices

# Chapter 1: Introduction and Problem Statement

## Introduction

Inquiry-based learning has the potential to foster a paradigm shift in education, drive 21st century learning forward, and help students achieve skills they will be required to demonstrate in the workforce. Broadly, inquiry-based learning is a learning process driven by an open-ended question that requires learners to formulate a hypothesis or theory, collect data or conduct research, analyze data, make conclusions, and communicate ideas (Minner, Levy, & Century, 2010). Inquiry aims to help students learn content knowledge while developing skills like self-regulation, problem-solving, critical thinking, communication, and creativity.

Most recently, the narrative on educational reform has been focused on 21st century education. Twenty-first century skills are core competencies that will help students thrive in the 21st century (e.g., collaboration, communication, global citizenship, problem-solving, creativity, etc.) (21st Century Competencies, 2016). Twenty-first century education, then, is all the practices, environments, technologies, structures, and pedagogies that will help students achieve 21st century skills. The movement towards 21st century learning has been gaining momentum for decades, with both pedagogical and economic factors contributing to its culmination (Barron & Darling-Hammond, 2008; Friesen & Scott, 2013; Growe, 2001; Minner et al., 2010; Palmer, 2002; Sandoval, 2005).

Researchers have demonstrated that transmission-based instruction (where students acquire knowledge passively from a teacher) is an ineffective instructional method to prepare students for the challenges of the 21st century (Barron & Darling-Hammond, 2008; Friesen &

Scott, 2013; Growe, 2001). Since the establishment of public education in the 19th century, cognitive psychologists have gained a better understanding of the kinds of learning that lead to improved problem-solving—and specifically, problem-solving in novel contexts. Strategies like engaged learning, scaffolding, modelling, and situated learning (which are all incorporated in inquiry-based learning) help students form schemas that allow them to solve problems effectively (Goldman & Pellegrino, 2011; Hmelo-Silver, Duncan, & Chinn, 2007; Loibl, Roll, & Rummel, 2017). It has become a pedagogical priority for students to learn more than literacy and numeracy (Ontario Ministry of Education, 2014). For students to be successful in the workforce, they must be prepared for future learning; 21st century education provides students with the skills to be life-long learners, instead of vessels of information.

Economically, the call for reform is predicated on the goals and purpose of education being misaligned with the demand in today's globalized economy (Murnane & Levy, 1996). Business leaders, corporations, and international organizations have expressed concern that students are leaving post-secondary education unprepared for the workforce (Growe, 2011; Wehling, 2007). This growing concern emphasizes the lack of alignment between the skills students acquire through education, and the skills needed to meet the challenges of the 21st century. Fundamentally, today's education reform movement is predicated on students not being adequately prepared for the unknown challenges. Preparing students for the future's challenges require a new model of teaching, a new educational environment, and a new culture of learning (Friesen & Scott, 2013).

In Ontario, inquiry-based learning has become more relevant in and for curriculum. Curriculum documents are critical for education in Ontario because they outline what is to be

learned, ways it can be presented, and what expectations need to be met in order for a student to have sufficiently learned in the given discipline. The secondary school curriculum is made up of 17 documents separated by subject: Mathematics, English, Science, Canadian and World Studies, and so on. Within each subject document, specific courses are outlined. For example, the Canadian and World Studies (CWS) curriculum consists of Law, Civics, Politics, History, Geography, and Economics courses. Of the 17 curriculum documents for secondary school, only five have been revised in the last 10 years, and of those five documents, two curricula dedicate an entire strand to inquiry-based learning (Social Sciences and Humanities and Canadian and World Studies). The Science curriculum, although not updated recently, also contains a strand dedicated to inquiry. Ontario's Ministry of Education has identified inquiry-based learning as a promising strategy for creating effective schools (School Effectiveness Framework, 2013), driving 21st century learning (Ontario Public Service, 2016), creating innovative learning environments (The Literacy and Numeracy Secretariat, 2013), and engaging students in deeper learning (Ontario Public Service, 2016).

Although some teachers have embraced inquiry-based learning and enthusiastically integrated it into their practice, other teachers are struggling to understand inquiry and how to integrate it into their practice (Capps & Crawford, 2013; Marshall, Horton, & Smart, 2009; McNew Birren & van den Kieboom, 2017). In addition, it is unclear how teachers make sense of inquiry, integrate inquiry, and refine their practice around inquiry. Given the recent addition of inquiry in the Canadian and World studies curriculum, CWS teachers are unsure about how to effectively integrate, use, and assess inquiry in the classroom (Madeline, personal communication, December 18, 2017).

The purpose of this study is to explore how Canadian and World Studies teachers understand and integrate inquiry-based learning into their practice. The literature on inquiry-based learning falls into three distinct categories: operationalization, science education, and testing inquiry against other learning approaches. Inquiry, as a practical approach, is abstract and unclear. Thus, a third of the literature is spent describing, defining, and providing practical examples to integrate inquiry into practice (e.g., Chinn & Malhotra, 2002; Friesen & Scott, 2013; Growe, 2011; Pedaste et al., 2015; Savery & Duffy, 1995; Thomas, 2000).

Because inquiry-based learning is subjective, it is difficult to define as a process. Much of the literature on inquiry is spent defining inquiry in theoretical and practical contexts. Since inquiry originates in science, another area of inquiry literature focuses on science education and how inquiry plays a role in teaching science literacy (e.g., Azizmalayeri, MishahJafari, Sharif, Asgari, Omidi, 2012; Kapur, 2012; Opara, 2011; Palmer, 2002). Finally, the last major area of inquiry literature addresses the dramatic controversy regarding inquiry-based learning, comparing inquiry's effectiveness with direct instruction (eg., Clark, Kirschner, & Sweller, 2012; Hmelo-Silver, Duncan, & Chinn, 2007; Kirschner, Sweller, & Clark, 2006; Mayer, 2004; Sweller, Kirschner, & Clark, 2007) . Between these three areas of literature, there is a clear lack of research exploring teachers' understanding of inquiry, how they integrate inquiry into their practice, and the perceptions and challenges teachers may face in trying to do so. Thus, this study aims to explore teachers' understanding and usage of inquiry. Understanding the perceptions, challenges, and changes teachers experience in trying to use inquiry will highlight the possible discrepancies between inquiry as conceived and inquiry as implemented. It is critical to explore teacher understanding and implementation of IBL because without a foundational understanding

in how teachers use IBL, defining inquiry and debating whether or not it is more effective than direct instruction becomes a useless narrative.

## Context

**Inquiry-based learning in Canadian and World Studies.** The Canadian and World Studies (CWS) curriculum provides information on courses from grade 9 through 12 and encompasses geography, history, civics, economics, politics, and law courses. When the grade 9 and 10 CWS curriculum was updated in 2013, followed by the grade 11 and 12 curriculum in 2015, one of the changes in the new curricula was the integration of inquiry. Both curriculum documents (moving forward no distinction will be made between the grades 9-10 and grades 11-12 curriculum as the inquiry content in both is identical), present inquiry in the first strand (or theme) of the curriculum document. Inquiry (i.e., Strand A) is intended to be integrated with, and not added onto other strands in the curriculum (Ontario Ministry of Education, 2013, 2015). The CWS curriculum (2013, 2015) defines inquiry as a process

> that students use to investigate events, developments, and issues; solve problems; develop plans of action; and reach supportable conclusions and decisions. The inquiry process consists of five components:
>
> - formulating questions
> - gathering and organizing information, evidence, and/or data
> - interpreting and analyzing information, evidence, and/or data
> - evaluating information, evidence, and/or data and drawing conclusions
> - communicating findings and/or plans of action

Inquiry is important in the CWS disciplines because it involves 'disciplinary thinking' (Ontario Ministry of Education, 2015). Disciplinary thinking requires taking the same critical perspective as experts in history, geography, or economics—which is a fundamental

curriculum expectation. In order to prepare students for future challenges in these disciplines, students must be able to use the same tools, processes, and thinking as experts in the field. Without a deep understanding of inquiry-based learning, however, guiding students through this process can be confusing for teachers (Madeline, personal communication, December 18, 2017). This happens to be the case in this particular Catholic school board in Southern Ontario.

**Overview of the case study.** In late 2017, a student achievement consultant sent an invitation to high schools principals, inviting teachers within the school board from the Department of Canadian and World Studies and teacher librarians to attend a two-part professional development series on inquiry-based learning in CWS. A group of 12 teachers and teacher librarians met during the January-June 2018 school term to discuss, share, and work through challenges regarding inquiry. The idea for professional development on inquiry in CWS began when Rosa, a CWS department head, approached the student achievement consultant about inquiry in the curriculum. Rosa had been using an inquiry approach in her classes long before it becomes an official strand in the curriculum and noticed that students became more responsible for their learning, and more engaged in the curriculum content when she used an inquiry-based learning model. Rosa was interested in sharing what she knew about inquiry, and believed inquiry could help transform teaching and learning.

## Research Questions

This study explores teachers' integration and understanding of IBL after attending professional development sessions on inquiry-based learning facilitated by the school board. Using interviews and field notes from each professional development workshop, teachers'

experiences, perceptions, and challenges in trying to integrate inquiry into their practice or improve their current practice around inquiry are described. The main research questions and subquestions as they pertain to CWS are:

Main Questions

1. How do teachers understand inquiry-based learning following professional development?
2. How are teachers integrating IBL in their practice?

Subquestions:

1. What are teacher perceptions around IBL as an approach to teaching and learning?
2. What challenges do teachers face in integrating IBL?

**Significance**

The significance of this study lies in its focus on the teacher experience using inquiry-based learning. By understanding the perceptions, experiences, and challenges teachers encounter, school boards may able to address and improve processes for engaging teachers in using inquiry-based learning. It may also provide insight into what is and is not feasible with inquiry-learning in Canadian and World Studies. A realistic account of how teachers integrate inquiry could provide education leaders a better idea of how to adjust expectations for 21st century education. Further, this research may validate challenges and reflections other teachers may encounter in trying to shift their practice from transmission-based instruction to inquiry-

based instruction. Shifting to inquiry-based learning after investing in direct instruction can be a challenging process, not only because of the time commitment and planning responsibilities but also because it requires a complete overhaul in thinking about the kinds of learning and content that should be prioritized in education.

## Chapter 2: Literature Review

### What is Inquiry-Based Learning?

Inquiry-based learning organizes learning around an open-ended question, prompts students to develop hypotheses or theories, provides the opportunity to investigate those theories through data collection and interpretation, requires students to connect ideas or offer answers to the question, and communicate or reflect on their findings (Pedaste et al., 2015). Generally, learners are guided through the inquiry process by an experienced facilitator or instructor, but an emphasis is placed on the exploration process rather than directly transmitting an answer. IBL draws on humans' natural curiosity while ensuring students are consolidating content knowledge and developing skills such as critical thinking, problem-solving, innovation, creativity, entrepreneurship, and collaboration (Ontario Public Service, 2016). It is important to acknowledge the distinction between definitions for inquiry, inquiry-based learning, and inquiry-based learning. In the literature on inquiry-based learning, all three terms are used interchangeably. For the purposes of this thesis, the following definitions will be used: *inquiry* is the process of discovering knowledge through questioning, investigating, analyzing, and connecting ideas, while inquiry-based learning is a learning model that relies heavily on inquiry for teaching and learning. Since inquiry is a learning process, including it in pedagogy today will help students learn how to learn: one of the main goals of 21st century learning. Learning how to learn enables students to explore beyond 'knowledge', and allows them to think in a way that is domain specific (Bereiter & Scardamalia, 2006; Bransford, Brown, & Cocking, 2000; Sandoval & Reiser, 2004)—that is, thinking the same way a historian or biologist, or mathematician

thinks.

Defining inquiry has proven to be a challenge. Despite the diverse body of literature on inquiry-based learning, no consistent or concrete definition exists (Lazonder & Harmsen, 2016). Because of the lack of definitions, I have chosen to use Pedaste and colleagues' (2015) operationalization of inquiry since it is the most comprehensive and systemically uses the overlap in definitions from other authors. According to their systematic review, inquiry is comprised of five phases, known as the inquiry cycle: orientation, conceptualization, investigation, conclusion, and discussion (Pedaste et al., 2015).

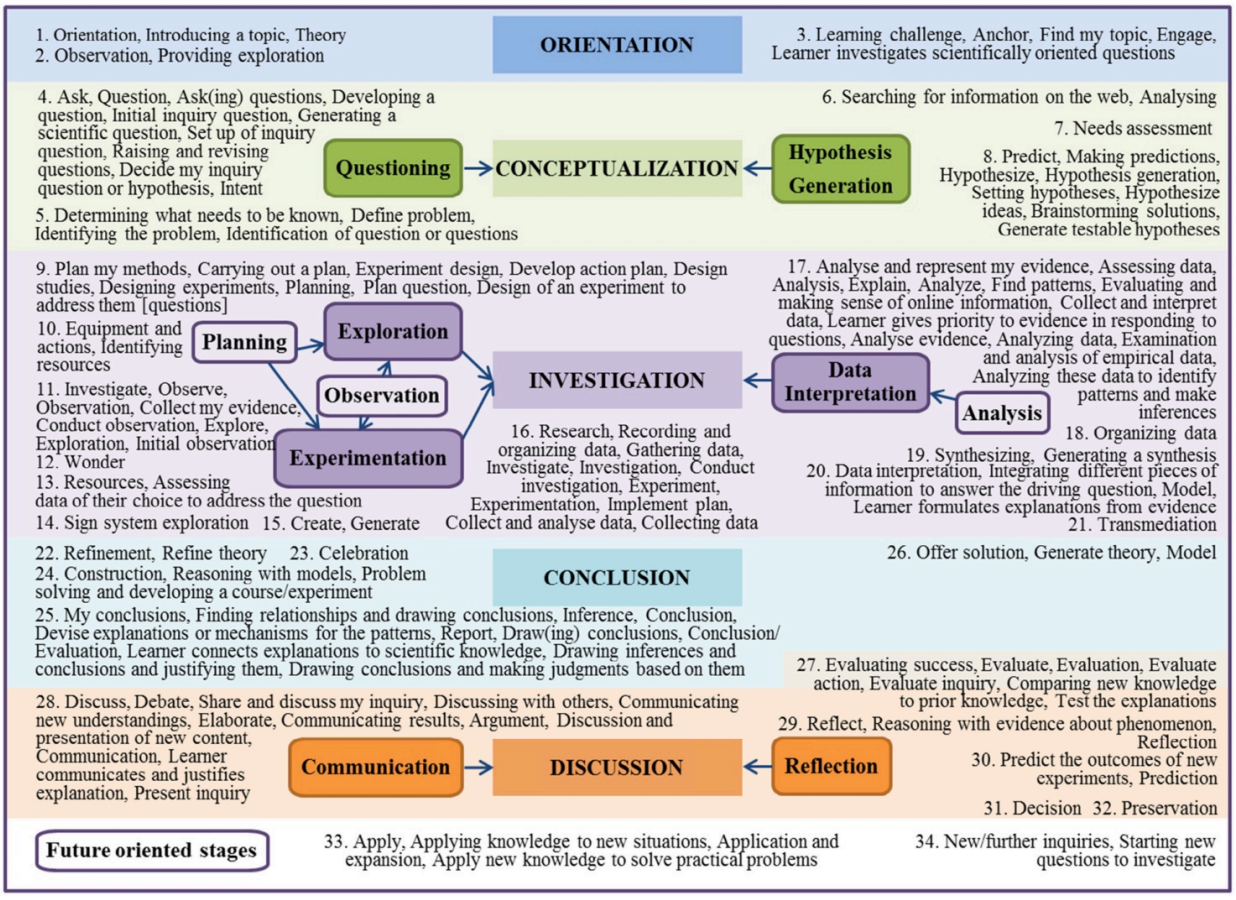


*Figure 1.* Visualization of the five phases of Inquiry-based Learning. Taken from Pedaste et al. (2015)

Evidently, the inquiry process is similar to the scientific method (i.e., form a research question, form a hypothesis, conduct an experiment, analyze the data, form a conclusion), which is reasonable considering inquiry is rooted in the field of science (Barron & Darling-Hammond, 2008). Scientists constantly use open-ended questions to drive research and build new knowledge. Although inquiry-based learning is rooted in science, its origins are in the Socratic method.

**History of inquiry.** Socrates' fundamental goal was to uncover the objective truth. He aimed to accomplish this by questioning people, often engaging them in logical and systematic questions until he found a flaw in their logic (Overholser, 1993). In the Socratic model, the teacher is not a teacher, nor are they a passive guide. Rather, the classroom is a dialogue between the learner and teacher, where both are responsible for pushing the dialogue further through questioning (Friesen & Scott, 2013; Ross, 2003). Although advocates of inquiry-based learning uphold the notion that inquiry is strictly Socratic, there exists a major difference between inquiry and Socratic questioning. Socratic questioning rests on a line of questioning that is specific, logical and leads the student directly to the answer (Overholser, 1993). For example, "What are five ways immigration is an advantage to Canada?" Inquiry, however, is driven by broad and open-ended questions: for example, "How has immigration contributed to Canada's prosperity?" Although the obvious similarity is that both methods are driven by questioning, the *types* of questions are vastly different. Thus, claiming inquiry is a Socratic method is a misrepresentation of the kinds of questions that drive inquiry.

The work of John Dewey—inspired by Socrates—is likely what lead to the model of inquiry we use today (Friesen & Scott, 2013). Dewey, a science teacher in the early 20th century,

was critical of transmission-based teaching because he believed transmissive teaching was robbing students of the opportunity to build and create knowledge for themselves in the same way scientists do (Dewey, 1910, as cited in Friesen & Scott, 2013). As Dewey's thinking and work evolved, he developed the belief that if students connected their personal experience to knowledge, they could enhance their understanding of content. Dewey also believed that a teacher's role in learning is to facilitate and guide knowledge building, not dictate it (Dewey, as cited in Barrow 2006; Scott and Friesen, 2013). He was also critical of teaching methods that required teachers to passively lecture, expecting students to simply acquire information. Dewey's beliefs opposed the factory-model of schooling that existed in his time and still exists today (Benham Tye, 1987).

The factory model of education was built for an era that required individuals to fit into a well-oiled industrial system (Sawyer, 2006). This model of education organized learning expectations around prescribed rules, protocols, and memorization of information. The factory model of education overlays several assumptions about how and what people should learn (Sawyer, 2006). Namely, that learning is linear and starts with acquiring knowledge, which is made up of facts and procedures. These facts and procedures exist within the teacher, who is required to transfer them to students.

Although today's education model is supposedly built for the 21st century, assumptions and practices from the factory model still exist today (Benham Tye, 1987; Brown et al., 1989; Friesen & Scott, 2013). For instance, knowledge is treated as isolated units of information, devoid of context. These "units" of knowledge must be learned before they can be transferred and used to solve problems and discuss broad ideas. Even more, learning *about* something is

evidence of learning how to *do* something (Brown et al, 1989; Perkins, 2009). Attempts to combat these assumptions are clear (Capacity Building Series, 2013; Watt & Coyler, 2014 ), and yet, it seems they are ingrained in our education system (Growe, 2011). Generally, education leaders have attempted to combat these assumptions by proposing and using constructivist learning models. The most popular models being inquiry-based learning, problem-based learning, and project-based learning.

**Inquiry-based learning, problem-based learning, and project-based learning.** In literature on IBL, inquiry-based learning, problem-based learning, and project-based learning are commonly lumped together as one learning model based on constructivism. Even more, researchers often extend evidence of one model to all three models since they are so closely related (e.g., Barron & Darling-Hammond, 2008). Although they are largely similar, differences between them do exist. For instance, inquiry-based learning is rooted in science, while problem-based learning (PBL) is rooted in medicine. PBL uses a problem or case scenario to drive the learning process, while inquiry most often depends on an open-ended question (Barron & Darling-Hammond, 2008). Because PBL begins with a problem or scenario, learners must use inductive—or bottom-up—reasoning. In comparison, inquiry requires deductive—or top-down —reasoning. Project-based learning (PrBL) involves a series of complex tasks and generally results in a completed product, event, or presentation (Barron & Darling-Hammond, 2008). Although there are differences between all three learning models, there are an over-abundance of similarities as well. All three learning models are based on questions, problems, or products that are authentic to the discipline. They also ensure that knowledge is taught in context. They emphasize learning as a scaffolded process rather than a by-product of retaining knowledge. In

practice, it can be difficult to differentiate instances of IBL, PBL, or PrBL because they all involve collaboration, critical thinking, problem-solving, innovation, and investigation (Barron & Darling-Hammond, 2008). Although PBL uses deductive reasoning, and IBL inductive reasoning, learners tend to use both as a cycle in order to arrive at a conclusion.

| | **Inquiry-based learning** | **Problem-based learning** | **Project-based learning** |
|---|---|---|---|
| **Driven by** | Questions | Problems, cases, scenarios | Products, events, presentations |
| **Type of reasoning** | Bottom-up reasoning | Top-down reasoning | Both |
| **Example** | "How does estrogen affect the female body?" | "A 63-year old man is brought to the Emergency Room by ambulance for a 30-second loss of consciousness while walking. He had a heart attack 5 years ago. What is the most likely cause of his loss of consciousness?" | "You have been nominated to run for Premier of Ontario. Create a platform addressing 4 issues Ontarians currently face." |
| **Differences** | Stems from the scientific method | Stems from medicine | Ends in a final product |
| **Similarities** | Requires collaboration, problem-solving, critical thinking, leadership, innovation, creativity | Requires collaboration, problem-solving, critical thinking, leadership, innovation, creativity | Requires collaboration, problem-solving, critical thinking, leadership, innovation, creativity |

*Table 1.* Summary table of constructivist models.

Currently, there exists a debate in the literature on whether PBL, IBL, or PrBL are better than direct instruction for teaching and learning. Literature comparing direct instruction with one or all of these models often refer to them as 'minimally guided learning' or 'discovery learning' (e.g., Kirschner, Sweller, & Clark, 2006; Kirschner & Clark, 2007). Categorizing IBL, PBL, and PrBL as discovery learning is problematic for several reasons. Discovery learning or unguided instruction is just that—unguided. Although inquiry-based learning and discovery learning both stems from constructivist perspectives in education, discovery learning uses a more radical instructional model of exploration than inquiry-based learning does. Discovery learning gives students the space to explore and discover knowledge without the guided nature of inquiry. In discovery learning, students are able to choose questions or topics and teachers are required to follow the students' line of interest. Discovery learning is an ineffective way to teach content as well as skills (Kirschner & van Merriënboer, 2013). Without any knowledge of background information, it is challenging and overwhelming for students to arrive at a well-structured and well-researched question (Krischner et al., 2006). The lack of background knowledge students have on a topic often leads them down unproductive lines of questioning (Mayer, 2004), while the mass amounts of information can be overwhelming without guidance and feedback (Hardiman, Pollatsek, & Weil, 1986; Brown & Campione, 1994). In addition, having teachers consistently teaching "on their feet" is not feasible for the teaching profession given the limited time teachers already have to plan lessons and activities. It would be impossible for a teacher to be knowledgeable on every topic a student may have a question about without adequate planning and preparation. Finally, the lack of guidance or feedback offers no opportunity for students to progress. Students are poor judges of what they know and what they do not know (Yue, Castel,

Bjork, 2013). Thus, in order for any type of learning model to be effective, it must include feedback so that students can be aware of where they need to fine-tune their thinking (Hays, Kornell, & Bjork, 2010). Discovery learning lacks the structure and guidance that allows inquiry-based learning to be successful, and thus lacks its effectiveness.

Within the body of literature on inquiry-based learning, a sub-section of literature concerns itself with the effectiveness of inquiry-based learning in comparison to other models of learning. Comparative studies tend to pit direct instruction against inquiry-based learning (e.g., Khlar & Nigam, 2004; Kirschner et al., 2006; Norman & Schmidt, 2016; Oguz-unver & Arabacıoğlu, 2014; Palmer, 2002). Almost invariably, studies that provide evidence *against* inquiry-based learning have incorrectly lumped together inquiry-based learning and discovery learning. Lumping together inquiry with discovery learning provides an invalid argument against inquiry-based learning since inquiry and discovery are vastly different. Studies that have compared *true* inquiry-based learning with direct instruction have found notable benefits to student knowledge retention, problem-solving skills, and transfer of learning. Of course, inquiry's potential benefits can be lost if its implementation is incorrect.

**Inquiry-Based Learning in Practice**

Although educators often concern themselves with finding the "best" teaching practices, decades of research have made it clear that no single practice is most effective (Watt & Coyler, 2014). Rather, a good instructional program is one that combines different practices to create a rich instructional model that is designed based on an understanding of how students learn (Watt & Coyler, 2014; Kischner et al., 2006). Even with inquiry-based learning, it is essential to

combine practices to yield optimal results. Effective inquiry-based learning consists of six key characteristics: **prior content knowledge**/instruction (Shwartz & Bransford, 1998; Watt & Coyler, 2014), **driving questions** (Watt & Coyler, 2014), **scaffolding** (Hmelo-Silver et al., 2007), **modelling** (Hmelo-Silver et al., 2007), and **formative assessment, and consistent feedback (**Hmelo-Silver & Barrows, 2006; Watt & Coyler, 2014). These characteristics, although necessary, are not sufficient to implement effective inquiry. Other characteristics include (but are not limited to) creating a culture where exploration and failure are normalized (Kapur, 2012) and situating the task or question in realistic problems of the field (Chinn & Malhotra, 2002).

**Background knowledge.** Although inquiry-based learning provides the opportunity to learn content knowledge, some background knowledge is required in order to initiate the inquiry process (i.e, formulating questions) (Shwartz & Bransford, 1998; Watt & Coyler, 2014). In fact, open-ended problems and questions only lead to learning gains when learners have sufficient domain knowledge with which to generate new knowledge (Shwartz and Bransford, 1998). Intuitively, background knowledge must be at the forefront of inquiry because learners cannot inquire about something they do not know (Shwartz and Bransford, 1998). For example, it is challenging, if not impossible, to formulate questions about racial injustice in the Canadian judicial system if you have no knowledge about racial injustice or Canada's judicial system. It is often assumed that inquiry requires an abandonment of other effective teaching strategies, such as direct instruction. On the contrary, inquiry-based learning *should* include other teaching strategies because inquiry-based learning is not one single strategy, but simply a model that relies mainly on inquiry for learning (Hmelo-Silver et al., 2007; Watt & Coyler, 2014). The Ontario

Ministry of Education's Capacity Building Series document on inquiry-based learning (2013), emphasizes that a teacher must recognize when to use direct instruction and when to initiate inquiry (Shwartz & Brandford, 1998). Not every learning opportunity is an opportunity for inquiry. Students will still require an understanding of major concepts before engaging in inquiry. Thus, teacher-directed instruction is necessary to build a foundation for inquiry to take place (Watt & Coyler, 2014).

**Driving questions.** Formulating a question is the first step to initiating the inquiry process, meaning that a poor question can push the inquiry cycle to fall apart or fail to move forward before it begins. A powerful inquiry question is focused on important ideas within and sometimes across disciplines, is open-ended with possible answers changing over time and through discussion, requires justification, and invites students to reconsider how they have thought about an idea previously (McTighe & Wiggins, 2013; Watt & Coyler, 2014). Effective inquiry questions ensure that students cannot answer them through recall of content, but must connect ideas. Effective questions also encourage students to think critically about learned content or about missing information needed to answer the question (Watt & Coyler, 2014). Although driving questions are often broad and open-ended, there is room for more focused questions. The following example demonstrates an appropriate inquiry question in a civics course: an orienting question could be "How should governments work?", followed by questions such as "Should our government be more democratic?", and "Should our government do more or less?" Questions like these naturally bring up civics curriculum content: how governments work, how different values affect government, how government affects our lives, Aboriginal self-government, electoral system, how to decide whom to vote for, and ways to influence

government (Watt & Coyler, 2014). Overly broad questions may be too difficult for students to break down themselves and may need a scaffolded approach, answering sub-questions until a justified answer for the broad question can be developed.

**Scaffolding.** Scaffolding breaks down an overwhelming task into smaller, more manageable tasks or questions. Scaffolding in inquiry allows learners to engage in complex questions that they may not be able to tackle traditionally (Hmelo-Silver et al., 2007). By breaking down complex tasks into smaller, more manageable pieces, students can focus on each distinct piece they need to complete for the broader, more complex problem (Hmelo-Silver et al., 2007; Holmes, Day, Park, Bonn, & Roll, 2014; Rogoff, 1990). By allowing students to focus on smaller parts of a large task, students are able to see where problems arise in their work (Reiser, 2004), giving them time to reflect and re-evaluate their strategies or direction. Scaffolding is a testament to the guidance and structure involved in inquiry; it would be unfeasible to expect a class to engage in inquiry without scaffolding the inquiry process several times before they might be able to do it independently. Effective scaffolding requires an understanding of a common goal, ongoing diagnosis, dynamic and adaptive support, dialogues and interactions, and finally the fading and transfer of responsibility (Puntambekar & Kolodner, 2005). Ideally, teachers will guide and scaffold complex tasks until students are able to break down the task into their basic elements on their own. Thus, teachers play a crucial role in guiding, engaging, modelling, and re-directing student thinking (Hmelo-Silver & Barrows, 2006). Although students may not always reach self-directed inquiry and it is not necessary to make self-directed inquiry the goal of a specific course, it is helpful to model scaffolding so that students are aware of how and when to scaffold problems (Watt & Coyler (2014). By scaffolding, teachers can also model how complex

problems are solved in outside of schooling. Experts break down complex questions and tasks into subcategories, identifying what sources and kinds of information are needed to work on each subcategory.

**Modeling.** Modelling explicitly shows students what is expected of them. Again, the role of the teacher in inquiry is paramount, specifically for modelling. When teachers model the questions, thinking, process, and connection involved in inquiry, students should become aware of the kinds of questions they should be asking themselves, the thinking they should be doing, the process it will take to bring complete a task, and the kinds of connections that are expected of them (Hmelo-Silver et al., 2007). These steps, although intuitive to most domain experts (biologists, historians, geographers), are not intuitive to students, making modelling a critical component of teaching students how to engage in inquiry.

**Feedback.** Feedback plays a critical role in learning (Larsen, Butler, & Roediger, 2008). Because inquiry is an iterative process, it requires teachers to constantly assess where students are in their learning and where they need to go to the next iteration (Watt & Coyler, 2014). It is important to acknowledge the difference between assessment and evaluation; assessment is evidence gathered of student learning with a purpose to improve teaching and learning. Conversely, evaluation is a judgment on the quality of student learning at the end of a learning cycle (Watt & Coyler, 2014). Constant assessment in the case of inquiry does not mean formal assessment. For example, a teacher can assess gaps in student understanding based on the questions students ask, the line of thinking they develop, a conversation they have with a student or an observation they make during group work (Watt & Coyler, 2014). In IBL, questioning students can often be a source of assessment and an opportunity to provide students with

feedback to help guide them. Asking students questions about their thinking pushes them to organize, communicate, and justify their thinking and pushes them to recognize the limits of their own knowledge (Hmelo-Silver & Barrows, 2006). Feedback is considered effective when it is focused on a learning goal, causes thinking, and gives the leaner actionable information (Watt & Coyler, 2014). The teacher's role in giving feedback is to continue to push students to the limits of their knowledge and task so that they meet the highest possible criteria for evaluation.

**Why Inquiry?**

Several challenges face our current education system, which has created a window of opportunity to use a model of learning that addresses these problems. For example, the changing workforce, the changing needs of 21st century education, the growing use of and access to technology, and new findings in cognition and learning science that contradict traditional approaches to learning. Inquiry-based learning addresses these challenges.

**Changing workforce.** Changes in the workforce have trickled into education, raising questions about whether or not the purpose of education and the models we use for schooling adequately prepare students for the 21st century (Barron & Darling-Hammond, 2008; Growe, 2011). In the 1900s, jobs did not require a high level of skill and only required employees to follow simple procedures (Barron & Darling-Hammond, 2008). As more tasks become automated, jobs must require a higher level of skill as well as varied competencies. Employees today are required to collaborate, communicate, and use multidisciplinary thinking to solve novel problems and accomplish tasks. This shift in the nature of work has changed the economy from an industrial-based economy to a knowledge-based economy (Scardamalia & Bereiter, 2006). A

knowledge-based economy or society can only be sustained by knowledge creation and discovery (Scardamalia & Bereiter, 2006). Traditional education practice— focused on knowledge transmission—will not adequately prepare students for a society dependent on their ability to create new knowledge (Scardamalia & Bereiter, 2006). The realization that transmission-based learning will not be helpful in preparing students, calls the entire purpose and model of education into question (Growe, 2011). Preparing students for the 21st century requires the Ministry of Education, school boards, administration, and educators to re-design the fundamental model of schooling. By teaching students to learn how to learn, IBL enables students to be prepared in diverse contexts and to troubleshoot problems they may not have experienced before.

**Traditional approaches to education are no longer effective.** Given that the world has changed and continues to change, it is assumed that education has changed with it. Much of education, however, has not changed in decades (Benham Tye, 1989). With the exception of smart boards instead of blackboards, walking into a [highs chool] classroom today would not be different from walking into a class in 1980: the teacher still stands at the front of the class, desks are still configured to face one direction, and students are likely required to copy notes from the blackboard (Benham Tye, 1989). Even more, facts, dates, and memorized pockets of knowledge are still the primary currency of learning (Brown et al., 1989; Friesen and Scott, 2013; Growe, 2011). This same-ness across decades is a result of the underlying beliefs and assumptions about knowledge. Perkins (2009) illustrated how students tend to learn in one of two ways: students learned the basic elements of something first in hopes of solving complex problems later, or students learned *about* something rather than learning to *do* something. In the prior scenario

(where students learn basic elements first), students learn knowledge in isolated pieces, devoid of context, often without getting the chance to strengthen their ability to use the knowledge to solve complex problems (Friesen & Scott, 2013; Perkins, 2009). Learning basic elements first, although intuitive, is flawed. For example, in a history class, students are taught often taught history in fragmented pieces through names, dates, and events, under the assumption that they will somehow be able to assemble, organize, and connect historical events to provide a comprehensive understanding and linear timeline of history and the present. In the second scenario (where students learn about something rather than how to do something), the logical jump from what is taught to what is expected to be learned is also flawed (Perkins, 2009).

These assumptions about how students should be taught and the nature of knowledge has persisted through attempts at reform, which have lead to the failure or "fizzling out" of most reform attempts (Friesen & Scott, 2013). Unfortunately, these assumptions were never based on evidence. Instead, emerging evidence on how to optimize learning suggests that knowledge is not inert and isolated, but rather adapts and is completely situated in context (Friesen and Scott, etc etc). When students learn information that is de-contextualized and separate from relevant topics it becomes more challenging to recall later on (Davis, Sumara, & Luce-Kapler, 2000, 2008).

**Cognition and the nature of knowledge.** Taking this research further would suggest that students may learn better when knowledge is meaningful, connected to something they already know, or is thought about deeply. A seminal experiment in cognitive psychology by Craik and Tulvig (1975) explored how different levels of processing information affected how that information was recalled later on. Participants were given a list of words and tasked with one of three tasks: identify words that start with a capital, identify words that rhyme with a cue word, or

identify whether or not each word fit into a specific sentence. Participants were later tested on the words; those who were asked to identify whether a word fits into a sentence remembered the most amount of words. Thinking about whether or not a word fits into a sentence requires that you think about the words itself, what does it *mean*. Thinking about the meaning of the information you are receiving and how it fits into other information you already know is called deep processing. On the other hand, shallow level processing only requires a surface level of understanding, such as identifying capital letters in words. These findings suggest that thinking deeply about the meaning of new information and being able to connect it to what you already know may facilitate learning. There are ways to facilitate recall even further: making more connections between information creates a better chance of the information being recalled when needed (Reisberg, 2013). What cognitive psychologists have known for decades about deep and shallow processing, is what education is starting to call 'deeper learning'. That is, making connections, thinking about the meaning of those connections, and creating more connections to other pieces of information to create a rich network of connected ideas—or a schema.

Inquiry-based learning addresses the shortcoming of the traditional model of education and is aligned with research on deep learning and the nature of knowledge. Given that deep learning is a priority for 21st century education, in addition to 21st Century competencies, inquiry-based learning has potential in driving 21st century learning forward to meet the needs of the knowledge-based economy.

**Re-designing the fundamental model: 21st Century Education.** The world is facing challenging problems: climate change, health inequalities, food insecurity, wealth disparity, job insecurity, and inconsistent economic growth (People for Education, 2016). The need to prepare

students to work on the world's developing problems has given rise to 21st Century education, which aims to make education more relevant for students by preparing them for the 21st century. According to the Ontario Ministry of Education (2014),

> many international thought leaders and business leaders—and many young people, too —are increasingly asking education systems to prepare students with "21st century" competencies that will enable them to face complex challenges now and in the future. These competencies—knowledge, skills, and attributes that help children and youth to reach their full potential—are additional to the important foundational skills of literacy and mathematics, and to the core learning in other subjects. (p. 5)

Just as jobs no longer only require employees to acquire knowledge and procedures, our model of education should be teaching students more than knowledge and procedures (Pellegrino & Hilton, 2012). Business leaders have recommended that schools focus on teaching skills that are in high demand: problem-solving, critical thinking, communication, collaboration, creativity, and innovation (Barron & Darling-Hammond, 2008; Goldman & Pellegrino, 2015; Growe, 2011; Ananiadou & Claro, 2009; Bellanca, 2014; Pellegrino & Hilton, 2012). Twenty-first century education emphasizes using intentional curriculum design and pedagogy changes to create opportunities for students to develop 21st century skills (Ontario Public Service, 2016).

Ontario has outlined four overarching goals for education: achieving excellence in students' academic performance, ensuring equity, promoting well-being, and enhancing public confidence. Twenty-first century learning falls under the achieving excellence goal. Ontario's rationale for focussing on 21st century learning rests on three main reasons: changes in the workforce from an industrial economic model to a globalized knowledge model, evidence on how to optimize and promote deeper learning, and students demanding their education become more connected and relevant to today's world (Ontario Public Service, 2016, p. 6).

Twenty-first century competencies are not new concepts, it has always been necessary for students to be competent problem solvers, critical thinkers, creators, and innovators. What has changed is the nature of these competencies, not the actual competencies themselves. It is no longer satisfactory to be able to communicate and collaborate effectively with a team of 12 people sitting at the same table as you. Instead, a knowledge-based economy requires effective collaboration and communications with dozens of people, often on the opposite side of the globe (Growe, 2011). Technology has changed the nature of competencies.

Technology and globalization have broken down the barriers to knowledge, releasing it from the exclusivity of experts and into the hands of anyone with an internet connection, which is seemingly in line with 21st century education. Unfortunately, the use of technology in schools has been restricted to automating traditional methods of teaching: reading conventional material on a computer, using a smart board to present videos, learning management systems using drills and study sheets, and one-to-one devices as a delivery method for traditional instruction (Dede, 2014).

**Challenges with the Literature on Inquiry-Based Learning**

Research on inquiry-based learning is scattered and polarized. Researchers tend to study inquiry using different measures and outcomes, making it difficult to definitively state benefits or drawbacks of inquiry. For example, some researchers measure the effectiveness of inquiry through students' knowledge after a learning cycle (Abdi, 2014; Minner, et al., 2010; Opara, 2011), while other studies measure student confidence (Shepherd, 1998; Gormally, Brickman, Hallar & Armstrong, 2009), classroom grades (Palmer, 2002), student motivation (Bayram,

Oskay, Erdem, Ozgur, & Sen, 2013), student engagement (Jang, Reeve, & Deci, 2010), critical thinking (Azizmalayeri et al., 2012), interest, and attitudes (Opara, 2011; Wolf & Fraser, 2007). Further scattering the literature is the amalgamation of studies on constructivist models such as IBL, PBL, and PrBl. Literature reviews use evidence from all three models to support the implementation and popularity of all constructivist-based models, making it difficult to parse benefits of a single model apart from the others. Even more, PBL, PrBL, and IBL employ similar strategies, making it difficult to categorize a teacher's constructivist practice as one model over another. Most reviews of PBL, PrBL, and IBL make the implicit assumption that if one model elicits benefits, the rest will too since their underlying theory of action is identical: engage students in learning autonomy while providing guidance and structure (e.g., Barron & Darling-Hammond, 2008). Unfortunately, since the theory of action is implemented differently in each model, it would not be accurate to assume that the benefits from one model extend to all constructivist models in every context.

The literature is polarized, most notably, because several reviews measure the effectiveness of inquiry by comparing it to direct instruction (DI) (e.g., Kirschner et al., 2006; Khlar & Nigam, 2004; Mayer, 2004; Moreno, 2004). Studies that compare DI with minimally guided instruction assume inquiry and direct instruction are polar opposite strategies when they can and should both be used together at their appropriate times (Shwartz & Bransford, 1998). Further muddling the inquiry literature, studies comparing DI and inquiry often tuck inquiry-based learning under the guise of minimally guided instruction, assuming inquiry, problem-based learning, and discovery learning all fall under the same category of 'minimally guided instruction', (e.g., Kirschner et al., 2006; Khlar & Nigam, 2004; Mayer, 2004; Moreno, 2004). It

would be incorrect to categorize inquiry as ‘minimally guided’ because inquiry is scaffolded, modelling, requires guidance, and includes direct instruction (for a critical review on why inquiry, PBL and PrBl are not ‘minimally guided’, see Hmelo-Silver et al., 2006).

Because inquiry is rooted in the scientific method, much of the studies on inquiry-based learning take place in science courses (e.g., Geier et al., 2008; Gormally et al., 2009; Khlar & Nigam, 2004; McNew-Birren & van den Kieboom, 2017; Minner et al., 2010). Science education studies tend to measure outcomes specific to science, such as science literacy and research skills (Gormally et al., 2009; Shwartz & Bransford, 1998). Measuring outcomes in terms of science curriculum expectations make it difficult to generalize the benefits of inquiry in subjects outside of science.

A limitation to the inquiry literature base is a lack of evidence about the benefits of inquiry. Published articles often cite the same research as evidence of learning benefits. Following the train of references, however, tells a different story. For example, in their practical guidebook on inquiry-based learning, Watt and Coyler (2014) answer “why is inquiry-based learning effective?” by stating its positive learning outcomes and citing Vajoczki, Watt, Vine, and Liao (2011). Vajoczki et al. (2011), however, conducted a document analysis of undergraduate course syllabi to identify how inquiry is used and when without actually claiming any learning benefits. Similar to Watt and Coyler (2014), Vajoczki et al. (2011) also introduce inquiry as a method that provides positive learning outcomes (p. 2):

> Research has demonstrated that the positive learning outcomes of Inquiry skill development include critical thinking, the ability to undertake independent inquiry, and responsibility for their own learning, intellectual growth, and maturity (Kuhn et al. 2000; Kinkead, 2003; Kirschner et al. 2006).

The three papers cited in this quotation do not provide any evidence of learning benefits as a result of inquiry-based learning. Kuhn et al. (2000) writes a theory about how epistemological understanding develops, not referencing inquiry-based learning whatsoever. Kinkead (2003) writes a case-study about undergraduate research in chemistry, and although she identifies learning benefits from conducting undergraduate research, the claims should not extend to inquiry-based learning since conducting an individual research project and inquiry-based learning in classrooms are not the same. Kirshner et al. (2006) actually argue against the use of inquiry, discussing reasons why inquiry should not be used and why direct instruction is a more effective approach. The incorrect referencing of studies to argue for the use of inquiry is a trend in the inquiry literature. By incorrectly referencing learning benefits, researchers perpetuate an idea that is weak at best, and nonexistent at worst.

In summary, the issues that exist within the literature base on inquiry-based learning make it difficult to confidently advocate or deny the use of inquiry. Addressing benefits and drawbacks of inquiry-based learning is a challenge because researchers measure inquiry using different outcomes, inaccurately categorize inquiry as minimally guided, have not applied inquiry-based learning to subjects outside of science courses, inaccurately cite evidence, and use questionable methodology.

Given the challenges in an unclear body of literature, the present literature review will focus on select areas of literature on inquiry-based learning, supported by evidence from PBL and PrBL. Specifically, this review will analyze why the inquiry movement has gained traction, discuss learning outcomes related to inquiry, and dissect prevalent arguments against the use of inquiry.

## Learning Outcomes

**Inquiry-based learning and academic achievement.** The literature on inquiry and academic achievement is less clear than the literature on PBL. Taking a closer look at studies that compare only inquiry to traditional instruction, there is some evidence suggesting inquiry produces the same and sometimes better test performance than traditional instruction. In a study on first-year university biology students, Gormally and colleagues (2009) measured science literacy, scientific process, and self-efficacy in IBL and non-IBL classes. Students in the IBL condition performed significantly better on the science literacy assessment (interpreting meaning from popular reports) and the scientific process assessment (identifying variables, interpreting data, designing an experiment, and constructing a graph given data). Based on the descriptions of the assessments, students were tested on both content knowledge and application based skills. Interestingly, students in the traditional instruction condition gained more confidence in their scientific abilities, leading the research team to conclude that traditional instruction may inflate students' sense of confidence in what they know.

In a review exploring student knowledge and student retention of knowledge in science, Minner and colleagues (2010) concluded that between the years of 1984-2002, studies favoured the implementation of inquiry-based learning in science classes. Using a validated survey and test, findings revealed inquiry-learning in science classes increased student cohesiveness but did not produce statistically significant measures on declarative knowledge (i.e., facts, formulas, information). Through qualitative interviews, Minner et al. (2010) found that activities that engaged student thinking and emphasized drawing conclusions from data increased students' conceptual knowledge of science. Unfortunately, because this review focused on science

concepts and curriculum expectations, it can only be assumed but not confirmed that the same effects would be seen across disciplines.

In the context of urban reform, Geier et al. (2007) found that students in inquiry-based sciences classes performed better than students in traditional sciences classes on state-wide standardized testing in both science content and processes. Even more, inquiry-based learning seemed to close the achievement gap for African-Americas boys, allowing them to perform equal to their female peers. Geier et al. (2007), emphasizing that the inquiry-based learning in this study was highly specified to the population, aligned with professional development, and was heavily supported by the administration. These results illustrate the importance of teacher capacity and administrative support in effectively incorporating inquiry.

As mentioned, evidence of problem-based learning is often cited as valid evidence for inquiry-based learning, since their underlying theories are similar. Although PBL has been studied more extensively, evidence from PBL paints a similar, unclear picture. On measures of factual knowledge and clinical knowledge, PBL and traditional instruction students performed the same. PBL students, however, performed significantly better on clinical performance measures and reported more positive attitudes and opinions about their program (Vernon & Blake, 1993). These findings generally support the use of PBL in medical education, with the addition of improvement in faculty and student attitude, student mood, class attendance, and humanism all increase with the use of PBL (Vernon & Blake, 1993). In post-secondary education, Dochy et al. (2003) find that across science-based subjects (Physiology, Anatomy, Medicine, Biochemistry, Pharmacology, etc), students in PBL classes perform better on skills-based assessment (i.e., application of knowledge) than knowledge-based assessments. However,

the decrease in knowledge seems to be moderated by expertise level: students with more expertise (measured by year level) do not show a decrease in knowledge compared to students in traditional learning environments. Interestingly, even when PBL students demonstrate less knowledge, they retain that knowledge for longer periods of time than do their traditional counterparts.

Even with the recorded benefits in knowledge application, there have been criticisms of PBL; arguing its popularity is unwarranted, given the lack of evidence that PBL is better than conventional instruction (Colliver, 2000). If PBL was as beneficial as claimed, it would allow students to perform better than traditionally taught student on every measure, including factual knowledge (Colliver, 2000). Even pioneers in PBL who have advocated for its use in medical education have recognized that the evidence on the benefits of PBL does not warrant its exponential popularity (Norman & Schmidt, 2016). Instead of blaming the underlying theory of PBL as being ineffective (e.g., Colliver, 2000), Norman & Schmidt (2016) argue the measurement of PBL is the faulty piece of the PBL equation. They argue that treating PBL studies—and likewise inquiry-based learning studies—as randomized controlled trials is a poor way of measuring curriculum-level interventions such as PBL and IBL. Education is too complex and riddled with confounding variables to attempt to isolate and measure single variables (Norman & Schmidt, 2016). Given the multiple caveats in the literature on IBL and PBL, it seems reasonable to conduct more, methodologically appropriate research before promoting IBL as a revolutionary model of learning.

Although inquiry has not been studied extensively regarding its effects on declarative knowledge, and studies that have been completed report no clear benefits, it is important to note

that if factual knowledge is the sole goal of education, inquiry-based learning is not likely to be effective because IBL targets more than declarative knowledge.

**Inquiry-based learning and 21st century competencies.** The scattered nature of literature on inquiry-based learning outcomes make it difficult to definitively explain which competencies inquiry-based learning enforces, and which aspects of inquiry lead to their development. Although inquiry is assumed to help students develop competencies and skills, there is little evidence that it does (Sandoval, 2005). In general, IBL, PBL, and PrBL have shown increases in attitudes towards learning, work habits, and self esteem (Tretten and Zachariou, 1995); flexible mathematical knowledge and engagement in thought exploration (Graves, 1998); improvements in articulating thoughts and ideas (Hmelo, 1998); and gains in conceptual understanding (Williams, Hemstreet, Liu, & Smith, 1998). Studies have focused most, however, on self-regulated learning, critical thinking, logical thinking, and problem-solving.

***Self-regulated learning.*** Self-regulated learning is a critical skill required for life-long learning and success in the workplace (Scardemalia & Bereiter, 2006; Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009; Zimmerman & Martinez-Pons, 1986; 21st Century Competencies, 2016). In a study exploring whether autonomous support or structure in an instructional model lead to self-directed learning, Sierens et al. (2009) found that structure predicted self-directed learning behaviours in students. Interestingly, this was only the case in moderate and high autonomous support conditions. Sierens et al. (2009). Given the effectiveness of modelling in inquiry, it is no surprise that providing structure in inquiry models how students should approach complex problems, thus leading to the development of self-regulation.

***Critical thinking.*** One of the main purposes of inquiry-based learning is to explicitly teach skills like critical thinking. Fortunately, IBL accomplishes this by asking deep, open-ended questions. In an inquiry-based intervention study, Azizmalayeri et al. (2012) found that guided inquiry significantly increased student critical thinking in high school. Critical thinking was measured through the Watson-Glaser test which uses five subscales: deduction, inference, recognition of assumptions, interpretation and, evaluation of arguments. Unfortunately, course subjects were not reported in the study so it is unclear in which subjects this study was conducted. Similarly, Shepherd (1998) found that over the course of a nine-week project, 4th and 5th grade students who were tasked with designing solutions to housing shortages performed better on a critical thinking test than students who did not complete the project.

***Articulating logical thinking.*** Students who learn through inquiry are better at articulating their ideas and logical thinking. A common strategy teachers use to guide and deepen inquiry is pushing students to further explain their thinking by asking questions (Watt & Coyler, 2014). Asking questions forces students to make their thinking visible (or rather audible), allowing them to practice reasoning by hearing themselves articulate ideas logically. Hearing their ideas out loud also allows students to hear the gaps in their thinking (Hmelo-Silver & Barrows, 2006). In another study, Chinn and Hung (2007) provided one group of students with a demonstration of two experts critically examining scientific methodology, discussing a study's advantages and disadvantages. Students who were given the modelled demonstration were able to reason and justify their arguments about scientific methodology better than those who received the same information without the models.

***Problem-solving.*** In a study on PBL and problem-solving skills, Gallagher, Stepien, and Rosenthal (1992) compared two groups of high school students taking a course called science, society, and future (SSF). Students were tested on six problem-solving steps: fact-finding, problem finding, brainstorming, solution finding, implementation, and evaluation. This study is cited as a seminal study providing evidence that PBL improves problem-solving. However, the results only support the notion that students in the PBL course increased their frequency of problem finding, and actually decreased their frequency of brainstorming. Even more, students in the study all attended a gifted school, and thus, these results are not likely generalizable. Ghallager et al. (1992) also found that students who were in the comparison group achieved higher SAT-Mathematics scores than students in the PBL group. Ghallagher et al. (1992) overlook this finding. Interestingly, Vernon and Blake (1993) found similar results that were also overlooked: medical students in a control group performed better on the National Board Medical Exam than their PBL counterparts. Both these studies provide evidence that PBL is not effective for national standardized testing, but neither studies discuss these results or comment on possible causes.

## Arguments Against Inquiry-Based Learning

**Direct instruction.** One of the biggest arguments *against* the use of inquiry-based learning and its relative instructional models (e.g., PBL), is the argument *for* direct instruction (Kirschner et al., 2006; ETC). Given the lack of robust evidence for inquiry, PBL, and PrBL, proponents of traditional, lecture-style instruction argue that the resources and effort required for inquiry provide the same outcomes as direct instruction, so the benefit is not worth the cost

(Colliver, 2000). Direct instruction is commonly seen as the polar opposite of inquiry-based learning in the literature (e.g., Kirschner et al., 2006). In practice, however, inquiry is a flexible model of instruction that *includes* direct instruction as one of many strategies. Since inquiry is often confused with minimally guided instruction, much of the arguments against the use of inquiry are actually directed at minimally guided instruction, and do not apply to inquiry. Nonetheless, they are valid arguments that call aspects of inquiry-based learning into question, and thus, will be discussed in relevance to inquiry-based learning (see Hmelo-Silver et al., 2006 for an in-depth commentary on why the arguments against minimally guided instruction do not apply to inquiry and PBL). In a controversial review titled *'why minimal guidance during instruction does not work',* Kirschner and colleagues (2006) outline several reasons why inquiry-based learning, discovery learning, problem-based learning, and similar models are not effective. In the months following the review's publication several researchers wrote commentaries responding to Kirschner and his colleagues criticizing the arguments made in the review, prompting the team to respond to the criticisms with their own commentary in 2007. Although Kirschner et al. (2006) believe that discovery learning, minimally guided instruction, inquiry-based learning, and problems based learning are all "pedagogically equivalent" (p. 75), they are not (Hmelo-Silver et al., 2006).

Inquiry is not unguided or minimally guided for the sole reason that it is heavily guided. The role of the teacher in the inquiry cycle is critical to the success of inquiry (Watt & Coyler, 2014). When beginning to use inquiry, students will be unfamiliar with the expectations and thinking being asked of them, thus, it is necessary to be explicit by modelling tasks from start to finish, as well as working with students in a cyclical nature (Pedaste et al., 2015) to guide them

to the expected outcomes using feedback (Watt & Coyler, 2014). Even more, literature and practical guides for teachers on inquiry are adamant about structuring inquiry so that students are able to navigate the process and fully engage in the tasks (Hmelo-Silver et al., 2006)). In a study comparing whether autonomy support (supporting student interest and learning decisions) or structure was more in important in engaging students in learning activities, Jang and colleagues (2010) found that both autonomy support *and* structure were required, and one without the other failed to predict student engagement. Thus, they conclude that autonomy support and structure are complementary to each other and not a dichotomy, a finding that contradicts the polarization of direct instruction and inquiry. Inquiry-based learning rests on a spectrum, with more 'teacher direction' on one end and 'more student autonomy' on the opposite end (Watt & Coyler, 2014). Thus, inquiry can be as structured or as autonomous as the learning requires.

**Cognitive architecture.** Inquiry-based learning has been argued to be ineffective because it does not lend itself to human cognitive architecture—or the way cognitive structures are organized and function (Krischner et al., 2006). Specifically, inquiry-based learning opposes working memory. Before information enters long-term memory, it must be processed by working memory. Working memory is a network of cognitive structures where information processing occurs (Reisberg, 2013). Incoming information from the world around us is consciously processed in working memory. Working memory allocated mental effort—or resources—to work current information being held in at the forefront of processing. Working memory does more than "holding" information though, it processes, understands, synthesizes, and encodes information, essentially 'working' on the information. When you pull information from the repository of long-term memory and begin to think about it or use it, you are conscious of that

information and thus, it is in working memory. Working memory, although multifaceted, has its limitations. When working on new information, working memory has a capacity limit, its resources become depleted and it cannot be replenished unless a break is taken. Requiring students to engage in inquiry when they are novice learners, then, seems counterintuitive. In inquiry, students are expected to process new information and problem solve all at once, which will drain cognitive resources quickly, resulting in a loss of focus or an inability to do the problem-solving required (Krischner et al., 2006). Instead, direct instruction seems to be more suited to the way we learn new information since it does not require learners to both hold the information and engage with it at the same time (Cronbach & Snow, 1977; Klahr & Nigam, 2004; Mayer, 2004; Shulman & Keisler, 1966; Sweller, 1999).

In fact, problem-solving is cognitively taxing. The overwhelming nature of problem-solving is precisely why guided instruction relies so heavily on scaffolding (Hmelo-Silver et al., 2006). Although the literature on inquiry-based learning fails to acknowledge limits in human cognition, the scaffolded nature of inquiry solves the problem of overloading working memory capacity (Hmelo-Silver et al., 2006). By breaking down complex problem-solving tasks into more manageable pieces, scaffolding transforms tasks beyond students' abilities into activities within their zone of proximal development (Hmelo-Silver et al., 2006; Vygotzky, 1978). Scaffolding allows students to engage and explore activities without being overwhelmed and confused with an abundance of new information and expectations.

**Expert thinkers.** One of the expected outcomes of integrating inquiry-based learning into a curriculum is that students will begin to think like experts, using the same tools and processes that geographers, historians, economists, and political scientists use. This expectation,

however, ignores what we know about the way novices and experts think (Goldman & Pellegrino, 2015). Although experts know more facts than novices, what differentiates an expert from a novice who knows a myriad of facts is the way experts organize knowledge into a conceptual framework or schema (Ericsson, Charness, Feltovich, & Hoffman, 2006). The way experts connect facts into elaborate frameworks allows them to transform a simple fact into "usable knowledge" (Goldman & Pellegrino, 2015, p. 35). Mental frameworks also allow experts to see patterns, identify missing information, and extrapolate relevant variables from problems that novices cannot. Individuals who learn information conceptually, rather than factually, are able to transfer that knowledge to novel situations more effectively (Schwartz, Bransford, & Sears, 2005). Goldman and Pellegrino (2015) eloquently summarize how conceptual learning makes future learning and problem-solving easier:

> Students who have learned geographical information for the Americas in a conceptual framework approach the task of learning the geography of another part of the globe with questions, ideas, and expectations that help guide acquisition of the new information. For example, understanding the geographical importance of the Mississippi River sets the stage for students' inquiry into the geographical importance of the Nile, the Rhine, or the Yangtze. Understanding why rivers are geographically important connects geography to other important systems of civilizations (e.g., economics, politics, social structures). (p. 35)

When conceptual frameworks become more elaborate, it allows experts to attend to specific aspects of a problem, expect outcomes, recognize violations of expectations, ask important questions, and make inferences about problems or new situations. The ability to transfer knowledge to new contexts seems seamless but is actually a complex cognitive process (Kulasegaram, 2013).

**The problem of transfer.** The key to an expert's ability to transfer knowledge from one situation to another is in the way their knowledge is constructed and organized in their mental

schema. One of the main tenets of inquiry-based learning is allowing students to develop the capacity to solve novel problems. Ideally, IBL would enable students to learn how to solve problems like an expert, recognizing important features, connecting previous experiences and knowledge, and using the correct tools to investigate and solve the problem. Unfortunately, the conceptual and theoretical frameworks on inquiry-based learning have failed to address or recognize the cognitive mechanisms involved in the transfer of learning, as well as other cognitive mechanisms in problem-solving.

The transfer of learning should be critical to any discussion on IBL because proponents of IBL posit that learning how to learn will prepare students for the 21st century, enabling them to solve a multitude of different kind of problems. To solve novel problems effectively, knowledge must be transferred from one problem, situation, or context, to another. Inquiry-based learning assumes that students are able to transfer knowledge between contexts if only they learn through inquiry. Embedded in this assumption, however, is an abundance of complex cognitive processes that have only begun to be understood in the last few decades.

The problem of transfer becomes apparent when we understand the effect of context on transfer. Problems consist of conceptual features and contextual features. A problem that is similar to the learned context but requires the same concept is a near transfer problem, whereas a problem that is sufficiently different contextually, is a far transfer problem (Blessing & Ross, 1996). It is more challenging for a learner to transfer knowledge to a novel problem when that problem is less similar (far transfer) to the context the knowledge was learned in (Dore, Brooks, Weaver, & Norman, 2012; Norman et al., 2007; Young, Brooks, & Norman, 2011). For example, if a student learns about exponents and exponential growth through examples of viral marketing,

a near transfer problem might consist of the exponential growth of the common cold. Here, the surface features of both problems are similar; the spreading of something across a population. In the case of near transfer, learners are able to recognize that the concept in both problems is exponential growth. A far transfer problem, however, might be related to the half-life of a radioactive chemical. In this far transfer example, the surface features of the question have departed from the familiarity of exponential growth, inhibiting students from recognizing that the concept is still exponential growth, but in reverse (exponential decay). If problems must be similar in order for students to recognize their conceptual features, students would need to learn every possible problem context in order to effectively solve problems (Campione, Shapiro, & Brown, 1995). This solution does not adequately meet the needs of 21st century education, because ideally, students should be able to solve problems they have *not* experienced yet.

Until the study of analogical reasoning between questions, cognitive psychologists believed that training students on every possible contextually similar problem were the best way to facilitate transfer (Godden & Baddeley, 1975; Gick & Holyoak,1980). Students could accomplish far transfer if they understood the analogical relationship, as well as the conceptual similarities between problems (Gick & Holyoak,1980). In analogical reasoning, students are explicitly prompted to recognize deep conceptual similarities rather than surface level similarities. The classical example is the 'tumour problem' (see Fig. 2).

Most participants were unable to solve this problem spontaneously. However, Gick and Holyoak (1980) explored the different conditions that allowed participants to solve the tumour problem. When participants received the 'fortress problem' (a conceptually similar but contextually dissimilar problems, see Fig. 2), before receiving the tumour problem, and explicitly

**Tumour problem (Gick & Holyoak, 1980)**

A doctor has a patient with a malignant tumour. The patient cannot be operated upon, but the doctor can use a particular type of ray to destroy the tumour. However, the ray will also destroy healthy tissue. At a lower intensity the rays would not damage the healthy tissue but would also not destroy the tumour. What can be done to destroy the tumour?

**Fortress problem (Gick & Holyoak, 1980)**

A general must capture a fortress. However, the most direct route that can accommodate all of his troops is mined heavily and an approach would cause too many casualties. The general decided to split his troops into smaller units and approached the fortress from multiple sides, thus capturing the fortress.

*Figure 2.* The Tumour problem and Fortress problem, adapted from (Gick & Holyoak, 1980).

told that one problem could help solve the other, participant rate of success at solving the tumour problem increased to 92% (Gick & Holyoak, 1980).

The analogy here is that the solution to both problems involves splitting a large amount of force into smaller parts. The solution to the tumour problem—if analogous to the fortress problem—is to use smaller doses of the ray from different positions in order to destroy the tumour. Interestingly, presenting the fortress problem before the tumour problem alone did not facilitate problem-solving for the tumour problem, it was the explicit cue that the concept from the fortress solution could be used for the tumour problem.

Inquiry-based learning advocates have assumed that knowledge will transfer to complex, 21st century problems if learned through inquiry, or if learned through other complex and realistic problems. No theoretical or practical framework for IBL, however, addresses the problem of transfer. In order for learners to problem solve like experts, not only must information be learned in a specific way to allow learners to organize information conceptually,

but they must also learn to reason problems analogically and without the distraction of surface-level features. Understanding transfer is vital to the success of problem-solving, and yet, the literature on inquiry learning does not dedicate any practical guides or frameworks for teachers to teach for the purpose of transfer.

**Methodology**

Finally, a major argument against the use of inquiry-based learning is its lack of controlled studies. Kirschner et al. (2006) argue that inquiry-based learning loses its track with many learning scientists because most of the studies on inquiry-based learning and other models are classroom-based, thus, not controlled. This argument, however, is weak because inquiry-based learning is meant to be implemented in classrooms. Studying inquiry in a controlled laboratory environment would not be valuable to the literature on inquiry because a controlled study would lose its validity and generalizability in a classroom. In a laboratory experiment, researchers have the ability to isolate variables and measure inquiry without the effects of peers, a teacher, a school, common classroom disruptions, and a classroom environment. Although scientifically rigorous, laboratory research is useless in a classroom because of the difference in context. In a classroom, disruptions exist, and unless inquiry-based learning is still effectiveness in a classroom setting, it is useless to isolate inquiry in a lab and study inquiry without the context of a classroom.

Unfortunately, classroom studies on inquiry-based learning and guided instruction can be poorly designed and analyzed. For example, in one 8 week study, Abdi (2014) compared two fifth grade classes' test performance on science content. One class was taught via inquiry while

the other was taught traditionally, or mainly by lecture. Students were given the 'Academic Achievement Test' as a pre-and post-test. Abdi (2014) concludes that students in the inquiry condition outperformed students in the traditional condition. Unfortunately, a critical examination of the methods and statistical analysis used in this study warrant the results to be questioned. In this particular study, the researchers used an ANCOVA to measure differences between groups. It is unclear why an ANCOVA was used, given that there were no covariates in the study. Further, Abidi (2014) did not report whether differences between groups were significant or not. Taking a more critical look at this study reveals another limitation: the academic achievement test that was distributed to students was not validated and the *same test* may have been delivered both before and after the intervention, which would incite a practice effect among students and confounding the results. Opara (2011) conducted a similar study in secondary school biology classes, concluding that inquiry-based learning was a better instructional strategy than traditional instruction after testing students using a textbook created test. Statistically, however, the results are questionable. Opara (2011) only used Z scores to explore performance means of traditional instruction compared to inquiry instruction, when a T-test should have been used.

A methodological limitation exists in any study that initiates an intervention. Namely, exposure to a new program or model of learning may lead students and teachers to feel more enthused, leading to better learning, or self-reports of increased learning (Thomas, 2000). It may be the case that the enthusiasm and increased motivation increases the amount of information learned rather than the intervention itself.

In summary, there is a clear controversy on the effectiveness and use of inquiry-based

learning. While some researchers argue that direct instruction is better suited for the way humans learn and process information, others have highlighted the lack of attention inquiry-based learning researchers have paid to the fundamental principles of transfer and problem-solving. In order for the literature on inquiry to maintain both its generalizability and rigour among the science community, particular attention must be paid to the design of classroom studies. Further, more research is needed to address challenges in inquiry that are still unclear.

**What is missing from the literature?**

Three main lines of research are clearly missing from the literature on inquiry-based learning: models of evaluating inquiry, teacher perceptions and use of inquiry, and students perceptions on inquiry. Since inquiry is a paradigm shift that requires students to think more deeply, it is unclear how deep thinking should be assessed. Even the Capacity Building Series (2013) (the most descriptive document on inquiry-based learning), does not include any details on how teachers can approach the assessment of inquiry. Ontario's own framework for assessment, evaluation, and reporting (Growing Success, 2010) does not include rubrics for evaluating inquiry, but rather embeds inquiry as a "skill" to be demonstrated (Table. 2). Even further, Growing Success only mentions inquiry one time in the entire document and only to clarify what is meant by thinking and investigation in the science rubric. Chinn and Malhotra (2002) developed a comprehensive theoretical framework for evaluating inquiry in science. They outline different types of inquiry tasks, what kinds of cognitive processing is required for each task as well as epistemological differences between inquiry tasks. Although comprehensive, the framework is heavily embedded in science and developing scientific experiments, which makes

generalizing to different disciplines difficult.

Teacher and student perceptions also remain almost unexplored in inquiry-based learning literature. Among university instructors, there seems to be a consensus about the value of inquiry, the role of instructors as facilitators, the benefit (but not necessity) of technology, and the challenges of facilitating inquiry in large class sizes (Vajocszki, Watt, & Vine, 2011). Among students, the only finding is an increased sense of classroom cohesion (Wolf & Fraser, 2008), and speculation that overcoming student resistance to inquiry remains a challenge for teachers (Gormally et al., 2009). Currently, it is not clear how teachers understand and implement inquiry in K-12 schools outside of science courses, as well as what kinds of challenges, and resistance they encounter in trying to integrate curriculum-mandated inquiry-based learning. This study seeks to understand how teachers understand and integrate inquiry in world studies classes, as well as their perceptions and challenges in integrating inquiry as a new model of learning in this Catholic school board in Southern Ontario.

**ACHIEVEMENT CHART – SCIENCE AND TECHNOLOGY, GRADES 1–8**

| Categories | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|
| **Knowledge and Understanding** – Subject-specific content acquired in each grade (knowledge), and the comprehension of its meaning and significance (understanding) | | | | |
| | The student: | | | |
| **Knowledge of content** *(e.g., facts; terminology; definitions; safe use of tools, equipment, and materials)* | demonstrates limited knowledge of content | demonstrates some knowledge of content | demonstrates considerable knowledge of content | demonstrates thorough knowledge of content |
| **Understanding of content** *(e.g., concepts, ideas, theories, principles, procedures, processes)* | demonstrates limited understanding of content | demonstrates some understanding of content | demonstrates considerable understanding of content | demonstrates thorough understanding of content |
| **Thinking and Investigation** – The use of critical and creative thinking skills and inquiry and problem-solving skills and/or processes | | | | |
| | The student: | | | |
| **Use of initiating and planning skills and strategies** *(e.g., formulating questions, identifying the problem, developing hypotheses, scheduling, selecting strategies and resources, developing plans)* | uses initiating and planning skills and strategies with limited effectiveness | uses initiating and planning skills and strategies with some effectiveness | uses initiating and planning skills and strategies with considerable effectiveness | uses initiating and planning skills and strategies with a high degree of effectiveness |
| **Use of processing skills and strategies** *(e.g., performing and recording, gathering evidence and data, observing, manipulating materials and using equipment safely, solving equations, proving)* | uses processing skills and strategies with limited effectiveness | uses processing skills and strategies with some effectiveness | uses processing skills and strategies with considerable effectiveness | uses processing skills and strategies with a high degree of effectiveness |
| **Use of critical/creative thinking processes, skills, and strategies** *(e.g., analysing, interpreting, problem solving, evaluating, forming and justifying conclusions on the basis of evidence)* | uses critical/ creative thinking processes, skills, and strategies with limited effectiveness | uses critical/ creative thinking processes, skills, and strategies with some effectiveness | uses critical/ creative thinking processes, skills, and strategies with considerable effectiveness | uses critical/ creative thinking processes, skills, and strategies with a high degree of effectiveness |
| **Communication** – The conveying of meaning through various forms | | | | |
| | The student: | | | |
| **Expression and organization of ideas and information** *(e.g., clear expression, logical organization)* **in oral, visual, and/or written forms** *(e.g., diagrams, models)* | expresses and organizes ideas and information with limited effectiveness | expresses and organizes ideas and information with some effectiveness | expresses and organizes ideas and information with considerable effectiveness | expresses and organizes ideas and information with a high degree of effectiveness |

*Table 2.* Science and Technology Achievement Chart from Growing Success (2010). Inquiry is used here as a skill to be demonstrated under "Thinking and Investigation", and not as a process in and of itself.

# Chapter 3: Conceptual Framework

The present study uses a developmental model of professional understanding and practice as a framework for analyzing data. In 2004, Dreyfus established a five-stage model of adult skill acquisition. In a critical review of the five-stage model, Dall'Alba & Sandberg (2006) suggest an alternative model, creating a two dimensional model of professional skill development: skill progression and embodied understanding of practice. More recently, McNew-Birren and van den Kieboom (2017) combined both frameworks to create the 'developmental model of professional practice framework', which they use to analyze the development of core teaching practices in inquiry-based science instruction. Similarly, the conceptual framework for the present study combines the foundation of the five-stage model with the dimensions of the professional development model to analyze teacher understanding and practice of inquiry-based learning in the Canadian and World Studies curriculum.

## Dreyfus' five-stage Model of Skill Acquisition

The five-stage model of skill acquisition proposed by Dreyfus (2004) outlines the stages learners go through when learning a new skill. This model is not specific to teaching or pedagogy, but has often been used and cited in order to frame the conversation on teacher professional development (McNew-Birren & van den Kieboom, 2017). The five stages of skill acquisition are: novice, advanced beginner, competent performer, proficient performer, and expert.

According to Dreyfus (2004), learning begins when an instructor teaches the basic building blocks of knowledge without context. Using a context-free environment to teach a novice can be helpful so that they are able to recognize features of the skill, without having developed the skill. Since novices have not yet developed the skill, they depend on learned rules, prescriptions, and salient features to drive their actions. Following simplistic rules, however, can be detrimental in real-world contexts. Learners require an understanding of the context where the information is being used, not just the information being used. For example, first-year medical students begin their education with the basics of anatomy, cell biology, genetics, immunology, and others, as separate and de-contextualized subjects. In the novice stage, their knowledge from each separate discipline lacks the understanding of how they are used in combination for patient care. A first-year medical student likely uses rules to solve questions and problems within each discipline.

In the advanced beginner stage, the learner has seen examples of the knowledge being used in context. As the novice experiences real situations, they begin to understand, and perhaps recognize the salient features of the context. A medical student enrolled in a clinical medicine course may experience combinations of the previously learned disciplines (cell biology, immunology, etc.) in the context of case studies, clinical reasoning, and small-group sessions. Thus, as an advanced beginner, the medical student will begin to identify symptoms of common illnesses.

In the third stage, competence, a learner has now faced more experiences and is able to identify important features and procedures. As the number of features they are able to identify increases, so does a sense of exhaustion. Learners can feel overwhelmed by the amount of

important information they must attend to in a situation. Thus, learners must make decisions about which elements require attention and which can be ignored. As the competent performer learns to make decisions about important and non-important features, decision-making becomes easier. As the learner takes responsibility for their decisions, they must understand that their decisions will not always be perfect, and can lead to failure. As a medical student starts their clinical rotations, they may become overwhelmed with the amount of information they must attend to. They often take advice from their teachers on what factors are the most important and must be attended to. As their own perspectives form, they begin to make these decisions on their own, sometimes failing and sometimes doing well.

As the learner becomes emotionally invested in their decisions (enjoying their correct decisions and feeling remorseful about mistakes), it becomes easier to depend on experience rather than set rules like the novice. As a proficient performer, the learner is able to automatically identify relevant features and establish goals but is not able to plan the steps to achieve those goals. The proficient performer has not received enough experience with the outcomes of responses and cannot predict which response will lead to which outcome. Thus, the proficient performer must still rely on set rules to decide on a response. In medical clerkships and internships, students may be able to identify relevant patient history, intake information, and symptoms, as well as the optimal end goal for the patient, but may be uncertain about which tests to run, drugs to prescribe, or referrals to make.

The expert, now experienced and immersed in professional practice or skill, is able to automatically identify goals as well as how to achieve them. An expert is also able to differentiate between situations that require subtly different courses of action. Residents, and

more likely physicians, are able to immediately and intuitively categorize situations and determine the appropriate the response using the same automatic intuition.

Theoretically, teachers move through the same five stages of skill acquisition. As teachers become more experienced and more immersed in their teaching, they come to understand their students, pedagogy, and student outcomes more intimately (McNew-Birren & van den Kieboom, 2017).

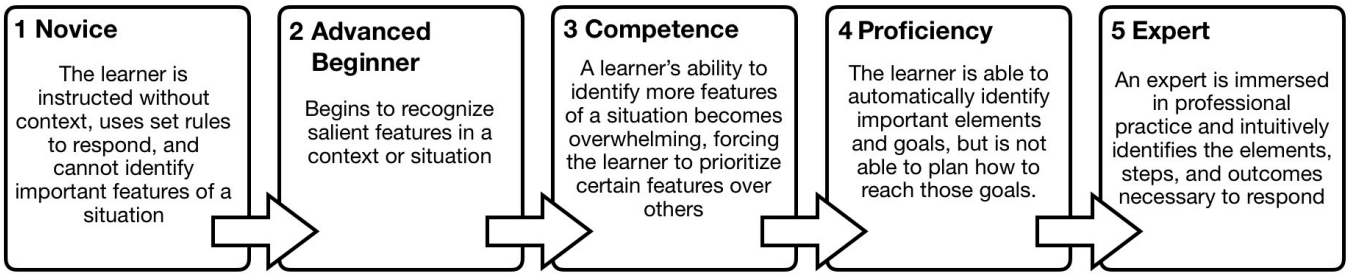


*Figure 3.* Stage model of professional practice development. Adapted from Dreyfus (2004).

**Dall'Alba & Sandberg's Dimensions of Professional Skill Development**

The five-stage model of skill acquisition, although comprehensive, assumes a fixed sequence of stages. Emphasizing stages fails to account for the skills being developed. Dall'Alba and Sandberg (2006) created a two-dimensional model to address the limitations of the five-stage (Fig. 4). Skill development refers to the "embeddedness within the situations encountered, which demands experience of those situations" (p. 29). Skill development manifests itself in several ways, depending on how the skill and practice are understood. This embodied an understanding of practice is the second dimension in this model. The particular way a skill or practice is carried out is highly dependent on how it is understood. A two dimensional model emphasizing embodied *understanding of practice*, and *carrying out the practice itself* allows for greater and

more realistic variance in learning trajectories. The dimensions of professional skill development account for professionals who may invest their time developing along one axis, without any progression along the other axis. For example, a teacher may invest their time gaining a better theoretical, conceptual, and epistemological underpinnings of inquiry, without improving their practice of inquiry in the classroom. Likewise, a teacher may practice inquiry daily and refine their practice, without gaining any new understanding of inquiry. Some teachers may even invest in both dimensions. This two-dimensional model facilitates the study of enactment of practice as a product of understanding of practice, and vice versa.

Ideally, teacher understanding and practice are constantly monitored so that professional development and learning may be adjusted accordingly (Dall'Alba & Sandberg, 2006; Guskey, 2002). Dall'Alba and Sandberg (2006) recommend questions central to the model: "How do participants understand the practice in question? What implications does this have for the issues that need to be addressed in the course and/or program?" (p. 33).

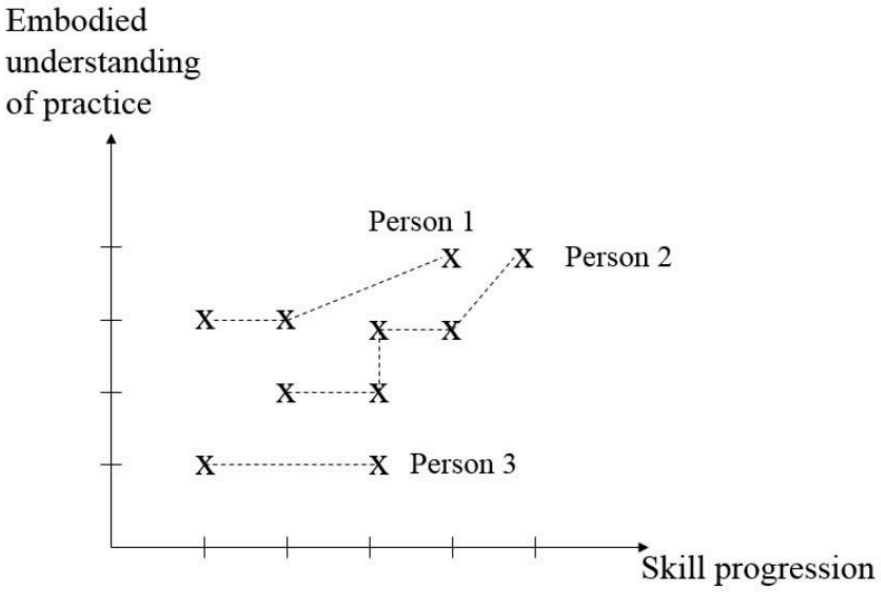


*Figure 4.* Model for development of professional skill with hypothetical developmental trajectories. Taken from Dall'Alba and Sandberg (2006).

**Conceptual Framework for the Present Study**

Combined, the two models discussed in this section form the basis of the conceptual framework used in this study. This research provides data on how teachers understand inquiry and how their understanding, in turn, impacts their practice. Given that the teachers in this study are novices in inquiry (except for Rosa, who initiated the workshops), the present study may be limited in how teachers understand and use inquiry. Thus, this study will focus on how teachers understand IBL and how their understanding impacts their practice as two dimensions of being a novice learner (see Fig. 5).

The present conceptual framework operationalizes e*mbodied understanding of IBL practice* as the ways in which teachers understand inquiry and inquiry-based learning with respect to practice (Dall'Alba & Sandberg, 2006). *Skill Progression* is operationalized as the ways in which teachers enact their understanding in their actual work (Borko, Davinroy, Bliem, & Cumbo, 2000; Borko, Mayfield, Marion, Flexer, & Cumbo, 1997).

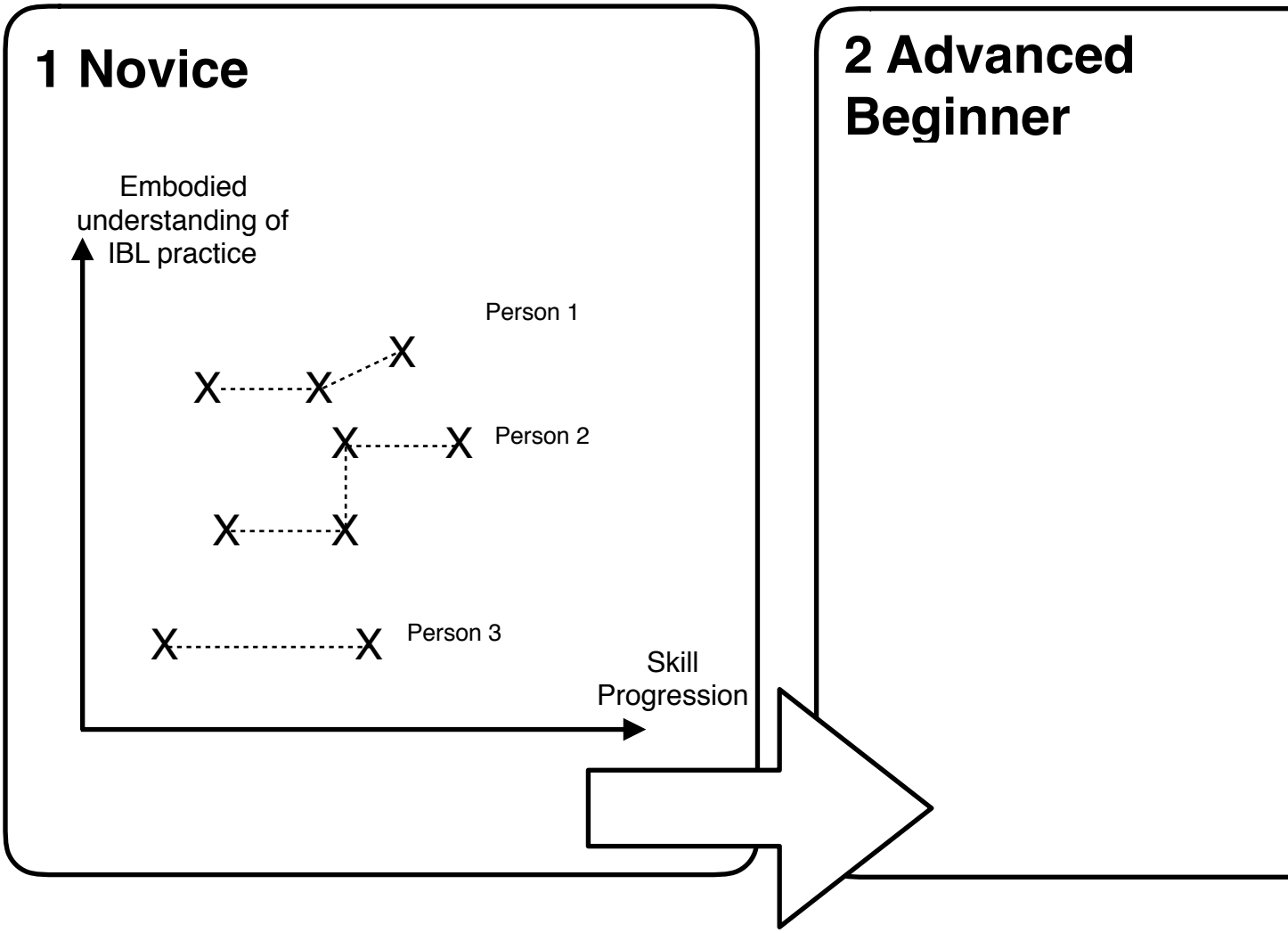


*Figure 5.* The present study uses Dall'Alba and Sandberg's (2006) two-dimensional model in the context of teachers being in the novice stage of development (Dreyfus, 2004). This figure illustrates hypothetical development trajectories.

# Chapter 4: Methods

The present study investigates a group of teachers partaking in a series of workshops on inquiry-based learning in Canadian and World Studies courses. According to Stake (1995), a case study focusses on a program, event, or activity involving individuals. More specifically, a case study is "a detailed examination of one setting, or a single subject, a single depository of documents, or one particular event" (Bogdan & Knopp Biklen, 2003, p. 54). A case study must also be contemporary and contextually specific (Yin, 2009). Since the addition of inquiry in CWS curriculum is recent in Ontario (2013 and 2015), and professional development training is specific to teachers in this Catholic school board in Southern Ontario who teach in CWS, this study is both contemporary and contextually specific, meeting the aforementioned requirements for a case study. Thus, the present study is an observational case study.

This particular case study follows a group of grade 9 and 10 History and Geography teachers taking part in a professional development workshop on inquiry-based learning in Canadian and World Studies. This study uses participant observation during the workshops but places more emphasis on data collected from interviews. The workshop was funded ($7,000) by the school board and had three short-term goals: increase teacher awareness and understanding of inquiry, increase understanding of why inquiry should be part of the instructional approach, and ensure inquiry is evident in lesson plans and task/assignment development. Long-term, the student achievement consultant hoped that two goals could be met: authentic integration of inquiry as an instructional approach in classroom instruction and planning, as well as increased capacity among staff in the CWS departments to use inquiry in their instruction.

## Ethical Considerations

This research study received ethical approval from the University of Toronto Research Ethics Board, as well as the Ethics Board belonging to the school board. In addition, principals from each school teachers taught at were informed (through a letter of information) and approved the study. After principals approved the study consent was obtained from teachers to take part in the study. Participants were notified of the study's purpose and their role in it. Each teacher received a letter of information and consent form that outlined issues of confidentiality, anonymity, risks, benefits, and the right to refuse participation at any time. In order to abide by ethical protocol, names have been changed to pseudonyms and any identifying information has been changed to retain individuals' anonymity without compromising the readers' understanding.

## Participants

There are seven high schools in the Catholic school board in Southern Ontario. Six of the seven high schools were represented by a teacher or a teacher librarian at the CWS inquiry workshops. The inquiry workshops consisted of seven teachers and five teacher librarians, totalling 12 individuals. All seven teachers gave their consent to be a part of the present study. Teacher librarians were not included in the interviews because they did not consent to taking part in the interview process. Since I received ethical approval from school board to conduct this research within the board, teacher librarians were included in overall workshop observations, but were never interviewed or referred to individually. Five of the teachers each taught at a different high school, while two teachers taught at the same school.

As a whole, this group of teachers varied in teaching experience but were all novices to

IBL (with the exception of Rosa). Some teachers were meeting for the first time, but many knew each other from previous school board events and in-service sessions. While most teachers seemed open to inquiry, it was clear that some were skeptical.

**Participant profiles.**

Gina teaches Gr. 9 Geography, as well as Gr. 11 Parenting and Gr. 12 Working with school-aged children and adolescents. Gina is a first-time teacher who was open and excited about IBL, learning how to engage students in higher level thinking, and trying new practices in the classroom.

Raymond teaches Gr. 9 Geography, as well as Gr. 11 and 12 Parenting, Environment, and Travel. Raymond has been a teacher for over 22 years but teaching specifically in CWS for 18 years. Overall, Raymond was skeptical that IBL is as promising a strategy as touted, but was willing to try new practices.

After teaching in the elementary school system for seven years, Amy became a high school teacher. Amy has been teaching Gr. 9 Geography for 12 years and Civics and Careers for approximately six years. Additionally, Amy teaches courses such as Integrated Technologies and Construction. Amy was highly skeptical of IBL and often questioned school board and ministry initiatives. Even still, Amy attempted to integrate IBL into her classes with an open, but cautious mind.

Rosa is a teacher and the CWS department head at her school. Rosa has taught Gr. 12 Genocide and Crimes against humanity for three years, Gr. 11 World History for 15 years, and Gr. 10 Canadian history for 20 years. She consistently uses IBL in her courses and has been an outspoken advocate for the use of inquiry in CWS. Rosa helped initiate the inquiry workshops

when she approached Madeline, a student achievement consultant at the school board. Rosa was aware that teachers are unsure and unaware of how to engage themselves and their students in inquiry and how it can be effective. Rosa brought her concerns and ideas to Madeline, who organized the inquiry workshops, invited teachers, and facilitated the workshops.

Adrian teaches academic, applied, and sometimes locally developed or ESL Gr. 10 Canadian History. Adrian has been teaching history for three years, but previously taught English for 11 years.

At the time of data collection, Charles taught Grade 11 and 12 Economics, Gr. 12 Law. In the previous term, however, he taught Gr. 9 Geography and Gr. 12 World Issues. Charles was reflective about his thoughts on inquiry and tended to highlight questions he was struggling with in his inquiry practice. Specifically, he was often concerned with the student experience and how well students are able to engage in inquiry. Charles often uses practices in his classes that align well with inquiry, such as modelling and questioning.

Jake teaches Gr. 9 Academic and Applied Geography and Gr. 12 World Issues. He has been teaching for four years. Overall, Jake was interested in learning about inquiry but often brought up concerns about student knowledge and lack of skills such as self-regulation.

**Motivation in attending.** After Rosa approached Madeline (the student achievement consultant) about creating a workshop series to help teachers engage in IBL in CWS, Madeline sent out emails to all secondary school principals and CWS department heads letting them know about the opportunity for professional development. The email asked (but did not mandate) department heads to share the opportunity with their colleagues. The email also specified that there were 12 spots available for this specific workshop. Interestingly, departments heads felt that they were

*required* to send a teacher (see chapter five for direct quotes). Although teachers were not technically forced to attend the IBL workshops, some teachers did feel forced. While Gina and Rosa were excited to attend the workshop, the rest of the teachers were asked to attend by their department heads, often expressing that "there was no one else to go" (Adrian, Charles, Raymond, Jake). Amy, however, was told that the workshop was about creating effective culminating assignments. She was surprised to find out it was about IBL but remained interested (but skeptical) because of the workshop focus on creating tasks, assignments, and activities.

## Data Collection and Analysis

**Interviews.** Teachers were interviewed using a semi-structured interview guide one to two weeks after each workshop. Thus, each teacher was interviewed twice between February and June. The first set of interview questions was created to build rapport with teachers, acquire demographic information, and gauge which stage of understanding and skill progression teachers were in after the first workshop. Theoretical sampling was used to create the subsequent interview questions. Theoretical sampling requires the researcher to seek specific data about categories that have risen from previous data in order to refine categories for an emerging theory (Charmaz, 2006). After the first round of interviews, data were coded in order to develop questions for the second round of interviews. Since interviews were audio recorded on an iPhone 7, they were first transcribed, imported into Quirkos, and then coded. Interviews were coded using Quirkos V. 5.1.2, a qualitative data analysis software that allows researchers to visually code text data into nodes. The interviews lasted between 15–60 minutes. Interview questions are included in Appendices C and D. Although each question was asked, the appendix does not

include a comprehensive list of questions asked. Due to the semi-structured nature of the interviews, teachers would often mention something that required further explanation. Thus, I probed teachers with follow up questions regarding their thoughts and reflections, following their line of thinking rather than my own. The main interview questions relied heavily on embodied understanding and skill progression (or practice), which are the main dimensions of the conceptual framework.

***Coding process.*** Data were coded in multiple stages and iterations. First, data were coded by key words and themes using open coding (Charmaz, 2006). I read each transcript multiple times and assigned chunks of each transcript to certain categories, or nodes. After open coding, I was left with broad categories of topics teachers had referred to in their interviews. Next, I conducted axial coding. Axial coding involves interrelating the categories developed from open coding (Creswell, 2007). In subsequent iterations, more nodes were created as they became relevant in more than one interview, while others were deleted or merged. In the end, 56 nodes were created (including sub-nodes). Sub-nodes are embedded as a sub-category under a main node. For example, a main mode included a node titled "challenges to doing inquiry", which encompassed the sub-nodes: system challenges, cognitive challenges, structural challenges, and student challenges. Finally, using selective coding, I selected categories that were most relevant to the research questions, conceptual framework, and goals of the research (Cresswell, 2007).

**Observation.**

During each workshop, field notes were taken, specifically noting conversation that occurred as a large group, or between smaller groups of teachers. I also sat in on small group discussion and planning time, noting the kinds of assignments and plans teachers were creating

for their classes. Field notes from workshop observations were coded using the same process that was used to code interviews. Themes that arose from the field notes were used to create probing questions for subsequent interviews. For example, during one workshop, an argument began about challenges of doing inquiry and how to overcome them, or even if overcoming them was possible. As such, an interview question asked about whether or not teachers felt effective inquiry was possible despite the numerous obstacles they discussed during the workshop.

**Timeline of Events**

On February 28th, 2018, the first workshop took place. This workshop was half a day, starting at 12:30 pm and ending at 3 pm. Workshop one was intended to introduce workshop participants to each other as well as introduce them to the idea of inquiry. At the end of the first workshop, teachers were given a letter of information and consent form to sign indicating their choice to participate in the study. The teachers who signed the consent form were contacted within the week to set up an interview date. All seven teachers who signed the consent form were interviewed within two weeks following the workshop. Interviews lasted between 10 minutes and 60 minutes. The second workshop took place on May 17th, after being postponed from April due to a snow day. Workshop two was a full day workshop, starting at 8:30 am and ending at 3 pm. The intention of this workshop was to develop inquiry-based lessons, tasks, and assignments to try out in class, bring back student work and reflections from the developed activities, and discuss them at a third and final workshop. However, the final workshop was cancelled due to a shortage of supply teachers at the end of the year. As such, the second workshop does not end with any concluding reflections. I attempted to capture final thoughts during the interviews that

followed workshop two, but since many teachers had not finished their school year, their reflections were more intermediate than concluding. This study focuses on the two workshops that occurred and the interviews following each workshop. After workshop two, all seven teachers were emailed to set up a time for the second interview. Teachers were interviewed within two weeks following the second workshop. Interviews lasted between 10 minutes and 60 minutes.

## Chapter 5: Data Presentation & Findings

This chapter is organized into an observation data section and interview data section. In each section, data are presented descriptively, followed by an analysis of the data. In this research, where teachers are being introduced to a new learning model it is important to capture teacher thoughts, perceptions, practices, and skepticisms accurately. For this reason, data is presented descriptively first, followed by my own analysis.

### Observation Data

**Workshop one. *Data*.** During the first workshop, each teacher received a copy of "IQ: A practical guide to inquiry-based learning" by Jennifer Watt and Jill Coyler. The workshops were heavily based on the guiding principles and examples in IQ. The student achievement consultant, Madeline, started the session by defining inquiry, why inquiry was important, and what it might look like in the classroom. Madeline used a powerpoint, as well as the IQ book to present information. Madeline also introduced questioning and the role of questioning in inquiry. At one point, when covering evaluation of inquiry-based learning, Amy brought up concerns about evaluating inquiry, a short but pointed discussion began. Amy seemed skeptical of inquiry and indicated that she was having trouble understanding how to evaluate students when there is "no right answer" in inquiry. Rosa responded with her own personal experience with inquiry: "I'm still using the same end product I've always used, I'm just changing the process or set up", further explaining that she is still assigning a research paper in history like she always has, but instead of giving students the thesis or argument, she requires them to learn about a topic on their

own and then come up with their own questions and thesis. Madeline shifted the workshop topic and introduced the See, Think, Wonder activity, hoping it might provide answers and context to


*Figure 6.* During the first workshop, teachers were asked to complete the See Think Wonder chart using this photo as an example.

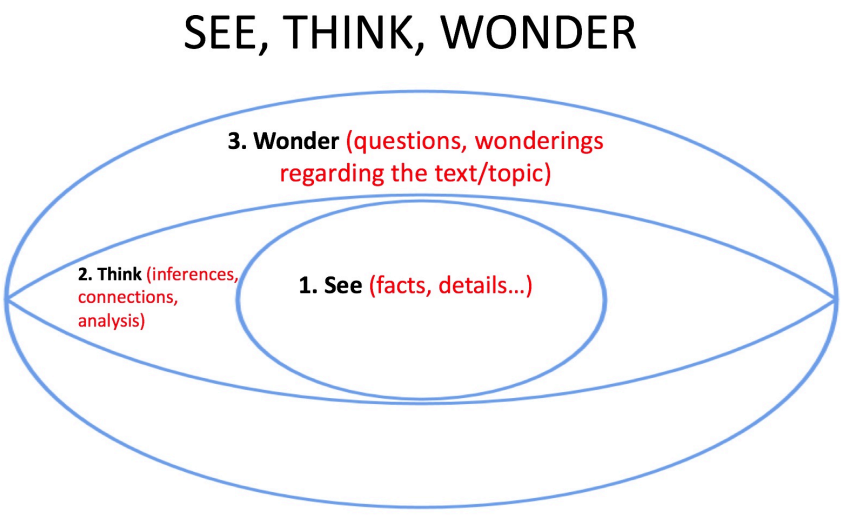


*Figure 7.* During the first workshop, teachers were asked to complete this See Think Wonder chart using the photo in Fig. 5.

Amy's concerns about evaluation. To complete the See, Think, Wonder activity, teachers were asked to look at a comic or photo without context (see Fig. 6) and fill in the "See, Think, Wonder" chart (Fig. 7). To end the first workshop, Madeline briefly reviewed the Question Formulation Technique found in IQ. The QFT was the starting discussion of the following workshop.

***Findings.*** It was unclear what teachers thought or understood during workshop one since the bulk of the first workshop was heavily focused on Madeline sharing content, information, definitions, and strategies. Many of the other teachers, however, were aware that Rosa extensively used IBL in her teaching. Because Rosa was more experienced than the other teachers, there was a clear power dynamic during the discussion on evaluation. Teachers who were, at first, confused about evaluation in IBL, immediately dismissed their own uncertainty and nodded in agreement after Rosa shared her experience, even though Rosa spoke about a single assignment (specifically an essay), not about inquiry-based learning as a whole. It is possible that teachers began to understand IBL simply as a change in task or assignment from this initial example that Rosa gave in workshop one.

**Workshop two. *Data*.** Workshop two was spent further understanding and developing the inquiry process, as well as planning inquiry-based lessons or activities in small groups. The first half of this workshop was content-based, leaving the second half for planning and small group work. The workshop started with a discussion on the role of critical thinking in inquiry-based learning. Teachers were then given time to share their experiences so far with inquiry. Then, Madeline modelled the Question Formulation Technique and gave teachers so time to try it out in pairs. She also reviewed what teachers can do after formulating questions and how to

sustain inquiry within everyday practice. Finally, teachers paired up with their teacher librarian or with each other to design lesson plans and activities.

At one point during the workshop, Madeline led a discussion on what a good inquiry question looks like compared to a poor inquiry question. The discussion digressed quickly and became impassioned, but described many of the issues that teachers face in trying to implement inquiry. Many of these challenges also arose during interviews, highlighting the patterns in teacher thinking. The discussion started with an objection from a teacher that students are not able to make judgements because they do not have background knowledge. The discussion became quickly heated with several teachers talking over each other. After stating that students do not have the background knowledge to make judgements about information, teachers identified possible causes: students do not do their homework, they do not watch the news so they do not know what is going on in the world, and students are not adequately taught in elementary school so content needs to be re-taught in high school. Furthermore, teachers expressed dissatisfaction with cross-multidisciplinary skills: students learn how to write an essay in English, but do not realize it is the same skill in history. Students suddenly forget how to write an essay when they are asked to apply skills outside of the context it was learned in. Another example is that students know how to complete an equation in math, but cannot complete them in geography, even though it is the same skill. Students are not connecting content between disciplines. Other challenges that arose included students not knowing how to cite information, students not reading enough so their vocabulary and writing is poor, students do not want to do work, and students missing class or coming late. Teachers also expressed concern that students always seem to be on their phone, and yet, they do not know how to effectively look something

up on the internet. One teacher responded to this concern by asking if banning cell phones in class was a solution, while another teacher argued that banning phones would incite backlash from parents who will complain to the administration, resulting in teacher remediation. Attempting to reel the conversation back, Madeline stressed the importance of inquiry-based learning needing the whole school to be on the same page; teachers, administration, and the school board need to think the same way about inquiry in order to defend teachers to the public if they come under scrutiny for using a new kind of teaching. Rosa quickly reeled in the conversation by demanding that each teacher raise their expectation of students, and standing their ground in front of parents and administrators. She pointedly asked "how can so many teachers complain about students not doing work and not being engaged when the system mean is so high? It makes no sense. If students aren't doing the work, their grades should reflect it". Raymond interrupted her train of thought by arguing that it does not matter if student grades reflect poor work because students can simply go to student success and get their full grade there. Raymond's comment incited more concerns about how as a system, we are "spoon-feeding" students. One teacher gave the example of students being out of uniform: if a student is not in uniform, the school provides one. The discussion took a new turn when a teacher librarian discussed her systemic challenge: the teacher librarian expressed frustration that she is not scheduled to teach during the same period as the teacher in the inquiry workshop. So she needs to "break the rules" in order to effectively collaborate. She also mentioned that she cannot ask the other teacher librarian to collaborate with the teacher because they have not received this inquiry training.

Finally, Madeline wrapped up the discussion and returned to the previous discussion on

critical thinking and inquiry. The remainder of the workshop (about an hour and a half), was spent planning. Teachers paired up with the teacher librarians at their schools to plan a lesson or activity.

***Findings.*** The main finding in workshop two was the discussion about challenges teachers face. While the challenges discussed are common in teaching, they play a unique role in the implementation of IBL. Teachers brought up three main kinds of challenges: student challenges, systemic challenges, and cognitive challenges. Student challenges refers to challenges in regards to student behaviour, understanding, or motivation. For example, students disengaging during class time and instead spending time on their phones was categorized as a student issue. Systemic challenges refer to challenges in the way the school system, rules, and policies are established. For example, when the teacher librarian was unable to use IBL with the teacher present at the workshop, it was because of a scheduling policy. In addition, she can not simply change her schedule (or take time off another period) because it would be violating school board policy. Even more, she was unable to ask her colleague to co-teach with the teacher because her colleague was not asked to attend the IBL workshops. All these challenges are systemic in nature, and seem to obstruct a teachers ability to use IBL. From the way teachers spoke about these challenges it seemed that IBL was far from realistic in the current landscape of schooling and the classroom. Instead of making the assumption that these challenges do in fact limit the extent to which a teacher is able to use IBL, each teacher was asked during their second interview whether or not they felt that challenges they mentioned deterred or inhibited them from using IBL. A cognitive challenge refers mainly to student cognition. Several teachers, during the workshop and during their interviews said the phrase “students just don’t think like that yet”

when referring to how their students reacted to elements of inquiry. Separating the challenges teachers face in regards to inquiry into only three categories simplifies teacher challenges. In actuality, many challenges they face overlap and can be categorized in more than one category because of their causes. For example, teachers claimed that students are not able to transfer skills across subjects (e.g., essay writing in english to essay writing in history), which is a student issue. However, students may have difficulty transferring their ability to write essays from english to history because of the way subjects and disciplines are separated in the school system. Separating disciplines into distinct subjects may promote the idea that what is learned in one class stays in that classroom, in that period, and in that environment (Wicklein & Schell, 1995). Thus, skill transfer between subjects is both a student challenge and a systemic challenge.

## Interview Data

Interview data in this section is presented by research question, followed by an attempt to answer the question through evidence from interview data. After presenting evidence from teachers, findings are presented as they relate to the conceptual framework.

## Teacher Understanding of IBL

**Data.** One of the main questions of this study, and main components of the conceptual framework attempts to uncover how teachers understand inquiry-based learning.

Although there was no interview question explicitly asking teachers how they understood inquiry, it was clear that teachers had different levels of understanding as to what inquiry is and what was expected of them. Amy's understanding was that inquiry is simply "asking questions",

however, she struggled to reconcile her understanding of inquiry (as a method to "figure things out") and inquiry as a teaching practice. Amy felt that inquiry as a teaching practice was a buzzword, or a trend, and did not truly capture the essence of scientific or social scientific inquiry. Amy also felt that she already uses inquiry through the debates she holds in class and the thought-provoking activities and questions she poses—but that she was not doing "inquiry" as a buzzword, she was just being a good teacher.

Rosa, who self-identifies as a teacher who regularly uses inquiry, understood inquiry as asking questions but also doing the exploration to answer those questions. Rosa also felt that inquiry was a cognitive skill that requires practice in order to master. As Rosa explained the reluctance she gets from grade 9 and 10 students to engage in deeper thinking, I asked her why the junior grades were more reluctant. Rosa clarified:

> I do believe they're capable but its like any other skill. A grade 10 skill is not the same as a grade 12 skill. Their ability to dig, right? Because they're not going to read at that level, that comprehension level is going to be different. So what kind of resources are they going to be accessing? They're going to be different. But yes—I think the core [inquiry] skill can go at any age. I think it could probably go at a young young age.

Adrian, on the other hand, felt that inquiry was a way to hand the responsibility of learning from the teacher, to the student. He expanded by saying that inquiry is a model where "…we present a broad topic and perhaps they pursue an avenue that they find interesting, which I think is probably really good for a lot of different skills with students." Gina understood inquiry in almost the same way as Adrian—a shift from teacher-entered instruction to student-driven learning. In comparing IBL to direct instruction she explained inquiry as being

> based off of the students taking charge of their learning, right? so having students come up with big questions, open ended questions. More student centred and student driven than direct teaching, and they're more involved. They are kind of taking the reigns on

where they want to take their learning.

Charles felt that teaching inquiry was more about giving students the strategies they needed to complete the inquiry process:

> A lot of it has to do with how do you as a teacher provide students with strategies to disseminate information and breaking it down or chunking it. That's what I do a lot of. I do a lot of concept maps where you're chunking information, organizers, just different strategies that they have access to, to make it easier for them to infer information or what is being implied explicitly or not. So, I think that helps provide them with strategies.

Charles went on to give a recent example in his economics class where students had questions about how much the LCBO makes in order to subsidize healthcare and education. Charles let them take out their phones and guided them on how to look up that information and how to ensure it was reliable. He finished his example by highlighting aspects that were important for student learning—especially in learning to do inquiry. Charles explained that it was important to provide students with quick and critical feedback and to model how to do things. Some students, he said, quickly understand what you're asking of them, but others need more time. Providing them with a model helps them understand what they need to do and "it's gradual and hopefully by the end of the semester they get it." Jake thought similarly about inquiry, but Jake used the term 'techniques', referring to the inquiry process—formulating a question, gathering information, and interpreting and analyzing content.

Contrarily, Raymond became more skeptical throughout the term. In the second interview he stated inquiry was "the next big thing", just like when the common curriculum became popular but then disappeared, Raymond thought inquiry would too. He also questioned what it would mean if a student could do an inquiry assignment: "just because [students] can do this assignment, doesn't mean they're really thinking the way we want them to."

**Findings.** Amy's understanding of inquiry was perplexing because she understood inquiry in two different ways. In the context of the CWS curriculum, the workshop, and ministry expectations, Amy understood inquiry as a buzzword. Specifically, a buzzword that simply refers to "asking questions." During the rest of her interviews, however, it was clear that Amy held a deeper understanding of inquiry—one that aligns with the idea that inquiry is an iterative process of answering complex questions and critically assessing information. Amy felt, however, that the second version of inquiry was just common sense and good teaching practice. Amy's inability to see these two versions of inquiry as the same version, highlights the strange dichotomy that teachers in this study seem to have created in their understanding of inquiry.

Teachers in the present study have understood inquiry as two mutually exclusive conceptions. One understanding of inquiry is that of a *task*: tasks, activities, and assignments. The other understanding is one of *paradigm*: inquiry as an attempt to shift the focus and priorities of education as a whole, in order to prepare students for our current knowledge economy and the 21st century.

***Task vs. Paradigm.*** The implications of understanding inquiry as two separate concepts —as a task and as a paradigm—are not ideal. Literature on inquiry-based learning does not make a distinction between inquiry as a paradigm and inquiry as a task, and rightfully so. Inquiry, as discussed in the literature review, is a process of learning (Pedaste et al., 2015)—a process of learning that can be used to create a paradigm shift, but is not a paradigm shift itself. Likewise, inquiry is not any single task, activity, or assignment. According to Minner et al., 2010, inquiry can be pedagogy (Minner et al., 2010), but requires specific conditions that were not met in the

present study. Namely, it requires a re-design of curriculum that allows students to conduct investigations over an extended period of time. When asked about their practice, in the context of inquiry, teachers often spoke about the assignments and tasks they administered to their class. It is important to note that inquiry (as a process of learning) cannot, and should not be reduced to a single task. A short-lived task, activity, or assignment can be a part of the inquiry process, but is not equal to inquiry-based learning on its own.

It is conceivable that teachers are using short and self-contained tasks to help students build the skills required to engage in inquiry. For example, completing a task on open- and closed-ended questions in order to learn how to create effective open ended questions that are researchable. Given the statements teachers have made during their interviews, however, it seems that teachers believe that the assignments and tasks they are asking students to complete *are* the inquiry. Activities and tasks are not 'bad', and using them to help build student skills is not wrong. The inaccuracy in understanding is believing that a stand-alone assignment can be the inquiry process. Tasks can and should be scaffolded, edited, revisited, and revised in order to contribute to true inquiry-based learning. Reducing the entirety of inquiry to an assignment robs students of the inquiry process and the learning gains that occur in the struggle to answer complex questions.

Returning to Raymond's skepticism about the assignment he administered, he said "Just because they can do this assignment, doesn't mean they're really thinking the way we want them to…I mean, we got them to do the assignment we wanted, but did we really get them thinking the way we wanted them to? I don't know. We'll see, that remains to be seen." Raymond's thinking about the assignment—that one assignment may not develop students' deep thinking is

completely accurate. One assignment will not change students thinking, knowledge, and understanding because one assignment is not inquiry. Raymond's underlying assumption, however, is a misrepresentation of what inquiry is. Raymond is skeptical of inquiry as a whole because he has made the assumption that inquiry is equal to an inquiry-based assignment. In fact, inquiry is more likely to be a series of scaffolded assignment, allowing students to answer a complex question through small tasks. Raymond's misunderstanding of inquiry—inquiry as a task—was common among other teachers. Thus, teachers' understanding of inquiry so far, has not been correct, according to literature on inquiry-based learning.

***Why might teachers be understanding inquiry as paradigm and task, rather than process?.*** Several reasons may explain why teachers have misunderstood inquiry. According to literature reviews and academic definitions of inquiry-based learning, inquiry "refers to at least three distinct categories of activities—what scientists do, how students learn, and a pedagogical approach that teachers employ" (Minner et al., 2010, p. 3). In the context of education, only the last two categories directly apply. The curriculum for CWS, however, does not specify these definitions. Rather, ministry documents are vague about what inquiry is and leave the concept open to interpretation. In order to gain an accurate understanding of inquiry, teachers would have had to read tens of papers, theoretical opinion pieces, systemic reviews, and literature reviews on inquiry-based-learning. The Ministry of Ontario also convolutes the definition of inquiry by tying IBL with 21st century skills, leading teachers to belief they are the same. In fact, IBL is intended to be used as a tool, among others, to push 21st century learning forward. Thus, the ministry of Ontario has not given teachers a clear understanding of inquiry, and what is expected of them as they engage in inquiry.

Alternatively, teachers may have received an unclear message on what inquiry is (as pedagogy) from the workshop itself. Field notes from the workshops reveal a pattern in the types of hands-on activities teachers practiced during workshops and were encouraged to complete with their classes: tasks, activities, and assignments. Thus, teachers may have understood inquiry-based learning *as* activities, tasks, and assignments. Perhaps it may have been helpful for teachers to visit with model inquiry teachers, or co-teach with them. At the end of his first interview, Jake stated that he still felt unclear about what inquiry was exactly and wished part of the workshop could have been spent watching other teachers teach in their own classroom using inquiry. Jake thought it would have been helpful for him to watch Rosa teach, because he felt that Rosa was a model inquiry teacher, since she had been using inquiry in her classes for many years. Because the workshops were entered around in-classroom tasks, and teachers were encouraged to use planning time to create or re-design assignments, it is likely that teacher entered their understanding of inquiry around in-class tasks as well.

Teachers invited to the workshops were, for the most part, novices. Given that teachers are resorting to assignments during their first attempts at inquiry, their behaviour aligns with the first stage (novice) of the five-stage model. At this point, teachers are using de-contextualized knowledge while attempting to recognize features within a situation. Being unable to, they respond or act by using prescriptive rules. In the case of teaching, prescriptive rules become tasks and assignments. Tasks are easy to administer and can be graded using a set of expectations or prescriptions: a rubric. Dreyfus (2004) would predict, however, that as teachers move through the stages of professional development, their ability to identify required steps and respond in an

appropriate manner will increase. As per suggests from Dall'alba and Sandberg's (2006) model, this study monitors teacher understanding of practice (i.e., inquiry) and in practice. Teacher understanding is likely to develop if teachers invest in deepening their understanding of inquiry as well as their inquiry practice.

## Teacher Perceptions of IBL

**Data.** 'Teacher perceptions' includes themes such as teacher attitudes, beliefs, concerns, and skepticisms. This section answers the first subquestion of this study: what are teacher perceptions around inquiry as an approach to teaching and learning?

***Concerns about inquiry.*** Raymond felt concerned that inquiry was a model that was too advanced for students, that students "aren't there yet", and that by asking students to think deeply, we would be skipping over the basic content that students still need to know. Amy felt concerned that low performing students might not be able to think deeply, ask thoughtful questions, organize and analyze information, and make connections, and that they would get left behind in class. Jake was concerned that inquiry was not realistic in today's classrooms because often, students do not have background knowledge on current world issues:

> …if they don't have the knowledge, how can they infer? How can they inquire? And you're trying to cover all this content in a lesson, if it takes 15 minutes to teach them the content and cover all of this vast curriculum that we have, how do you do it? How do you now spend your last 26 minutes getting them to inquire and ask questions?

***Skepticisms*.** One of the biggest skepticisms among teachers, expressed at length by both Raymond and Amy, was that IBL is just a trend and that it will fade away like every other education trend. Specifically, that educational trends are bureaucratic; the ministry feels like they

need to come up with something new or else they become obsolete:

> There has to be change all the time. So as good as something is, someone's going to try to improve on it, change it, or make it work different…it's another strategy that will come and go. Not to say that it wont be a good one, but even if it's a good one, somebody will want to change it. Well, because thats their job. Somebody has to do it. Otherwise, they're going to sit at a desk and become irrelevant. (Raymond)

Amy echoes Raymond's belief that IBL is a trend put forth by the Ontario Ministry of Education:

> Some of this is just faddism, and thats what it becomes. It's a buzzword. The ministry gets a bee in their bonnet and then suddenly we're all doing something you know. Differentiated instruction was nothing more than good practice… except somebody made money on it because they gave it a good name. (Amy)

Rosa, although not skeptical of IBL as a model, felt that IBL was being presented as a new innovation, when in reality, many teachers were already doing elements of inquiry-based learning long before it was added in curriculum or ministry documents:

> 25 years ago when I started, I always used to say—like I think the teachers have been teaching inquiry for a long time—I used to say to English kids: I'm going to teach you how to think by the end of the course. So I do think that inquiry has had different—the skill has been taught to varying degrees. I think it's been called different things and I think good teachers have always been teaching inquiry. It just hasn't always been so explicit. (Rosa)

Another skepticism of inquiry surrounds its touted outcomes. Raymond expressed his skepticism about what kinds of evidence we were using to evaluate whether or not inquiry is actually working: "I guess the challenge that inquiry is gonna have is not so much getting the kids to do it, I think they'll be able to do it. I just think it might not accomplish everything we think it's going to accomplish. Just because they can do this assignment, doesn't mean they're really thinking the way we want them to."

**Findings.** ***Motivation.*** The effects of a professional development program or course often depends on the teachers' motivation to learn and willingness to change. Teachers expressed

variations in motivation to learn and change their practice (Kennedy, 2016; Timperly, 2012). When learning or collaboration is mandated, it creates a contrived culture, which is not conducive to learning or collaboration (Hargreaves & Dawe, 1990). When Madeline sent emails to principals and CWS department heads across the school board, she was aware that mandated attendance would not lead to true learning. The email did not mandate teachers to attend, but rather encouraged principals and department heads to send one teacher from each school. Interestingly, departments heads felt that they were *required* to send a teacher. The teachers in this study, although not forced, reported that "someone from the department had to go" followed by either "so I volunteered" or "my department head asked me to go." Thus, teacher motivation to attend the workshops have likely had an influence on the outcomes. Madeline was not aware that teachers were not willingly attending the workshop and felt as though the outcomes of the workshops may have been different if teachers had not been pushed to attend by their department heads or principals.

***Concerns and skepticism.*** Amy, Raymond, and Jake felt concerned that students may not be ready for inquiry-based learning in classes, that low-performing student might not able to keep up, and that students do not have enough background knowledge to engage in inquiry. Students lacking background knowledge coming into a course is problematic for inquiry. However, as Rosa points out, it is possible to use inquiry to teach content, and explains how her teaching has transformed:

> Years ago in grade 10, I usually teach the cold war, and there's what we call 'hot spots', so, the Korean war, the Vietnam war, the Cuban Missile. So kids really have no idea. Yes they've heard of the Vietnam war, they couldn't tell you when it happened, why it happened. Some even don't know what it is. So, I would methodically go through, chronologically, and teach it all. So now, in a different approach what I do is I put those

> things up on the board and I do a little “have we heard of these”, they do have background to the cold war and the ideological differences, now I’m going to put them into groups and I’m going to ask them to select something they’re interested in, and then one group will inquire about the Vietnam war, based on cold war premise. How does it relate? Then, I will have some method of them sharing their inquiry. Now sometimes it can be written, sometimes it can be presented, sometimes, and it could be posted online, it could be posted electronically. And then on the test, when I’m asking about those things —and I will highlight things so rather than going through and teaching everything right, I let them talk, I will highlight certain things that have been difficult maybe to understand, and then the next day I check for understanding. Years ago I might have said: tell me why the Korean war was historically significant. Now I’m gonna say, choose the Korean war, choose the Vietnam war, choose the one that you worked on and tell me how that relates to the concept of the cold war. And so they have more choice. Sometimes, I’ll even say, I want you to write on one that you weren't in the group for. But I warn them about that. so I say when we’re debriefing, I don’t expect you to know everything. I know you know one because you did it, you all worked through it and I walked around and I know you’re doing it. I want you to know another one. You go ahead and choose which one you wanna dig into, make sure you understand that, because you’re gonna be asked to comment on that on the test. So they do! So now I know, that they know at least two really really well. Whereas before, they were all madly trying to memorize all of them, and because I may have delivered those in a very traditional teacher way, how effective was that? Really, to be honest, it probably all jumbled together. And do they really need to know every single detail about every single one? No. They need to understand here’s the cold war premise, this is an event, wow how did that connect?

Since Rosa has been engaging in inquiry for many years now, and even consulted with the ministry of education when developing the inquiry portion of the CWS curriculum, Rosa is not likely in the novice stage, but in the advanced beginner or competency phase.

Teachers felt apprehensive about inquiry, that it may not be realistic with today’s students and that it will not achieve its highly touted benefits. As discussed in the literature review,, evidence supporting and replicating positive outcomes of inquiry-based learning is questionable. Thus, teachers’ concern that inquiry will not actually lead to benefits is substantiated. Similarly, teachers felt that inquiry was a trend, and would likely fade. Teachers have witnessed many trends in education that become suggested or mandated, where teachers receive professional

development for it, but eventually, the trend fades away to make room for a new trend (Anderson, 2008). Raymond and Amy both reiterate this point. Particularly, Raymond refers to trends and says "…even if it's a good one, somebody will want to change it. Well, because thats their job. Somebody has to do it. Otherwise, they're going to sit at a desk and become irrelevant.." This kind of thinking speaks to the bureaucracy, policies, and rules teachers feel they must abide by.

**Teacher Integration of IBL**

**Data.** When asked whether or not and their practice had changed over the course of the term, and if so, how their practice changed, teachers automatically defaulted to an assignment or task they would complete in class. For example:

> It was the one that we were asked to do within the inquiry, within the forest where you just show pictures of WW2 or the great depression, and ask the kids to form open and closed questions and then pursue a little research based on those open and closed questions. (Adrian)

Similarly, Raymond responded to the question about changes in practice with doing the infographic assignment that he, Rosa, Gina, and a teacher librarian put together: "Today we started working on the project that we worked on in the workshop. Giving it a go this week and we'll see how it goes." The other answer teachers gave was that their practice had not changed because they were already using inquiry, but rather, the workshop reinforced what they already knew should be working in classrooms: "No it's, its pretty much reinforced what I've always thought" (Charles). Rosa reiterated the same thought: "I think for me, its just reinforcement because I'm pretty comfortable with it. I mean its always great to see the new information but

there wasn't anything super new for me."

Amy tried the See Think Wonder activity and ran into the problem of students not engaging with the task and doing a poor job with writing down questions. She also tried the open- and closed-ended question example that Madeline gave during the workshop, but ran into a philosophical problem when students came up with questions that could be either closed-ended or open-ended, for example, "What is climate change?" Amy explained that you could answer this question with a sentence, or you could write a dissertation on it. She found it challenging trying to dichotomize certain questions (as open- or closed-ended) when there seemed to be a grey area. Amy also adapted a previous activity she assigns students in her law class to align better with one of the worksheets that Madeline handed out during the second workshop. Amy explained her assignment and why she was having trouble with it, as well as how she adapted it:

> I taught them these 4 legal concepts and then they go and read a real case and they have to apply these concepts and say you know, was this principle applied in this case, was it applied correctly or was it ignored? Ultimately the question becomes, based on these, was this person wrongfully convicted? Now, the answer is yes in all these cases because they're all wrongful convictions. But I had a problem with the kids, taking this and applying it and saying and creating something. So that chart that [Madeline] did, I started re-writing this in a chart because I thought it would make it easier for them to note down the evidence. So I'm going to see whether or not that gives me a better—gets me more organized thoughts from them. So I'm going to see if that works.

Although constantly skeptical of inquiry, and insisting that inquiry was a buzzword or a fad, it was evident that Amy constantly tried to implement ideas from the workshop to the best of her ability.

**Findings.** Consistent with Dall'Alba & Sandberg's (2006) two dimensional model, teacher understanding of practice affects their understanding in practice. Thus**,** how teachers use inquiry in their classrooms is heavily dependant by how they understand inquiry. Data from the

present study support this assumption; because teachers understood inquiry as tasks and assignments, teachers primarily used inquiry in their classrooms by incorporating assignments and tasks.

Because teachers have misunderstood inquiry, it has translated into practice that is inquiry-like, but is not inquiry. Rather, their practice is pseudo-inquiry; it contains elements of inquiry but is not connected by the essence of inquiry. Teachers use driving questions, scaffolding, modelling, or formative assessment, without placing the learning in inquiry. One example is Raymond's first attempt at an assignment: an info-graph. He questions if student thinking will really change just because they are able to complete the 'inquiry assignment'. More specifically, he comments on the rubric he is using, stating that the rubric is "basically the same" as the rubric he uses for other assignments. Thus, his expectations for his students have not changed. If Raymond's expectations of his students' performance and thinking has not changed, and he has not made it explicit to his students what he expects from their thinking, students will likely not engage in inquiry. Grading inquiry in the same way traditional learning is graded will not produce inquiry. Although Raymond's assignment required students to research a topic, analyze the credibility of the information, and synthesize the information in an easy-to read format, there are no real elements of inquiry. The steps students must undertake to complete the info-graph are inquiry-like, but are not inquiry. Thus, teachers and students will have engaged in pseudo-inquiry. Teachers, schools, boards, and those facilitating inquiry PD should be cognizant of pseudo-inquiry. Mcnew-Birren and van den Kieboom (2017) predict that the simple recognition that pseudo-inquiry may take place in the novice stage can help PD facilitators anticipate this practice and plan more effective development programs.

Based on Dreyfus' (2004) stage model, and Dall'Alba and Sandberg's dimensional model, psuedo-inquiry may simply be a symptom of existing in the novice stage of skill development, where understanding and practice are rudimentary. It can be expected that as teachers are exposed to more examples of inquiry-based learning and inquiry infused pedagogy, they will progress through the stages of skill acquisition, deepening their understanding and improving their practice.

## Challenges to Implementing IBL

**Data.** ***Student challenges.*** Teachers almost unanimously agreed that students' attitudes toward learning was a challenge for doing inquiry in class. Teachers found that students often want teachers to give them the answers to questions, instead of figuring it out on their own. Students were also unengaged in many topics, so teachers found it difficult to hold a class discussion or get students interested in learning more about a topic. Jake explained that students in grade 10 history are much less engaged in content and discussion than students in 12 history for example, likely due to grade 10 history being mandatory while grade 12 history is optional. After the first workshop, Jake tried to spark student interest by introducing a new topic with a video followed by a discussion. Even still, students saw a video go up on the projector and proceeded to put their heads down or take out their phones: "and when the video clip goes on, their phones come out, or their heads go down. Their attention is like, 'Oh, I have a break.'" Charles and Rosa echoed the same challenges: "it doesn't help when, I don't wanna say all of them but a lot of students are disengaged. They don't wanna do that work, they don't wanna do that inquiry. That's the tough part, is getting them motivated to do it."

Not only do teachers feel that students are not engaged and interested, but they often do not want to take the extra step in learning. Amy shared that students are unsure of what the right answers are, so they constantly ask teachers instead of working it out themselves. With inquiry, however, there is often no right or wrong answers, which Amy explained, “scares [the] high achievers. They have a lot of anxiety over this." Although she has found some success with her grade 12 students, Rosa shares the same experience as Amy, Jake, and Charles, specifically with her grade 10 students:

> They really really have a weak initiative. They really don’t seem to have the motivation to do anything different. Like they're still in the stage where they want me to tell them what they should wonder about, what they should learn about…again, I think to some degree the system has created that." She goes on to say “I’m still dealing with oh can you just tell us the answer.

Teachers also struggled to reconcile how inquiry was related to 21st century skills. For example, as mentioned before, Gina felt that “self-regulation should come before collaboration because you need to self-regulate before you can work with others." At the same time, however, Jake questioned the role a teacher plays in the development of 21st century skills: “how do you teach self-regulation? Can you teach it? Or is it something the student just has?” Jake went on to explain that it is almost impossible to do inquiry when a student cannot prioritize tasks, organize their time, and regulate their behaviour to, for example, do an assigned reading in preparation for a class discussion the next day.

More logistically, teachers unanimously found student absences and arriving to class late to be a challenge for inquiry-based learning. When students are absent it becomes difficult to engage them in the same learning everyone else in the class did:

> I think with my older classes, attendance kind of throws things off. In terms of implementing inquiry in the classroom, you know, if students are away and you're working on a group project or building that community with your class, is difficult to do when attendance is low. (Gina)

A couple teachers also felt that students being on their phones was a challenge in doing inquiry because students' attention is focused on their phones rather than the class: "I do know that there were several [students] that became completely disinterested in the conversation and went to their phones" (Amy). Other teachers felt that it was the responsibility of the student to realize the consequence being on your phone in class would entail. Rosa points out that if "[students] wanna take [their] phone out then, the price is they missed that and it does show up in their work", while other teachers found ways to take advantage of students having their phones out, often by prompting them to use it to look up information or complete tasks requiring knowledge from the internet:

> The kids they always have they're phones. when they ask me a question I go, you guys are so lucky, you have access to a library at your finger tips. I do that with my kids, when they ask what does that mean, I go check! You have your phone there. It's technology, use it for something good. (Charles)

Similarly, Gina felt that there were ways to bypass phone usage in class, and that it was their responsibility as teachers to do so effectively: "…but there are ways to go around the phone issue, like teaching them how to use their phone properly in class" (Gina).

Unfortunately, for all the time students seem to spend on their phones, they have difficulty looking things up. Amy explains that learning to search things on the internet is a vital skill in the 21st century, and yet, it is not in the curriculum. Teachers simply expect students to know how to search the internet because they themselves know how to: "These kids…they have all this information at their fingertips but their biggest problem is that they get completely

overwhelmed. We don't teach them how to search." Another challenge is trying to turn student phone usage into an advantage but not having the appropriate resources, Gina expanded her previous quote and added that "teaching them the proper tools of how to maybe if—I mean I don't have wifi in the portables so it's a little bit different for me."

***Cognitive challenges.*** Aside from student attitudes and behaviours, a challenge teachers seem to be facing is cognitive. In each interview, teachers unanimously reported students "just not being able to think that way yet", or being unable to grasp inquiry concepts, or not seeing the value in learning through inquiry. Some teachers gave explanations for some of these challenges, while others assumed it was simply too early for junior grades, or that students did not possess the ability to think deeply in junior grades. Gina, Rosa, Charles, and Jake attributed some of the students' cognitive challenges to the range of ability that exists in each classroom:

> They have a really hard time coming up with those really in depth above and beyond type questions. Which is sometimes difficult because you have such a fluctuation of abilities in your classes so some students are maybe 10% of them get it and can come up with those questions on their own but the other 90% of them are kinda all over the map… just that like some of the students in my university course should be in a college course, like really really low level. Thats a challenge, especially when it comes to inquiry because they really really struggle digging deep and coming up with mindful inquiry questions. (Gina)

Rosa reiterates the same variation in ability in her class where "some kids can do it, stronger kids can do it, the weaker ones sometimes harder for them." Again, Charles echoes that the variability is a challenge "in the sense that some kids can— very few kids can excel at it whereas others can't, so that the tough part." Jake repeats this thought, even using some of the same languages in that "some kids are good, they can do that but I find as the majority, you have to really pull teeth to get these responses from them"

Although the present study is preliminary, and findings are not conclusive, teachers did note the concepts students struggled with the most. Most commonly, students seemed to struggle with differentiating open- and closed-ended questions, narrowing down research questions, answering deep questions, and making connections between content:

> students are having a really hard time coming up with an inquiry question. and what is an inquiry question and what's an open ended question vs an open ended questions. we've been focussing on that a lot…but also how to research based off of inquiry questions and how to conduct their own research based off of one specific question. (Gina)

Adrian reiterated the same challenges: "Certain classes find it hard to come up with open and closed questions and a lot of teacher support is needed. That's tough when you've got a bigger class." It is no surprise that students struggled with open- and closed-ended questions, given that even teachers themselves can struggle with the concept:

> I explicitly taught them open and closed questions but then I ran into a problem with some of them because some closed questions can be open questions depending on what you mean. For example, what is climate change? Well, you can answer that in 5 seconds with the simple definition. You could also answer that with a 100 page dissertation. It just depends what you mean by the question. So is that open or closed? (Amy)

According to Gina, students struggle just as much with open- and closed-ended questions as they do with developing an inquiry question: "students are having a really hard time coming up with an inquiry question. And what is an inquiry question? And what's an open-ended question vs a closed-ended question?" Jake also found students struggling to narrow down questions: "these kids have problems with—they can't narrow down...they can't create their own topics." Gina reiterated the same sentiments: "I see a lot of my 9s struggle with even coming up with coming up with questions." Amy saw students struggling the same way "when they give me their questions I say, I think you're going to find that's too big, so think about narrowing it down when

you’re doing your research."

In addition, both Raymond and Amy felt like students could not answer deep questions. As Amy attempted to use more guiding and targeted questions, she found that “the kids aren’t good at answering them." Interestingly, Raymond uses the same language when describing his students’ abilities: “I think the kids aren't there with it. Our books are full of inquiry type questions, and I’m spending all my time re-wording those questions so the kids understand what they’re being asked.”

Even when teachers try to model thinking and question development (modelling being one of the characteristics of inquiry), students do not steer far from that model:

> If I give them an example, they won’t steer very far away from it. Like they’re not really thinking outside of the box. So they have a really hard time coming up with those really in depth, above and beyond type questions. (Gina)

Jake succinctly explains with an example, how students struggle to make connections between topics:

> With the social sciences, we’re always making connection and like especially in a history class. You’re sort of dissecting and analyzing like what are the leaders thinking? What’s Winston Churchill thinking? What’s Robert Borden thinking? What’s their thought process? And you’re making connections to like the different the laws the statutes of Westminster, the Balfour Report, how does that lead to Canada’s independence? I think they have trouble making the connection. Like connecting those two things. Because they’re so used to looking for an answer in a textbook and copying that answer word for word, they don’t know how to put it into their own words.

Jake also brought up that inquiry requires students to come into class with background knowledge—because you cannot inquire about something you do not know. Students do not do their homework, and often do not keep up with the news. Thus, discussing history, geography and current events become increasingly more difficult, leading to a systemic problem of teachers needing to prioritize curriculum breadth over depth or vice versa. Jake reflected on his own

education and the differences between inquiry then and inquiry now. In discussing deeper thinking, he says:

> …but see all that can be very challenging to a kid who is learning a subject or a topic for the very first time. Like when I was growing up, I was more into what was going on in the world around so like I watched the news, documents, and I knew some information, and then when I went to school, if the teacher was asking me an application question or a thinking question, I had the background to draw upon that.

When asked if he felt that students did not have the same background knowledge, he continued:

> No. I still feel like we have to teach too much content. Like, [students] don't read—so the outlines I give the kids—the expectation here is they have to read the section or the chapter prior to the lesson. So the night before the lesson, they should be reading those pages. That way when we sit down we have, we talk about the content, they have some background information.

Deciding whether to cover content or depth of content is a curriculum issue, however, and exists both as a student issue and a systemic issue.

***Systemic challenges.*** Systemic challenges that teachers reported ranged from logistical challenges to policy challenges. Logistical challenges included lack of wifi, access to printers, and library booking time. Gina reported having to book library time months in advance because of her school's library time, which is necessary for computer use, gets booked up quickly. When Amy did the See Think Wonder activity for her class, she needed photos to base the activity on. She had trouble finding a working printer with ink in her school.

Unanimously, teachers all felt that time was a challenge, but in different ways. Rosa, for example felt that teaching inquiry was not time consuming, but rather, "it takes more time to plan." Charles felt that time was a challenge because giving students the space and time to learn is more time-consuming than simply providing students with the answer:

> [inquiry] may a take a long time and that's why I think a lot of teachers struggle with it. They wanna cover all this curriculum but with them putting in the hands of the students —where the students has to find the answer— its gonna be longer, its gonna take a longer time.

In another sense, Charles felt crammed for time in the school year when exams are coming up and he still has content to teach:

> …the thing I struggle with too is time. So now the next two weeks before exams, theres still—like its gonna be hard for me to incorporate this whereas now its gonna be more direct instruction.

Amy felt like she was wasting time by having to teach things that are not in the curriculum, as well as having to re-teach content from previous years: "when I teach grade 9 Geography, I have an entire month of activities that are not in the curriculum. you know what I'm teaching? The first 8 years. I am re-teaching." Other teachers felt similarly; teachers are spending time teaching either content or skills (e.g., how to make an inference), that students should have already been taught.

If teachers are required to teach material from previous years of education, it may be indicative of a larger systemic problem of continuity: continuity of content and learning expectations. Amy reported having to re-teach material, while Charles pointed out that inquiry is just as difficult of a shift for students as it is for teachers, if not more. He explains that students are not "ready" or "used to" having to engage with content the way inquiry-based learning expects them to because they learn passively in elementary school. Both Jake and Charles questioned why and how students are expected to suddenly be able to do inquiry in grade 9, 10, 11, and 12, when they previously were not expected to think for themselves, ask thought provoking questions, or engage in the process of learning rather than passively acquiring information. Teachers unanimously felt like students "aren't there with it…they don't think that

way yet" (Raymond), and "they can't narrow down...they can't create their own topics" (Jake)

Grades, measurement, and evaluation also seem to be a challenge. Evaluating inquiry can be difficult for several reasons. Namely, engaging and guiding student thought and discussion makes it more difficult to grade their thinking during, for example, a whole class discussion. Amy makes this point precisely when she "was engaging with the students which means that I don't remember every kid who asked what question." Amy goes on to reflect on how teachers are expected to measure students without providing realistic guidance, specifically for inquiry: "The fact is that the school and school boards, ministry are obsessed with being able to measure things but they don't provide realistic guidance." Aside from a lack of ministry guidance on assessment and evaluation, even practical books on IBL are not clear. In reference to the IQ book that each teacher received Amy stated the challenge she had in trying to assess her students during an in-class task:

> Their suggestion on assessment is observation. Who has time for observation? I spent the whole time circulating and answering questions. If you've got a really engaged class, you don't actually have time to sit back and look—oh look Johnny's not talking, okay I need to make a note of that. Or oh look Suzy and Jenny are having a great animated conversation. I wonder what it's about? Because of course I'm halfway across the room, but if I go and sit there, it makes the kids nervous…it's like having someone stand behind you during an exam. So how do they do these observations?

Both Amy and Raymond reflected on what it would mean for students to engage in inquiry, to think the way we want them to. While Amy asks "How do I know it worked?", Raymond shares his concern that even if students are able to complete his planned assignment, "doesn't mean they're really thinking the way we want them to. We have a rubric that we put in. I don't think it's challenging, I just think that it is, at least right now, pretty generic. So not much different than other things we've done." Raymond was deeply skeptical of student outcomes and how we

measure those outcomes. He did not feel that changing an assignment will really change how students think because the way we measure how students think is using a rubric that does not change much. Amy goes on to question the types of learning that teachers are typically taught to assess and the ones they do not. She describes one of her classes as more discursive than the others and shares that her students

> ask me questions all the time about whatever is going on. We had a whole discussion about rape and sexual assault today. None of that is in the curriculum but curious classes will suck you off track and so, do I think learning went on? Yes. Can I measure it? No.

Conversely, Rosa believes that evaluating inquiry is not difficult. She concisely explains how and why assessing and evaluating inquiry might scare teachers, but should not:

> I think the assessment piece is the other piece that holds teachers back from that. They will shy away from it because they don't understand how to assess it. I don't think its necessarily hard to evaluate deep thinking. But you have to have a lot of written proof, it cant be subjective it has to be objective. Because you can tell when a student has deep thinking because there will be more connections, there will be more wondering, there will be more prediction, there will be more hypothesizing, if they're thinking deeply. So theres a big difference from a student answer of, that bomb was bad because it killed a lot of people, to the fact that wow we've never dropped another atomic bomb on a civilian target. So that in 50 or 60 years has to tell me something and this is what it tells me. So I think you can evaluate it. I think you have to have it: the process clearly outlined, I think you have to have criteria, I think you have to put it all into a rubric, I do believe its possible. I just don't think its as simple as is the answer A, B, C or D or did you list 5 facts. It's not as simple.

For Adrian, it was creating the criteria (as Rosa suggested), that required a shift in understanding because "normally it's more black and white, like do they have these facts or this research. But inquiry, you have to kind of assess how well they're thinking, or how much they're thinking about certain aspects."

The final question asked in each interview was intended to gain a better understanding of the heated discussion that took place in the second workshop. Specifically, to understand the

relation between the challenges teachers mention and inquiry-based learning. Each teacher was asked ‘Do you think effective inquiry is possible despite all the barriers and challenges mentioned in the last workshop?’. Unanimously, teachers answered that effective inquiry was still possible. The following quotations exemplify common answers teachers responded with:

> Absolutely. I think that students are gonna have their phones out regardless. It’s how you handle them using their devices… so if you have a handle on your class and you can gain the trust of your students and you give the trust back, I think there’s a way to work around the cell phone issue and there is like, with students not showing up and with absences, that can be a little bit more challenging, because in the end it’s more time consuming for the teacher. Because the teacher is now going to have to re-teach that to the students. So in terms of that, that’s a challenge, but there’s always a way to effectively teach inquiry. (Gina)

Jake takes the same approach as Gina, believing that each teacher is in control of the learning in their own classrooms “…but with the actual like inquiry process, inquiry-based learning, the teacher has control over that. They should.” Amy, however, takes the opposite approach, believing that “good kids will learn in spite of you." Raymond, although skeptical of the inquiry model and need for inquiry felt that “There’s always gonna be outside challenges." Rosa responded similarly: “Yes. Those challenges are classroom management. So you know, kids are always gonna come in late…” However, Rosa continued with a contradiction:

> I’ll tell you when it can be problematic, repeated absences can be because with inquiry, you do a lot of work, it’s a lot of collaborative work, and its scaffolded and if you miss chunks of it, it now becomes independent learning.

Charles responded with an understanding that inquiry is a paradigm shift: “Yeah, but its gonna take time. Like I said it’s a shift, it’s a shift for the way teachers instruct” but continues using the same logic as Rosa: “…it'll be tough, it'll be tough, I’ll be honest. Or if a kid is absent a lot. How are they gonna make that up?” Similarly, Adrian comments on the time it will take, understanding that reform takes time: “I think it is, but I think it is a long process because you’re

shifting a paradigm and you're never gonna shift things easily."

**Findings.** ***Student challenges.*** Teachers have rationalized pseudo-inquiry as inquiry because the tasks they assign students "require them to think critically." Critical thinking, although a goal of inquiry, is not a characteristic of inquiry. Teachers have also rationalized pseudo-inquiry by arguing that students are not able to engage in real inquiry, or there are challenges preventing them from engaging in inquiry-based learning.

Major challenges for teachers to engage students in inquiry include student attitude, motivation, and initiative. Interestingly, a characteristic of effective IBL is that questions, problems, and projects are situated in authentic context. This specific characteristic exists to motivate and engage students. If students are not becoming engaged then, it may be due to inauthentic learning; students may not be seeing the relevance in the content and skills they are learning and thus, disengage (Knowles, Holton & Swanson, 2005). Based on teachers' experiences with students lacking initiative It seems that, before high school, students are not expected to complete assigned readings before class or research answers themselves. Teachers teaching grade 9 and 10, must now deal with students who are shocked to learn that they will not be given the answer right away, or find an answer they can copy in a textbook. According to grade 9 and 10 teachers, elementary school teachers expect less of their students. Thus, students are not prepared to emerge in inquiry, deep thinking, or asking questions themselves. Perhaps this explain why high school teachers are still being asked for the answers.

More logistically, teachers face the problem of students arriving to class late, and student absences. Because IBL is a process, and not a one-time strategy, students are required to provide constant effort. If a student is absent on the day a teacher starts an inquiry project or topic, the

student has missed a day's worth of thinking, debating, discussing, and analyzing. Likewise, if a student is absent or late the day students spontaneously start a debate, they have missed the cognitive learning environment created by students engaging in a thoughtful discussion, as well as the content discussed. Learning opportunities in inquiry are hard to re-create, especially when student collaboration is involved. Rosa recognized that lates and absences are an obstacle for inquiry. Her solution is to limit inquiry to one single period:

> It's a lot of collaborative work, and it's scaffolding, and if you miss chunks of it, it now becomes independent learning. Because you're not really gaining the benefit of it, the benefit of the group, the wondering. Right? So yes, do I believe attendance can be a challenge, yes. The thing that I have personally done to avoid that is that I like to keep any sort of work like that really tight with timelines and if I can keep it in a class I will. because if it goes over to the next day and you've got kids away…so I try not to let it spill over too much.

Inquiry, in the way geographers, historians, and economists conduct their work, exceeds timelines. Inquiry often cannot be limited by time. Due to the nature of schooling however, inquiry must be limited to a period, course, term, and subject. By working around obstacles, Rosa has truncated inquiry, finding a clever solution to a practical problem. A by-product of practicality, though, is pseudo-inquiry. Limiting the timeframe in which inquiry can exist, limits the learning that can occur as well. These limitations call into question whether inquiry—as a practical pedagogy in K-12 classrooms, is possible at all.

***Cognitive Challenges.*** Teachers commonly felt as though the "strong" or "good" students were able to excel at inquiry, compared to the majority of students who struggle with it. As a student attempting inquiry for the first time, though, it will be challenging. Students will struggle because even expert struggle with developing and answering their own questions. When using inquiry as a pedagogy, it is important to understand that students are allowed to struggle. In fact,

struggling with concepts often leads to learning (Holmes, Day, Park, & Roll, 2014; Kapur 2012a; Kapur, 2012b; Loibl, Roll, & Rummel, 2017). The premise of inquiry allows and encourages students to grapple with topics, concepts, and questions because inquiry promotes the process of learning over the learning outcome. It is not likely that students will excel at inquiry on the first or fifth attempt. Just as teachers are acquiring the skill of using inquiry as pedagogy, students are learning to use inquiry as a means of learning.

When students struggle without any sign of progression, though, it can become problematic. More specifically, if over time only the “stronger” students are excelling and “weaker” students are not progressing, inquiry (or its implementation) must be called into question. Inquiry should then be questioned because as Amy recognizes, “good students will learn in spite of you."  Empirical evidence supports a similar model; learning interventions and teaching styles show almost no effect in populations of students with high working memory capacity (Fenesi, Rana, Kim, & Shore, 2014). Rather, students with low working memory capacity are easily influenced by interventions, teachers, and environments. As such, Fenesi et al. (2014) recommend for those who create learning interventions to target low performing students. Thus, if long-term data show that inquiry is only effective for high performing students, it may as well be completely ineffective.

Teachers also felt that students simply were not able to answer deep questions. It is likely that teachers were asking students questions, without scaffolding or modelling them, leading students to be confused and overwhelmed. Because inquiry is a complex learning process, thinking needs to be scaffolded to ensure students are not overwhelmed (Hmelo-Silver et al., 2007). Alternatively, it is possible that because teachers are novices with inquiry, the questions

they pose to their students may not be suitable. It may take practice and professional development for teachers to understand how students may be thinking about their questions. For this reason, formative assessment is a critical component of IBL (Watt & Coyler, 2014). Without formative assessment, teachers risk progressing through topics, units, and questions, while students are still struggling with elementary concepts. Interestingly, when asked about assessment, teachers immediately defaulted to assessment *of* learning rather than *for* learning. As critical as assessment to inform teaching is in IBL, it was not discussed during workshops, which is likely why teachers did not use it or think of it when discussing assessment. Future professional development programs for IBL should emphasize the importance of assessment to inform teaching.

***Systemic challenges.*** Several systemic challenges exist for teachers trying to engage their students in inquiry. First, Gina explains that she is unable to book library time for her class to conduct research using the computers. Being unable to book library time becomes problematic because inquiry cannot always be scheduled, and there exists a lack of technological resources to give teachers the flexibility of engaging in IBL. Often, teachers who engage in inquiry must think on their feet, connect student interest and discussion to curriculum content and expectations (Mcnew-Birren & van den Kieboom, 2017). As we have already discussed, it is difficult fro students to feel interested and engaged in topics. So if a topic arises in class where students are spontaneously engaged, a teacher will want to use the opportunity for learning. Being unable to book time for your class on the computers, and using the library as a resource though, can be a barrier for learning. Even worse, Gina teaches in a portable, where WiFi connection is unavailable. Even if students wanted to use their own devices to learn or research a topic, they

would not be able to.

***Curriculum.*** The the amount of content teachers are required to cover in a course has created a systemic issue. Jake describes how difficult it is for teachers to engage their students in inquiry when they have so much content to cover. He explains that if he has to teach content for even 15 minutes, trying to cover the "vast content", then how does he spend the remaining 26 minutes trying to get students to think deeply about the content they just learned, ask questions, gather data, analyze information, and make connections? His solution is to assign reading and homework before class, so that students have the background knowledge to do inquiry in class, as a class. The issue that arises then, is students not doing the assigned readings and coming to class unprepared. Thus, this problem is two fold: inquiry is challenging when there too much content to cover, and even more challenging when students are not prepared for learning. Exacerbating the curriculum issue further, is that fundamentally, inquiry is a process. A process that encourages failure, many attempts, trial and error, and struggle, all of which take time. The temporal structure of a typical course period and school term require teachers to "complete" curriculum learning expectations within a short time-frame. Simply put, the overwhelming amount of content that teachers are expected to teach, in the short time-frame of a 4 month term, does not allow for room for failure, trial and error, and extra time to grapple through complex questions. The curriculum is systemically designed in a way that contradicts inquiry-based learning.

***Re-teaching.*** Aggravating the curriculum issue, teachers are finding that they often have to re-teach content and skills from previous grades. Re-teaching content is a challenge because as discussed, each grade's curriculum expectation is already over crowded. When teachers are

required to take even more time to re-teach material students should already know, it takes time away from the current grade's curriculum the teacher is trying to teach. As a student achievement consultant, Madeline believes that curriculum expectation outlined by the Ministry of Education are not mandated, but suggested; by trying to cover breadth and sacrificing depth, teachers are doing their students a disservice. On the flip side, consequences of not exposing students to all curriculum expectations are two fold: administrative remediation and student preparedness for post-secondary education (PSE). Teachers commented on the consequences they felt they would be responsible for if they did not meet every curriculum expectation. Students, parents, and administration may complain about teachers not teaching enough, potentially inciting punishments for the teacher. The other consequence is that students may go on to post-secondary education and be expected to know about, for example, the Vietnam war. But if a teacher decided to teach for depth and did not have time to cover the Vietnam war, that student will be disadvantaged in PSE compared to their peers, whose teachers may have decided to prioritize breadth rather than depth.

***Grades, measurement, evaluation.*** The fundamental conflict with inquiry and the current grading system western schools use, is that measurement aims to quantify a learning outcome. Inquiry, however, is fundamentally about the process of learning and how the learning occurs. Amy questioned the kinds of learning teachers are taught to measure. For example, Amy believes that when students engage in impassioned debates and discussions, students learn more than almost any other method. Teachers, however, are not trained to see this as learning, and thus, she feels she cannot measure it. Even though it may be a better indicator of learning. By trying to measure inquiry using the logic of traditional assessments, teachers, students, and parents will

end up prioritizing the outcome of learning over the process of learning. While learning outcomes are still important, emphasizing them over process will lead to teachers relying on traditional models of teaching (i.e., transmissive instruction). Raymond stipulates that he has altered his rubric for the 'inquiry assignment' but continues to say that its similar to a traditional rubric, which is not challenging enough for students. Rosa, on the other hand insists that teachers attempting inquiry must challenge the way they think about teaching, learning, and assessment. Amy states that her students ask her questions that lead to learning, but are not measurable. She gives an example where her students began a debate about rape and sexual assault. Although not in the curriculum for civics and careers, and not concretely measurable, she still felt that students walked away from that class having learned something. Amy's experience is not unique, and forces teachers to question what our schooling system qualifies as evidence of learning. While most teachers are taught to use tests, assignments, and projects as evidence, inquiry lends itself to more non-measurable indicators of learning, like discussions. It must be difficult, then, for teachers to reconcile competing priorities: do we want students to learn? Or do we want to measure what we think is learning? Unfortunately, learning is not always explicit or quantifiable. Arguably, the grading system in western schools is not conducive to inquiry-based learning; its assumptions and priorities are inconsistent with the assumptions and values of inquiry-based learning.

**Are Challenges Damning to IBL?**

The crux of the second interview aimed to unpack teacher thinking around systemic challenges and the ways they may limit inquiry. Given their passion in discussing obstacles to teaching and learning, I had expected teachers to either give varied responses or feel as though there were too many obstacles to effectively enable in inquiry. Surprisingly, this was not the case. In fact, the opposite was true; teachers unanimously indicated that effective inquiry was possible despite systemic barriers. Teachers felt as though they were in responsible for the learning inside their own classrooms and had control over the challenges inside the classroom. Their contradiction may stem from their understanding of inquiry as paradigm and as task. It is likely that teachers felt that systemic obstacles were barriers to inquiry as a paradigm, but not to inquiry as a task because inquiry as a task is limited to the classroom, which teachers have control over. The way teachers answered the systemic challenges question highlights makes it evident that teachers are understanding IBL on two different levels.

# Chapter 6: Discussion & Conclusions

## Discussion

**The Grammar of Schooling: Tyack and Tobin (1994).** Many of the systemic barriers discussed in this section are a result of the grammar of schooling. The grammar of schooling is a term that was first coined in 1994 by Tyack and Tobin, who define the grammar of school as all "the regular structures and rules that organize the work of instruction. They continue with several examples: "standardized organizational practices in dividing time and space, classifying students and allocating them to classrooms, and splintering knowledge into "subjects"" (p. 454). In the present study, the grammar of schooling is evident when teachers report an over-crowded curriculum, measurement and grading systems that are not effective, unmotivated students, lack of continuity of expectations (and curriculum) through K-12 grades, policies about student misbehaviour, etc. In their definition, Tobin & Tyack (1994) also include the structure of schooling, specialized departments in high schools, the way classrooms are organized, and curriculum. In essence, the grammar of schooling is "organizational framework that shapes the conditions under which teachers instruct students" (p. 455). Many policy-makers, educators, administers, and thought leaders have attempted to enact small and large-scale reform in schools over the last century, only to be met with fleeting success or immediate failure. For example, small-size classrooms, grouping teachers in teams, flexible scheduling, independent study (versus batch-processing), etc. These reforms have not lasted, even when successful. Tyack & Tobin (1994) argue that the grammar of schooling is responsible for the lack of reform in western schooling systems. It is the deep-seeded and entrenched assumptions, beliefs, and values of the

grammar of schooling that have barred any real change from occurring. The grammar of schooling is steadfast and unchanging, even in the face of total education reform. The main reason schools have not changed for over a century is that most innovations occur at the surface level of schooling, and do not target fundamental assumptions and values. In the present study, the implementation of IBL has done precisely this: targeted surface level changes rather than deep level changes.

**Conclusions**

These findings suggest that, as novices, teachers have a poor understanding of what inquiry is. Teachers conceptualize inquiry as a paradigm and as a task but have difficulty reconciling both understandings. Poor understanding leads to poor implementation; teachers perceive themselves as engaging their class in inquiry when they assign an inquiry-like task. Since a stand-alone activity or task does not qualify as inquiry, I have termed this behaviour as “pseudo-inquiry". Pseudo-inquiry is further exacerbated by the grammar of schooling, bounding the limits and possibilities teachers can engage in inquiry. The systemic challenges that teachers face in their work every-day limit their ability to truly engage in inquiry-based learning with their students. The bounds that the grammar of schooling have created will become more problematic when policy-makers expect IBL to become a paradigm shift. Ideally, the small changes that occur inside the classroom would contribute to a whole-school paradigm shift, leading to a board-wide and province-wide reform. As a theory of action, this linear progression of events is sound. The success of the theory of action, however, rests on the initial success of in-class changes, which are problematic as teachers are novices. It may be predictable that as

teachers move away from the novice stage of professional development, their understanding and practice will become more expert-like (Dreyfus, 2004). However, their understanding is most likely to be improved as a result of professional development focused on understanding of practice and understanding in practice (Dall'Alba & Sandberg, 2006). Changing teacher understanding of inquiry will require teachers to challenge their own assumptions about their role, teaching, and learning. Teachers must believe that they are no longer the gate-keeps of knowledge. Their efficacy stems from their ability to critically think about information. Their efficacy lies in their ability to guide students through learning, not give them the learning.

**Implications.** The present study provides major implications for researchers who study IBL as well as those developing or implementing IBL professional development programs. This research provides examples of how teachers may (mis)understand IBL, as well as how they use IBL as novice teachers. For instance, given the finding that teachers have a rudimentary understanding of inquiry (i.e., one that a novice would have), it is important to focus future PD on developing a foundational understanding of inquiry. PD may also be required to last longer than a single school term in order to ensure teacher skill development occurs concurrently with teacher training. Lengthening PD will also ensure that learning is sustained, and allow teachers to trouble shoot any question, concerns, or issues as they begin to use inquiry. Dall'Alba & Sandberg (2006) emphasize teacher understanding *of* practice and *in* practice, and while the inquiry workshop discussed understanding of practice, there was a lack of emphasis on understanding *in* practice. As a result, some teachers misunderstood what inquiry may look like in practice. Thus, it may be helpful to provide teachers with opportunities to watch expert inquiry teachers or co-teach, in order to deepen their understanding in practice. Even more, it may be

helpful to provide teachers with inquiry coaches so that each teaching experience is tailored for their classroom.

Most importantly, the present study reveals the difference between how literature has operationalized inquiry and how teachers operationalize inquiry. So far, teacher use of inquiry has been inconsistent and understudied (Capps & Crawford, 2013; Marshall, Horton, & Smart, 2009; McNew Birren & van den Kieboom, 2017). The literature that does exist, however, misses one key element when discussing inquiry practice. Literature on teacher use of inquiry fails to acknowledge that a teachers' teaching philosophy lies at the heart of their practice. Thus, even if the grammar of schooling was conducive to inquiry-based learning, the linear theory of action (small changes inside the classroom would contribute to a whole-school paradigm shift) may not be realized unless teachers' assumptions about their role, teaching, and learning, are challenged. Teachers must believe that they no longer hold all the knowledge. Their efficacy stems from their ability to think critically about information and to guide students through learning, rather than presenting them the learning.

Finally, the findings of this study provide a realistic boundary within which teachers can engage their students in inquiry. This study sheds light on system level issues that may inhibit teachers from investing in and engaging in inquiry. Future iterations of assessment frameworks (such as Growing Success), or education frameworks (such as 'Achieving Excellence'), should take these boundaries into consideration when outlining the expectations of inquiry. The boundaries outlined in this study also illustrate the limitations of inquiry; it may be possible to engage students in inquiry on a single classroom level, but it may not be realistic to expect a paradigm shift without changing elements of the grammar of schooling.

**Limitations.** Given that the present study is a case study, several limitations exist. The workshop was conducted in a short-time frame which did not allow teachers to discuss ideas and troubleshoot problems. Although the workshop provided teachers with planning time, teachers were encouraged to create tasks or activities, which may have lead teachers to understanding inquiry as a type of task to be assigned.

The workshop placement along the school term was also limited teachers' time and space to try inquiry, fail, and do better the next time. Because the workshops took place later in the term, teachers felt crammed for finals exams, pushing them to use direct instruction to meet curriculum expectations. Ideally, the workshops would take place throughout the whole year and extend longer than a single school year to provide teachers with a deeper understanding of inquiry, and time to practice inquiry in order to move from novice to expert.

Another limitation in this study relates to teacher motivation: some teachers felt forced to attend the workshops. Although teachers were not required to attend, some felt pressured by their department heads or principals to attend the workshop, likely leading to more resistance to change (Evans, 1996).

In their framework, Dall'Alba & Sandberg (2006) state that "If understanding of, and in, practice is to be promoted as part of professionals' work, the workplace must encourage critical reflection on practice in a manner that enhances this understanding." (p. 36). During the workshop, teachers did not engage in any critical reflection. It was not clear whether whether or not individual schools promote critical reflection for teachers. In the workshop, there was meant to be time to reflect, but due to system challenges (i.e., not enough substitute teachers at the end of the year), the last session was cancelled, which may have diminishing the potential impact of

the workshops.

Methodologically, validity and reliability remain a limitation in the present study. Due to a lack of resources and a short time-frame, the reliability and validity of the qualitative data was not ensured.

**Future Directions**. Given the limitations of the present study, future research should account for and actively pursue alternative avenues of research. Ideally, a study investigating teacher understanding and perceptions around inquiry would be longitudinal because of the progression of stages from novice to expert. A longitudinal study could also investigate changes in understanding and practice as teachers develop over time. Another benefit of a longitudinal study is the ability to track student outcomes on academic achievement and 21st century skills. Since reform should always be driven by student outcomes (Little, Gearhart, Curry, & Kafka, 2003), monitoring student outcomes will allow teachers to better plan future learning, researchers to better understand the effects of using IBL, and policy makers to exact a more realistic outlook on the future of education.

To better explore teacher practice, future research should include classroom observation. For example, McNew Birren and van den Kieboom (2017) investigated the progression of teacher inquiry practice through video recordings of classroom lessons. Teachers then analyzed their own video recordings as a critical reflection exercise. Documenting or observing teacher behaviour in the classroom will provide a better understanding of the strategies teachers are actually using.

One of the most common themes that arose in this study was that teachers found students to struggle with inquiry-type questions and tasks. Due to the limited scope of the present study,

student struggle was not explored. Investigated how and why students struggle with inquiry-type concepts, however, could shed light on how student schemas and trajectories when engaging in inquiry, which would allow teachers to better tailor inquiry to common difficulties students have.

**Final Thoughts**

Data from the present study show that teachers' development, understanding, and practice of inquiry is bounded by the grammar of schooling. These limitations have forced inquiry into what I found to be pseudo-inquiry, where elements of inquiry seem to exist but without the essence of inquiry. In addition, reconciling inquiry as paradigm and inquiry as an in-class practice will be difficult, if not impossible if teachers continue to misunderstand inquiry as a task or assignment rather than a process for learning. Ideally, the small changes that occur inside the classroom would contribute to a whole-school paradigm shift. Thus, when teachers understand inquiry as learning process (and not a task), and inquiry-based learning as a model that relies on inquiry, it may be possible to reconcile inquiry as practice and inquiry as paradigm. Even if teachers deeply understood IBL, teachers might still practice some variation of pseudo-inquiry because of the assumptions that organize western schooling systems (learning must be evidenced and measured, subjects must be separated and timed, classes must be separated by age, we must teach content before application, etc.). Therefore, even if teachers had an excellent understanding of inquiry, their practice would be bound by the current grammar of schooling.

## References


Abdi, A. (2014). The effect of inquiry-based learning method on students' academic achievement in science course. *Universal Journal of Educational Research, 2*(1), 37–41. http://doi.org/10.13189/ujer.2014.020104

Alberta Ministry of Education. (2010). Inspiring action on education. Edmonton, AB: Government of Alberta.

Ananiadou, K., & Claro, M. (2009). 21st century skills and competences for new millennium learners in OECD countries.

Anderson, S. (2008) "Comparative Perspectives on School Improvement" In K. Mundy, K. Bickmore, R. Hayhoe, M. Madden, & K. Madjidi (Eds.) *Comparative and International Education: Issues for Teachers.* New York, NY: Teachers College Press.

Azizmalayeri, K., MishahJafari, E., Sharif, M., Asgari, M., & Omidi, M. (2012). The impact of guided inquiry methods of teaching on the critical thinking of high school students. *Journal of Education and Practice*, 3(10), 42–48.

Barron, B., & Darling-Hammond, L. (2008). Teaching for meaningful learning: A review of research on inquiry-based and cooperative learning. *In powerful learning: What we know about teaching for understanding* (1st ed., pp. 11–70). San Fransisco: Jossey-Bass. http://doi.org/10.1207/S1532799XSSR0501

Bayram, Z., Oskay, Ö. Ö., Erdem, E., Özgür, S. D., & Şen, Ş. (2013). Effect of inquiry based learning method on students' motivation. *Procedia-Social and Behavioral Sciences*, 106, 988–996. http://doi.org/10.1016/j.sbspro.2013.12.112

Bellanca, J. A. (Ed.). (2014). *Deeper learning: Beyond 21st century skills.* Solution Tree Press.

Benham Tye, B. (1987). The deep structure of schooling. *Phi Delta Kappa International, 69*(4), 281–284.

Bereiter, C., & Scardamalia, M. (2006). Education for the Knowledge Age: Design-Centered Models of Teaching and Instruction. In P. A. Alexander & P. H. Winne (Eds.), *Handbook of educational psychology* (pp. 695-713). Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.Berman, P., Lehming, R., & Kane, M. (1981). Educational change: An implementation paradigm. *In Improving schools: Using what we know* (pp. 253–286).

Blessing, S. B., & Ross, B. H. (1996). Content effects in problem categorization and problem solving. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*(3), 792.

Bogdan, R. C., & Knopp Biklen, S. (2003). Q*ualitative research for Education: An introduction to theories and methods.* Boston: Pearson Education Group, Inc.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher, 33*(8), 3–15. http://doi.org/10.3102/0013189X033008003

Borko, H., Davinroy, K.H., Bliem, C.L., & Cumbo, K.B. (2000). Exploring and supporting teacher change: Two third-grade teachers' experiences in a mathematics and literacy staff development project. *The Elementary School Journal,* 100, 273-306.

Borko, H., Mayfield, V., Marion, S., Flexer, R., & Cumbo, K., (1997). Teachers' developing ideas and practices about mathematics performance assessment: Successes, stumbling blocks, and implications for professional development. *Teaching and Teacher Education,* 13, 259-278

Boud, D., Garrick, J., & Greenfield, K. (2000). Understanding learning at work. *Performance Improvement* (Vol. 39). http://doi.org/10.1002/pfi.4140391013

Bransford, J., Brown, A., & Cocking, R. (2000). *How people learn: Brain, mind, experience and school.*Washington, DC: Commission on Behavioral and Social Sciences and Education, National Research Council.

Gormally, C., Brickman, P., Hallar, B., & Armstrong, N. (2009). Effects of inquiry-based learning on students' science literacy skills and confidence. *International Journal for the Scholarship of Teaching and Learning*, *3*(2), 16.

Brown, A. L., & Campione, J. C. (1994). *Guided discovery in a community of learners.* The MIT Press.

Brown, J. S., Collis, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*(1), 32–43. http://doi.org/10.3102/0013189X018001032

Bunterm, T., Lee, K., Ng Lan Kong, J., Srikoon, S., Vangpoomyai, P., Rattanavongsa, J., & Rachahoon, G. (2014). Do different levels of inquiry lead to different learning outcomes? A comparison between guided and structured inquiry. *International Journal of Science Education, 36*(12), 1937–1959. http://doi.org/10.1080/09500693.2014.886347

Campione, J. C., Shapiro, A. M., & Brown, A. L. (1995). Forms of transfer in a community of learners: Flexible learning and understanding.

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis.* Sage.

Chinn, C. A., & Malhotra, B. A. (2002). Epistemologically authentic inquiry in schools: A theoretical framework for evaluating inquiry tasks. *Science Education, 86*(2), 175–218. http://doi.org/10.1002/sce.10001

Chinn, C. A., & Hung, C. C. (2007, April). Learning to reason about the methodology of scientific studies: A classroom experiment in the middle school. In *annual meeting of the American Educational Research Association, Chicago, IL*.

Clark, R. E., Kirschner, P. a, & Sweller, J. (2012). Putting students on the path to learning the case for fully guided instruction. *American Educator, 36*, 6–11.

Colliver, J. A. (2000). Effectiveness of problem-based learning curricula: Research and theory. *Academic Medicine*, *75*(3), 259–266.

Craik, F. I., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General*, *104*(3), 268.

Creswell, J.W. (2007). *Qualitative Inquiry & Research Design: Choosing among Five Approaches* (2nd ed.). Thousand Oaks, CA: Sage Publications Inc.

Dall'Alba, G., & Sandberg, J. (2006). Unveiling professional development: A critical review of stage models. *Review of Educational Research, 76*(3), 383–412. http://doi.org/10.3102/00346543076003383

Davis, B., Sumara, D., & Luce-Kapler, R. (2000). Learning theories. *Engaging minds. Learning and teaching in a complex world.* Mahwah: Lawrence Erlbaum Associates.

Dede, C. (2014). Deeper learning research series: The role of digital technologies in deeper learning.

Desimone, L. M. (2011). A primer on effective professional development. *Kappan Magazine, 28*–31.

Dewey, J. (1910). Science as subject-matter and as method. *Science*, *31*(787), 121–127.

Dochy, F., Segers, M., Van den Bossche, P., & Gijbels, D. (2003). Effects of problem-based learning: A meta-analysis. *Learning and Instruction, 13*(5), 533–568. http://doi.org/10.1016/S0959-4752(02)00025-7

Dore, K. L., Brooks, L. R., Weaver, B., & Norman, G. R. (2012). Influence of familiar features on diagnosis: Instantiated features in an applied setting. *Journal of Experimental Psychology: Applied*, *18*(1), 109.

Dreyfus, S. E. (2004). The five-stage model of adult skill acquisition. *Bulletin of Science, Technology and Society, 24*(3), 177–181. http://doi.org/10.1177/0270467604264992

Evans, R. (1996). The culture of resistance. *In The human side of change* (pp. 40–50). San Fransisco: Jossey-Bass.

Fenesi, B., Sana, F., Kim, J. A., & Shore, D. I. (2015). Reconceptualizing working memory in educational research. *Educational Psychology Review, 27*(2), 333–351. http://doi.org/10.1007/s10648-014-9286-y

Friesen, S., & Scott, D. (2013). *Inquiry-based learning: A review of the research literature*. Alberta Ministry of Education. Retrieved from http://galileo.org/focus-on-inquiry-lit-review.pdf

Gallagher, M., & Griffore, J. (2013). School effectiveness framework. Retrieved from https://www.wcdsb.ca/about/pdf/Ministry-SEF-Document-2013.pdf

Gallagher, S. A., Stepien, W. J., & Rosenthal, H. (1992). The effects of problem-based learning on problem-solving. *Gifted Child Quarterly, 36*(4), 195–200. http://doi.org10.1177/001698629203600405

Geier, R., Blumenfeld, P. C., Marx, R. W., Krajcik, J. S., Fishman, B., Soloway, E., & Clay-Chambers, J.(2008). Standardized test outcomes for students engaged in inquiry-based science curricula in the context of urban reform. *Journal of Research in Science Teaching, 45*(8), 922–939. http://doi.org/10.1002/tea.20248

George, K., & Cunningham, G. K. (2008). University of North Carolina Education Schools: Helping or Hindering Potential Teachers.

Gholami, M., Moghadam, P. K., Mohammadipoor, F., Tarahi, M. J., Sak, M., Toulabi, T., & Pour, A. H. H.(2016). Comparing the effects of problem-based learning and the traditional lecture method on critical thinking skills and metacognitive awareness in nursing students in a critical care nursing course. *Nurse Education Today, 45*, 16–21. http://doi.org/10.1016/j.nedt.2016.06.007

Gick, M. L., & Holyoak, K. J. (1980). Analogical problem-solving. *Cognitive Psychology*, *12*(3), 306–355.

Godden, D. R., & Baddeley, A. D. (1975). Context‐dependent memory in two natural environments: On land and underwater. *British Journal of Psychology*, *66*(3), 325–331.

Goldman, S. R., & Pellegrino, J. W. (2015). Research on learning and instruction. *Policy Insights from the Behavioral and Brain Sciences, 2*(1), 33–41. http://doi.org/10.1177/2372732215601866

Graves, K. L. (1998). Experiencing school mathematics: Teaching styles, sex and setting. *Gender and Education*, *10*(4), 467.

Growe, R. (2011). The new inquiry in education: Reshaping the skill demands of today' s students. *Schooling, 2*(1), 1–7.

Gusky, S. (2002). Stream of consciousness. *Hieroglyphics: the NSU University School Literary Magazine*, 9(1), 90–91.

Hardiman, P. T., Pollatsek, A., & Well, A. D. (1986). Learning to understand the balance beam. *Cognition and Instruction*, *3*(1), 63–86.

Hausfather, S. J. (1996). Vygotsky and Schooling: Creating a Social Context for Learning. *Action in Teacher Education, 18*(2), 1–10. http://doi.org/10.1080/01626620.1996.10462828

Hays, M. J., Kornell, N., & Bjork, R. A. (2010). The costs and benefits of providing feedback during learning. *Psychonomic Bulletin & Review*, *17*(6), 797–801.

Hill, N. M., Schneider, W., Ericsson, K. A., Charness, N., Feltovich, P. J., & Hoffman, R. R. (2006). Cambridge handbook of expertise and expert performance.

Hmelo-Silver, C. E. (1998). Problem-based learning: Effects on the early acquisition of cognitive skill in medicine. *Journal of the Learning Sciences, 7*(2), 173–208. http://doi.org/10.1207 s15327809jls0702

Hmelo-Silver, C. E., Golan Duncan, R., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist, 42*(2), 99–107.

Hmelo-Silver, C. E., & Barrows, H. S. (2006). Goals and strategies of a problem-based learning facilitator. *Interdisciplinary Journal of Problem-Based Learning, 1*(1), 5–22. http://doi.org/10.7771/1541-5015.1004

Holmes, N. G., Day, J., Park, A. H. K., Bonn, D. A., & Roll. (2014). Making the failure more productive: scaffolding the invention process to improve inquiry behaviours and outcomes in invention activities. *Instructional Science, 42*(5), 523–538.

Jang, H., Reeve, J., & Deci, E. L. (2010). Engaging students in learning activities: It is not autonomy support or structure but autonomy support and structure. *Journal of Educational Psychology, 102*(3), 588–600. http://doi.org/10.1037/a0019682

Kapur, M. (2012). Productive failure in learning math. *Cognitive Science, 40*(2), 651–672. http://doi.org/10.1111/cogs.12107

Kapur, M. (2012). Productive failure in learning the concept of variance. *Instructional Science, 40*(4), 651–672. http://doi.org/10.1007/sl 1251-012-9209-6

Kennedy, M. M. (2016). How does professional development improve teaching? *Review of Educational Research, 86*(4). http://doi.org/10.3102/0034654315626800

Kinkead, J. (2003). Learning through inquiry: An overview of undergraduate research. *New Directions for Teaching and Learning*, *2003*(93), 5–18.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work. *Educational Psychologist, 41*, 87–98. http://doi.org/10.1207/s15326985ep4102

Kirschner, P. A., & van Merriënboer, J. J. G. (2013). Do learners really know best? Urban legends in education. *Educational Psychologist, 48*(3), 169–183. http://doi.org/10.1080/00461520.2013.804395

Klahr, D., & Nigam, M. (2004). The equivalence of learning paths in early science instruction: Effects of direct instruction and discovery learning. *Psychological Science, 15*(10), 661–667. http://doi.org/10.1111/j.0956-7976.2004.00737.x

Knowles, M. S., Holton, E. F., & Swanson, R. A. (2005). *The Adult Learner.* Burlington, MA.

Ko, B., Wallhead, T., Ward, P. (2006). Chapter 4: Professional development workshop: what do teachers learn and use? *Journal of Teaching in Physical Education, 2*(25), 397–412.

Krajcik, J. S., Blumenfeld, P. C., Marx, R. W., & Soloway, E. (1994). A collaborative model for helping middle grade science teachers learn project-based instruction. *The Elementary School Journal, 94*(5), 483–497.

Kuhn, D. (2007). Is direct instruction an answer to the right question? *Educational Psychologist, 42*(2), 109–113. http://doi.org/10.1080/00461520701263376

Kuhn, D., Cheney, R., & Weinstock, M. (2000). The development of epistemological understanding. *Cognitive Development, 15*(3), 309–328. http://doi.org/10.1016/S0885-2014(00)00030-7

Kulasagarem, M. (2013). *Conceptual and contextual strategies for transfer* (Doctoral Dissertation). McMaster University, Hamilton.

Kuhn, D., Black, J., Keselman, A., & Kaplan, D. (2000). The development of cognitive skills to support inquiry learning. *Cognition and Instruction*, *18*(4), 495–523.

Larsen, D. P., Butler, A. C., & Roediger III, H. L. (2008). Test-enhanced learning in medical education. *Medical Education*, *42*(10), 959–966.

Lazonder, A. W., & Harmsen, R. (2016). Meta-analysis of inquiry-based learning: Effects of guidance. *Review of Educational Research*, *86*(3), 681–718.

Little, J. W., Gearhart, M., Curry, M., & Kafka, J. (2003). Looking at student work for teacher learning, reacher community, and school reform. *Phi Delta Kappan, (Novemeber)*, 184–192.

Loibl, K., Roll, I., & Rummel, N. (2017). Towards a theory of when and how problem-solving followed by instruction supports learning. *Educational Psychology Review, 29*(4), 693–715. http://doi.org/10.1007/s10648-016-9379-x

Martínez Arbelaiz, A., & Correa Gorospe, J. M. (2009). Can the grammar of schooling be changed? *Computers and Education, 53*(1), 51–56. http://doi.org/10.1016/j.compedu.2008.12.016

Mayer, R. E. (2004). Should there be a three-strikes rule against pure discovery learning? The case for guided methods of instruction. *American Psychologist, 59*(1), 14–19. http://doi.org/10.1037/0003-066X.59.1.14

McNew-Birren, J., & van den Kieboom, L. A. (2017). Exploring the development of core teaching practices in the context of inquiry-based science instruction: An interpretive case study. *Teaching and Teacher Education, 66,* 74–87. http://doi.org/10.1016/j.tate.2017.04.001

McTighe, J., & Wiggins, G. (2013). *Essential questions: Opening doors to student understanding*. Alexandria, VA: Ascd.

Meirink, J. A., Meijer, P. C., Verloop, N., & Bergen, T. C. M. (2009). How do teachers learn in the workplace? An examination of teacher learning activities. *European Journal of Teacher Education, 32*(3), 209–224. http://doi.org/10.1080/02619760802624096

Mergendoller, J. R., Maxwell, N. L., & Bellisimo, Y. (2006). The effectiveness of problem-based instruction: A comparative study of instructional methods and student characteristics. *Interdisciplinary Journal of Problem-Based Learning, 1*(2), 11–17. http://doi.org/10.7771/1541-5015.1026

Minner, D. D., Levy, A. J., & Century, J. (2010). Inquiry-based science instruction-what is it and does it matter? Results from a research synthesis years 1984 to 2002. *Journal of Research in Science Teaching, 47*(4), 474–496. http://doi.org/10.1002/tea.20347

Moreno, R. (2004). Decreasing cognitive load for novice students: Effects of explanatory versus corrective feedback in discovery-based multimedia. *Instructional Science*, *32*(1-2), 99–113.

Muijs, D., Kyriakides, L., van der Werf, G., Creemers, B., Timperley, H., & Earl, L. (2014). State of the art: Teacher effectiveness and professional learning. *School Effectiveness and School Improvement, 25*(2), 231–256. http://doi.org/10.1080/09243453.2014.885451

Murnane, R. J., & Levy, F. (1996). *Teaching the new basic skills: Principles for educating children to thrive in a changing economy*. Free Press, 1230 Avenue of the Americas, New York, NY 10020.

Norman, G. R., & Schmidt, H. G. (2000). Effectiveness of problem-based learning curricula: Theory, practice and paper darts. *Medical Education, 34*(9), 721–728. http://doi.org/10.1046/j.1365-2923.2000.00749.x

Norman, G. R., & Schmidt, H. G. (2016). Revisiting effectiveness of problem-based learning curricula: Theory, practice and paper darts'. *Medical Education, 50*(8), 793–797. http://doi.org/10.1111/medu.12800

Oguz-unver, A. Arabacıoğlu, S. (2014). A comparison of inquiry-based learning (IBL), problem-based learning (PBL) and project-based learning (PJBL) in science education. *Academia Journal of Educational Research, 2*(7), 120–128. http://doi.org/10.15413/ajer.2014.0129

Ontario Ministry of Education. (2010). Growing Success: Assessment, Evaluation, and Reporting in Ontario Schools. http://doi.org/10.1017/CBO9781107415324.004

Ontario Ministry of Education. (2015). Canadian and World Studies. The Ontario Curriculum: Grades 11 and 12. http://doi.org/10.1016/S0022-3913(12)00047-9

Ontario Ministry of Education. (2014). Achieving Excellence: A Renewed Vision for Education in Ontario. http://doi.org/10.1016/j.athoracsur.2007.04.131

Ontario Ministry of Education. (2013). Inquiry-based Learning: On transforming wonder into knowledge. Retrieved from www.edu.gov.on.ca/eng/literacynumeracy/inspire/.

Ontario Ministry of Education. (2013). Canadian and World Studies. The Ontario Curriculum: Grades 9 and 10. http://doi.org/10.1016/S0022-3913(12)00047-9

Ontario Public Service. (2016). 21st century competencies: Towards defining 21st century competencies for Ontario.

Opara, J. A. (2011). Inquiry method and student academic achievement in Biology: Lessons and policy implications. *American-Eurasian Journal of Scientific Research, 6*(1), 28–31.

Overholser, J. C. (1993). Elements of the Socratic method: II. Inductive reasoning. *Psychotherapy, 30*(1),75–85. http://doi.org/10.1037/0033-3204.30.1.75

Palmer, S. (2002). Enquiry-based learning can maximize a student's potential. *Psychology Learning & Teaching, 2*(2), 82. http://doi.org/10.2304/plat.2002.2.2.82

Pedaste, M., Mäeots, M., Siiman, L. A., de Jong, T., van Riesen, S. A. N., Kamp, E. T., … Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review, 14*, 47–61. http://doi.org/10.1016/j.edurev. 2015.02.003

Pellegrino, J. W., & Hilton, M. L. (Eds.). (2012). *Education for life and work: Developing transferable knowledge and skills in the 21st century*. Washington, DC: National Academies Press.

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education, 93*(7), 223–231. http://doi.org/10.1002/j.2168-9830.2004.tb00809.x

Puntambekar, S., & Kolodner, J. L. (2005). Toward implementing distributed scaffolding: Helping students learn science from design. *Journal of Research in Science Teaching, 42*(2), 185–217. http://doi.org/10.1002/tea.20048

Putnam, R. T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher, 29*(1), 4–15. http://doi.org/ 10.3102/0013189X029001004

Reeve, J., & Jang, H. (2006). What teachers say and do to support students' autonomy during a learning activity. Journal of Educational Psychology, 98(1), 209–218. http://doi.org/ 10.1037/0022-0663.98.1.209

Reisberg, D. (2013). *Cognition: Exploring the science of the mind.* New York: WW Norton.

Reiser, B. J. (2004). Scaffolding complex learning: The mechanisms of structuring and problematizing student work. *The Journal of the Learning sciences*, *13*(3), 273–304.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context.* Oxford University Press.

Sandoval, W. A. (2005). Understanding students' practical epistemologies and their influence on learning through inquiry. *Science Education, 89*(4), 634–656. http://doi.org/10.1002/sce.20065

Sandoval, W. A., & Reiser, B. J. (2004). Explanation-driven inquiry: Integrating conceptual and epistemic scaffolds for scientific inquiry. *Science Education*, *88*(3), 345–372.

Savery, J. R., & Duffy, T. M. (1995). Problem based learning: An instructional model and its constructivist framework. *Educational Technology,* (35), 31–38. http://doi.org/47405–1006

Sawyer, R. K. (Ed.). (2005). *The Cambridge handbook of the learning sciences.* Cambridge University Press.

Schwartz, D. L., & Bransford, J. D. (1998). A Time for Telling. *Cognition and Instruction, 16*(4), 475–522.

Schwartz, D. L., Bransford, J. D., & Sears, D. (2005). Efficiency and innovation in transfer. *Transfer of learning from a modern multidisciplinary perspective*, 1–51.

Schwartz, D. L., & Martin, T. (2004). Inventing to prepare for future learning: The hidden efficiency of encouraging original student production in statistics instruction. *Cognition and Instruction*, *22*(2), 129–184.

Shepherd, N.G. *The Probe Method: A problem-based learning model's affect on critical thinking skills of fourth and fifth grade social studies students* (Doctoral Dissertation). North Carolina State University, North Carolina.

Shulman, L. S., & Keisler, E. R. (1966). *Learning by discovery*. Chicago: Rand McNally.

Shulman, L. S., & Shulman, J. H. (2004). How and what teachers learn: A shifting perspective. J*ournal of Curriculum Studies, 36*(2), 257–271. http://doi.org/10.1080/0022027032000148298

Sierens, E., Vansteenkiste, M., Goossens, L., Soenens, B., & Dochy, F. (2009). The synergistic relationship of perceived autonomy support and structure in the prediction of self-regulated learning. *The British Journal of Educational Psychology,* 57–68. http://doi.org10.1348/000709908X304398

Şimşek, P., & Kabapinar, F. (2010). The effects of inquiry-based learning on elementary students' conceptual understanding of matter, scientific process skills and science attitudes. *Procedia: Social and Behavioral Sciences, 2(*2), 1190–1194. http://doi.org/10.1016/j.sbspro.2010.03.170

Sweller, J., Kirschner, P. A., & Clark, R. E. (2007). Why minimally guided teaching techniques do not work: A reply to commentaries. *Educational Psychologist, 42*(2), 115–121. http://doi.org/10.1080/00461520701263426

Thomas, J. W. (2000). A review of research on project-based learning. *The Autodesk Foundation*, 94903, 46. http://doi.org/10.1007/s11528-009-0302-x

Sweller, J. (1999). Instructional Design in Technical Areas. *Australian Education Review.*

Timperley, P. H. (2012). Leading teaching and learning through professional learning. *Australian Educational Leader, 37*(2).

Tretten, R., & Zachariou, P. (1995). *Learning about project-based learning: Self-assessment preliminary report of results.* San Rafael, CA: The Autodesk Foundation.

Tyack, D., & Tobin, W. (1994). The "grammar" of schooling: Why has it been so hard to change? *American Educational Research Journal, 31*(3), 453–479. http://doi.org/10.3102/00028312031003453

Vajoczki, S., Watt, S., & Vine, M. (2011). Inquiry learning: Instructor perspectives. *Canadian Journal for the Scholarship of Teaching & Learning, 2*(2), 1–18. http://doi.org/10.5206/cjsotl-rcacea.2011.2.3

Vajoczki, S., Watt, S., Vine, M. M., & Liao, X. (2011). Inquiry learning: Level, discipline, class size, what matters? *International Journal for the Scholarship of Teaching and Learning, 5*(1), 1–12.

Vernon, D. T., & Blake, R. L. (1993). Does problem-based learning work? A meta-analysis of evaluative research. *Academic Medicine*. http://doi.org/10.1097/00001888-199307000-00015

Vygotsky, L. S. (1978). Mind in society: The development of higher mental process.

Watt, J. G., & Colyer, J. (2014). *IQ: A practical guide to inquiry-based learning.* Oxford University Press.

Wehling, B. (2007). Building a 21st Century US Education System. *National Commission on Teaching and America's Future*.

Wicklein, R. C., & Schell, J. W. (1995). Case studies of multidisciplinary approaches to integrating mathematics, science and technology education. *Journal of Technology Education*, *6*(2), 59–76. http://doi.org/https://doi.org/10.21061/jte.v6i2.a.5

Williams, D. C., Hemstreet, S., Liu, M., & Smith, V. D. (1998). Examining how middle school students use problem-based learning software. U.S. Depertmant of Education.

Wolf, S. J., & Fraser, B. J. (2008). Learning environment, attitudes and achievement among middle-school science students using Inquiry-based laboratory activities. *Research in Science Education, 38(*3), 321–341. http://doi.org/10.1007/s11165-007-9052-y

Yin, R. K. (2009). How to do better case studies. In Bickman, L., & Rog, D. J. (Eds.), *The SAGE handbook of applied social research methods* (pp. 254–282). Thousand Oaks, CA: SAGE Publications, Inc.

Young, M. E., Brooks, L. R., & Norman, G. R. (2011). The influence of familiar non‐diagnostic information on the diagnostic decisions of novices. *Medical Education*, *45*(4), 407–414.

Yue, C. L., Castel, A. D., & Bjork, R. A. (2013). When disfluency is—and is not—a desirable difficulty: The influence of typeface clarity on metacognitive judgments and memory. *Memory & Cognition*, *41*(2), 229–241.

Zimmerman, B. J., & Pons, M. M. (1986). Development of a structured interview for assessing student use of self-regulated learning strategies. *American Educational Research Journal*, *23*(4), 614–628.

February 28th, 2018

Letter of Information and Consent Form

Dear Participant,

I am writing to request formal permission to conduct a research within the [SCHOOL BOARD]. The study will investigate how teachers understand and use inquiry after attending the workshops on IBL. Specifically, I will be working with the teachers involved in Inquiry Learning in World Studies project at the [school board learning centre].

If you agree to support the study, which I will carry out, you would be agreeing to allow me to interview you, given that you give your signed consent. The interviews will focus how teachers understand and use inquiry that have stemmed from the workshop you are involved in. Interviews may last between 15-45 minutes. I will also be attending workshop meetings.

I intend to have the interviews recorded, but you have the choice of declining to have your interview recorded, in which case written notes will be taken. You have the right to refuse to answer any questions and to withdraw from the study at any time. I will ensure that participation in the study would be kept strictly confidential. Teachers could contact the Research Ethics Board of the University of Toronto if they had any concerns about how the research is being conducted.

Please let me know by return email whether you are willing participate in the study and whether I can answer any questions you might have.

Sincerely,

Marina Sadik, M.A student
Department of Leadership, Higher & Adult Education
Ontario Institute for Studies in Education (OISE)
252 Bloor St. West
Toronto, Ontario
[PHONE NUMBER]
[EMAIL]

Appendix A: Letter of Information and Consent Form

**Exploring the development of teacher understanding and use of inquiry-based instruction in Canadian and World Studies**

**Researcher:** Marina Sadik
**Research Contact Number/Email:** [EMAIL], [PHONE NUMBER]
**Principal Investigator (P.I.):** Dr. Nina Bascia, [EMAIL], [PHONE NUMBER]

**Purpose:** The purpose of this research is to understand the changes teachers make in their practice as a result of their involvement in a professional learning community.

**Description:** In a face-to-face interview, you will be asked about the experiences you have developing your own practice within the professional learning community. The interview will last anywhere from 15-45 minutes. You will be interviewed three times throughout the semester: at the beginning, middle, and end.

**Risks:** There is very little risk for you as a participant in this research. Psychological risk may include worrying or embarrassment that answers are not sufficient. However, there is no 'right' answer to the interview questions. If you wish to stop the experiment for any reason at any time, you can inform the researcher immediately and the interview will be terminated.

**Benefits:** Your participation in the experiment will further our understanding of the impact professional learning communities can have. Your participation may be a reflective experience.

**Compensation:** There is no compensation for your participation in this research.

**Confidentiality:** Any information that is obtained in connection with this study and that can be identified with you will remain confidential. All data will be coded by pseudonym and only the researcher will have access to which names correspond to which people. Your participation and anything you disclose during the interview will not be available to anyone outside the research team. In any written or oral sharing of the findings, only pseudonyms will be used when referencing conversations or descriptions of practice.

**Participation:** You can choose whether to be in this study or not. You may withdraw at any time without consequences of any kind. You may also choose to remove your data from the study. You may refuse to answer any questions you do not want to answer and still remain in the study. To receive a summary of the findings in April 2018 please email the researcher.

You may withdraw your consent at any time. This study has been reviewed and received ethics clearance through the UofT Research Ethics Board (REB). If you have questions regarding your rights, please contact:

Office of Research Ethics, McMurrich Building, 2nd floor
12 Queen's Park Crescent West

Appendix A: Letter of Information and Consent Form

Toronto, ON M5S 1S8
FAX: 416/946-5763

I understand the information provided for the “PLC influence on teacher practice: Building case studies from inquiry learning in world studies” study as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study.

| | |
|---|---|
| _____ | _____ |
| Name | Email/Contact info of choice |
| _____ | _____ |
| Signature | Date |

Appendix B: Letter of Information for Principals

February 1st, 2018

Dear (Principal name),

I am writing to request formal permission to conduct a research study at INSERT SCHOOL NAME HERE. The study will investigate how teachers understand and use inquiry in Canadian and World Studies courses. I will be working specifically with the team involved in Inquiry learning project at the [school board learning centre], coordinated by [Madeline].

If you agree to support the study, which I will carry out, you would be agreeing to allow me to conduct interviews with the teachers involved in the inquiry project, given that they each give their own consent. I will be conducting three interviews which may last 15-45 minutes. I will also be attending workshops at the [school board learning centre]. I will not be evaluating teachers or students, but rather collecting information on how teachers understand and use inquiry.

I intend to have the interviews recorded, but teachers have the choice of declining to have their interview recorded, in which case written notes will be taken. Teachers have the right to refuse to answer any questions and to withdraw from the study at any time. I will ensure that participation in the study be kept strictly confidential. Teachers can contact the Research Ethics Board of the University of Toronto if they have any concerns about how the research is being conducted.

This study has been approved by the [School board name] Research Council, chaired by Dr. [Head of Research], as well as the Research Ethics Board of the University of Toronto.

Please let me know by email or phone whether you are willing to have the teachers in your school participate in the study and whether I can answer any questions you might have.

Sincerely,

Marina Sadik
M.A student
Department of Leadership, Higher & Adult Education
Ontario Institute for Studies in Education (OISE)
252 Bloor St. West
Toronto, Ontario
[PHONE NUMBER]
[EMAIL]

Appendix C: Interview 1

Date: P#:

First interview:

1. What courses do you teach and how long have you taught them?
2. What would you say the purpose of this committee is?
3. Do you see any value in attending these meetings? If so, what?
4. How would you describe your practice currently? specifically around inquiry?
   *Prompt: current understanding of inquiry?*
5. Do you have any goals/expectations for yourself?
   *Prompt: Is there anything you hope to know, accomplish, or learn about by the end of the term?*
6. What is your first impression of this group?
   *Prompt: How does this compare to other groups of teachers you've worked with in the past?*
7. What challenges do you think might arise?

Appendix D: Interview 2

Date: P#:

Second interview:

1. Why do you think inquiry has become a popular instructional model?
2. What was your motivation in joining this group?
3. How do you think inquiry compares to other teaching models?
4. How does this compare to other groups of teachers you've worked with in the past?
5. So far, has your thinking or perspective on inquiry changed at all? Last time you said:

6. Are you doing anything differently now than you did at the start of the term? (asking different questions, assigning different tasks? etc)
    1. Prompts: teaching wise, learning wise, with your students, with colleagues, collaboration?
    2. How often?
    3. What challenges are you finding?
7. How are you finding the evaluation for inquiry?
8. In the last meeting there was a heated discussion about systematic problems that make inquiry a challenge (phones, students showing up late, taking off grades vs going to students success, students not being prepared), do you think effective inquiry is possible despite these challenges?