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Lesson Study-Building Communities of Learning Among Pre-Service Science

Teachers

By

Fouada Hamzeh

A Thesis

Submitted to the Faculty of Graduate Studies

through the Faculty of **Education**

in Partial Fulfillment of the Requirements for

the Degree of **Master of Education**

at the University of Windsor

Windsor, Ontario, Canada

2014

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Lesson Study-Building Communities of Learning Among Pre-Service Science

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ABSTRACT

Lesson Study is a widely used pedagogical approach that has been used for decades in its country of origin, Japan. It is a teacher-led form of professional development that involves the collaborative efforts of teachers in co-planning and observing the teaching of a lesson within a unit for evidence that the teaching practices used help the learning process (Lewis, 2002a). The purpose of this research was to investigate if Lesson Study enables pre-service teachers to improve their own teaching in the area of science inquiry-based approaches. Also explored are the self-efficacy beliefs of one group of science pre-service teachers related to their experiences in Lesson Study. The research investigated four questions: 1) Does Lesson Study influence teacher preparation for inquiry-based instruction? 2) Does Lesson Study improve teacher efficacy? 3) Does Lesson Study impact teachers' aspiration to collaborate with colleagues? 4) What are the attitudes and perceptions of pre-service teachers to the Lesson Study idea in Science?

The 12 participants completed two pre- and post-study surveys: STEBI- B, Science Teaching Efficacy Belief Instrument (Enochs & Riggs, 1990) and ASTQ, Attitude towards Science Teaching. Data sources included student teaching lesson observations, lesson debriefing notes and focus group interviews. Results from the STEBI-B show that all participants measured an increase in efficacy throughout the study. This study added to the body of research on teaching learning communities, professional development programs and teacher empowerment.

DEDICATION

To my best friend and my husband – Thaer - For your love, your faith in me and for your continued support. I could not have done it without you!

To my children, Omar and Mia - I am so thankful for your understanding why mom could not be there all the time. You are my miracles and my inspiration.

To my mom - Thank you for teaching me perseverance.

To dad - I know you are watching over me.

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I would like to acknowledge my advisor, Dr. Geri Salinitri who has been my role model for many years and I am blessed to have worked under her supervision. Her guidance, support and faith in me are the pillars of my success.

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LIST OF ABBREVIATIONS AND SYMBOLS

ASTQ- Attitudes toward Science Teaching Questionnaire

M- Mean

PSTE- Personal Science Teaching Efficacy Scale

STOE- Science Teaching Outcome Expectancy

STEBI form B- Science Teaching Efficacy Belief Instrument

SD- Standard Deviation

SPSS- Statistical Package for Social Sciences

CHAPTER 1

INTRODUCTION

Most of Ontario school boards' improvement plans are geared towards student achievement. These plans are based on a well-known belief that improving teacher quality through high quality forms of professional development will improve student achievement (Darling-Hammond, 1998; Hargreaves & Fullan, 2012). According to research in science teacher professional development, teacher beliefs are significant in the development of teacher practice (Lakshmanan, Heath, Perlmutter, & Elder, 2011; Loucks-Horsley, 1998). Moreover, self-efficacy beliefs expressed during professional development programs play a fundamental role in the efficiency of the program itself, and in its effectiveness in supporting teacher growth. The format of professional development programs has taken a new stance, whereby many professional development programs are now sustainable, place teachers in learning environments that allow them to build their knowledge alongside their peers and that in turn empower teachers (Kibodeaux, 2010; McLester, 2012).

Japanese Lesson Study is a promising approach that has been used for decades in Japan as the predominant means of teacher improvement. It is a teacher-led, learning community form of professional development that is embedded within the regular role of teachers. Education researchers, Lewis and Tsuchida (1997) introduced Japanese Lesson Study to the United States in 1998 after decades of success in Japan. Lesson study involves the collaborative efforts of teachers in co-planning and observing the teaching of a single lesson within a unit for evidence that the teaching practices used are appropriate for helping students learn. The teachers begin by setting long-term learning goals and

success criteria for their students based on achievement gaps or student characteristics identified for improvement. The lesson is planned collaboratively, taught in a classroom by one of the teachers while the other teachers observe the classroom climate and video record the lesson. The observations focus on collecting evidence of the instructional strategies used in the lesson to promote the desired student learning. It is based upon logic that the best place to begin to improve teaching is in a classroom context where student learning occupies the heart of the process (Lewis, 2002a; Stigler & Hiebert, 1999). Soon after the lesson is taught, the group discusses their observations in a post colloquium group meeting. The discussion leads to revisions to the lesson, which is then followed by a second teaching with observation. Lesson Study offers a unique prospect for teachers to examine student work, which allows the educators within a school community to make important decisions regarding the diagnosis and treatment of learning gaps and challenge of practice in their school context. Lesson Study is conducted within a collegial learning community environment.

Some of the recent research on the lesson study practice in the United States and Canada has fixated on the obstacles of implementing the practice and the reliability of that implementation to the ideal Japanese Lesson Study (Chokshi & Fernandez, 2004, 2005; Takahashi & Yoshida, 2005). There is limited research on specifically how lesson study might help teachers improve their practice and self-efficacy. Lesson Study's status is a relatively new form of professional development in this nation. When it was first introduced into North America, research efforts focused on describing the process as it was introduced, practiced, adapted, and maintained in schools across the country

(Chokshi & Fernandez, 2004, 2005; Takahashi & Yoshida, 2005). Later, Lesson Study was used predominantly in Mathematics to improve teacher practice and in turn student achievement.

As a promising form of professional development, Lesson Study can support teacher led endeavours such as learning communities instead of traditional expert-led workshops that are disconnected from real classrooms. Learning communities have the potential to empower teachers in a variety of ways that can lead to improved student learning (Murphy & Lick, 2004). Such professional learning communities provide teachers with the opportunity to establish the direction of their own professional growth and improve their practice in a collegial, supportive environment (Desimone, Porter, Garet, Yoon & Birman, 2002). Participating in a learning community is essentially an empowerment process that has the potential to be a positive influence on practice (Marks & Louis, 1997, 1999). Empowerment should start at an early stage in a teacher's profession, better yet at the preparation stage in pre-service programs. Learning communities should be part of the teacher preparation programs in order to provide the pre-service teachers with the opportunities to establish the course of their own professional growth.

Purpose of the Study

In this study, I explored how Lesson Study affects pre-service teachers in their own teaching in the area of science inquiry-based instruction. Further I examined the self-efficacy beliefs of science teachers related to their experiences in a Lesson Study group. This study was qualitative in nature and I used both social constructivism and self-efficacy as a dual theoretical framework. I relied on a pre and post case study approach to

explore the experiences of twelve pre-service teachers. Conducting a case study allowed me to focus on the impact of Lesson Study on pre-service teachers who were determined to improve their teaching. This study adds to the body of research on teaching learning communities, professional development programs, Lesson Study and teacher empowerment.

Theoretical Framework

Theories of constructivism and social cognition formed the framework of this study. This study focused on self-efficacy of the pre-service teachers and the effectiveness of Lesson Study using inquiry-based science approaches.

Constructivism

The principles of constructivism lay the foundation for understanding and implementing inquiry-based learning. Llewellyn (2007) stated constructivism is based on the ideas that knowledge is constructed by thinking individuals and that knowledge is self-regulated and self-mediated based on prior knowledge and experiences. In a constructivist classroom, emphasis is placed on first acknowledging students' personal schema and how the students interpret the teacher's language (Llewellyn, 2007). Similarly, great thinkers (Dewey, 1929; Kolb, 1975; Montessori, 1945) assert that education is a result of experiential learning based on real life experiences in order to construct knowledge. In Dewey's mind, learning had to have personal meaning for the student. In a classroom built upon the constructivist values, students learn naturally through their own explorations and inquiries. Likewise, in a classroom where constructivism is understood, students work together to solve real world problems and

analyze the opinions of others. Shifting traditional teacher directed modes of instruction towards a student-centered model where learning is co-constructed by the teacher and the students.

It is the learning community nature of Lesson Study and its constructivist approach in implementing science inquiry-based approaches that informs this study. According to the principles of constructivism, the individual learner constructs knowledge through a social process of sharing and interacting in a specific social or cultural context (Guba & Lincoln, 1989). Throughout Lesson Study, the learners create an understanding of their experience through the social interaction and the reflective process.

In education, the dominant view of learning has shifted to one where the student is an active participant in the learning process and brings to the learning task, prior knowledge from experiences that will affect the learning that will take place (Haney & McArthur, 2002). In turn, the learners are not spoon-fed knowledge, but instead construct it through active and hands on investigations that relate to their everyday life (Driver, Newton, & Osborne, 2000). This kind of knowledge construction may be achieved in an inquiry-based science classroom. To elaborate more on this type of a constructivist classroom, I taught the process of evolution to students. Students had a difficult time visualizing the little details that were mentioned about the evolution of species and the geographical changes in the Galapagos Islands off the coast of Ecuador. Some of my students accompanied me on a fieldtrip to the Galapagos Islands. They were able to formulate their own knowledge of evolution based on the observations they took on the islands. They made the connections between the concepts taught in class and what they

were able to see. That was a true construction of knowledge based on new learning experiences and prior knowledge.

Substantial research (Baker et al., 2008; Burris & Garton, 2007) suggests a positive impact of constructivist approaches on student dispositions. Herman and Knobloch (2004) found that the constructivist approach generated increases in motivation and interest. They reported that students preferred the constructivist approach to the traditional methods. The National Research Committee (NRC, 1996) released the National Science Education Standards (NSES). These standards highlight the ability to conduct inquiry and develop an understanding about scientific inquiry. The NSES recommended that students in all grades and every domain of science should have the opportunity to engage in inquiry-based learning. This approach allows students the freedom to frame their own research questions, to design and develop methods for testing the questions, to use appropriate tools and techniques to gather data and to think critically and logically about their results in order to construct explanations. In this approach, the teacher will have to modify their teaching practice in order to support the learning through inquiry. Subsequently, students are motivated by inquiry learning. This type of constructivist environment promotes students' curiosity and motivates them to investigate their interests, which promotes independent learning (White-Clark, DiCarlo, & Gilchrist, 2008).

Becoming an inquiry teacher requires creating and sustaining reflective practices and discourse with other teachers. Sergiovanni (1996) states that good teaching requires teachers to reflect on their practice. For that reason, teachers should establish a network of collaboration such as Lesson Study groups in order to abolish the reluctance that

accompanies the changes in instructional practices when their beliefs about teaching and learning are incompatible with that of the innovation (Davis, 2003; Haney, Lumpe, Czerniak, & Egan, 2002).

Social Cognitive Theory

Based on social cognitive theory, teacher self-efficacy may be conceptualized as individual teachers' beliefs in their own ability to plan, organize, and conduct activities that are needed to reach given educational goals. Personal self-efficacy is defined as "a judgment of one's ability to organize and execute given types of performances" (Bandura, 1997, p. 21). Based on Bandura's definition of self-efficacy numerous instruments have been developed to measure (personal) teacher self-efficacy. Most of these instruments either do not measure teacher self-efficacy as a multidimensional construct, do not reflect the variety of tasks and demands that are put upon a teacher, or do not follow Bandura's recommendation for item construction (Skaalvik & Skaalvik, 2007). In the field of science education, monitoring and reacting to the issue of self-efficacy is measured through Science Teaching Efficacy Belief Instrument (STEBI), which was developed by Enochs and Riggs (1990).

Since there is a causal relationship between beliefs and behaviour, it is important to note that self-efficacy can be influenced by four major factors: mastery experiences, vicarious experiences, verbal persuasion, and physiological arousal (Bandura, 1977). Mastery experiences refer to previous experiences gained through performance of a given task. Success with mastery experiences increases self-efficacy beliefs, whereas frequent failures will decrease self-efficacy. In addition, the greater the self-efficacy, the more likely the participant will be to carry on when complications arise (1997). Vicarious

experiences are another source of efficacy beliefs in which individuals learn from others through observation and use these observations as a source of information in the beliefs that are formed about the self (Bandura, 1997). In essence, when an individual observes a person believed to be of similar ability achieve success, this raises the observers' beliefs in their own efficacy, whereas failures of this similar other, lower the individuals' beliefs in their own efficacy (1997). The third source of efficacy beliefs is verbal persuasion. This is found in the voiced support of friends and colleagues as they offer verbal support for the attempts and completion of tasks (Bandura, 1997). However, verbal persuasion success is dependent upon the reliability of those providing the feedback, as well as the way in which it is "framed, structured, and delivered" (Bandura, 1997, p. 102). The fourth efficacy-influencing factor is physiological reaction. An individual's self-efficacy is based in part on analysis of his or her emotional and physical states during task planning and performance. Feeling calm and composed, rather than nervous and worried, when preparing for and performing a task leads to higher self-efficacy. These four factors have been shown to be important influences for improving efficacy. Henson (2001) suggests that teacher efficacy is malleable. In particular, mastery experiences have a strong influence on efficacy due to the direct nature of the feedback.

Pajares (1992) and Cantu (2001) have argued that a teacher's beliefs act as "a filter through which a host of instructional judgments and decisions are made." While Duffy and Anderson (1984) added that teachers possess theoretical beliefs that frame their instructional behaviours and that research in this area has the potential to provide information concerning how teachers think (Pintrich, 2002). Researchers Clark and Peterson (1986) brought the ideas of theoretical beliefs and teacher's beliefs together in

that “the process of teaching will be fully understood only when these two domains are brought together and examined in relation to one another” (p. 256). This statement has become the inspiration of this study.

Research Problem

The use of Lesson Study is commonly studied in the area of Mathematics. Very little research has been done in the context of science inquiry approaches and Lesson Study. Basically, Lesson Study is new to North America and specifically to Canada (Chassels and Melville 2009; Lewis, Perry, Hurd, and O’Connell, 2006). Furthermore, most pre-service teachers are not familiar with Lesson Study approaches that focus on active learning in the classroom.

In the past 14 years as a secondary school science teacher, I have often observed in-service and pre-service teachers teaching science lessons. I have noticed that most experiments and activities follow a recipe book format. Problem based and inquiry-based activities are rarely introduced to students. I was also involved with an action research collaborative study to introduce and assess the use of inquiry in the science classroom. The study involved two experienced secondary science teachers who collaborated with elementary science teachers on the development of inquiry-based approach lessons. The lessons were then delivered in the elementary science classrooms. The examples of the inquiry-based activities addressed higher-order thinking levels in their learners. Elementary teachers reported that the learners were “very happy with the lesson” and “gained a lot of knowledge.”

Research Questions

Given these purposes and objectives, and against the background of my working assumptions, I sought to address the following questions:

1. Does Lesson Study influence teacher preparation for inquiry-based instruction?
2. Does Lesson Study improve teacher efficacy?
3. Does Lesson Study impact teachers' aspiration to collaborate with colleagues?
4. What are the attitudes and perceptions of pre-service teachers to the Lesson Study idea in Science?

Definitions and Operational Terms

The meanings of terms commonly used in education can be interpreted in different ways. To ensure clarity for the reader the following definitions are provided below:

Attitudes toward Science Teaching Questionnaire- ASTQ is an adapted version of the Revised Science Attitude Scale (Thompson & Shrigley, 1986). The Revised Science Attitude Scale consists of 19 items, which are five point Likert-type attitude scale ranging from strongly agree to strongly disagree.

Inquiry is a term defined by the National Science Education Standards (NRC, 1996) and refers to the following:

Diverse ways in which scientists study the natural world and propose explanations based on evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world. (p. 23)

Inquiry-Based approach identifies researchable questions, designs and conducts experiments, develops explanations, and forms a relationship between evidence and explanations after rigorous critical thinking.

Knowledgeable Other is defined as a content specialist or a content educator who provides information about subject matter content, new ideas, or reforms (Watanabe & Wang-Iverson, 2002).

Learning Community is formed when educators committed to working collaboratively in ongoing processes of collective inquiry and action research to achieve better student achievement results. Professional learning communities operate under the assumption that the key to improved learning for students is continuous job-embedded learning for educators (Dufour, Dufour & Eaker, 2011).

Lesson Study is a professional development approach that originated in Japan. The translation of the word “lessons” is *jogyo* and “study” is *kenkyuu* (Lewis, Perry, & Murata, 2003). Lesson Study encompasses a teacher-led instructional improvement cycle in which teachers work collaboratively to formulate goals for student learning, plan a lesson, teach and/or observe the lesson, and reflect on the taught lesson (Perry & Lewis, 2003).

Personal Science Teaching Efficacy Scale (PSTE) is one subscale of the STEBI that measures the belief that one’s teaching ability is related to positive changes in students’ behaviours and achievement levels.

Professional Development, according to Guskey (2000), are those processes and activities designed to enhance the professional knowledge, skills, and attitudes of educators so that they will improve the learning of students.

Research Lesson, according to Lewis (2002b), is the centerpiece of lesson study; an actual classroom lesson revised by a group of teachers participating in a lesson study.

Science Teacher Efficacy Belief Instrument (STEBI Form B) is a quantitative instrument based upon Bandura's social learning theory that beliefs are part of the foundation upon which behaviours are based. The STEBI form B is used with pre-service science teachers. It is composed of two subscales that specifically measure and come self-efficacy and outcome expectancy. Self-efficacy is measured by the subscale Personal Science Teaching Efficacy Scale (PSTE). Outcome expectancy is measured by the subscale, Science Teaching Outcome Expectancy Scale (STOE; Enochs & Riggs, 1990).

Science Teaching Outcome Expectancy (STOE) is one subscale on the STEBI that measures the belief that any teacher, in spite of all factors, can affect student learning.

Teacher Efficacy is described as "a belief that is a judgment of his or her capabilities to bring about desired outcomes of student engagement and learning, even among those students who may be difficult or unmotivated" (Tschannen- Moran & Woolfolk Hoy, 2001, p. 783).

CHAPTER 2

LITERATURE REVIEW

Lewis, Perry and Murata (2006) stated a need for research into the iterative processes through which innovations can be simultaneously refined and more fully theorized. As Lewis et al. argue, “ideally, a strong theoretical base as well as extensive descriptive information are in place to provide the intellectual foundation for understanding causal relationships” (p. 8). In this section I outline my understanding of the importance of introducing and developing lesson study in pre-service teacher education as one strategy to equip teacher candidates to enter the profession with an inquiry that will allow them to approach their work as research in action and decide on their own professional development (Hiebert, Morris, Berk, & Jansen, 2007). This literature review examines the elements of how Lesson Study and inquiry-based approaches foster teacher efficacy and collaboration. As well, the effect of Lesson Study on professional growth is discussed. The goals of Lesson Study do not explicitly include collaboration and teacher efficacy. Therefore, a review of the research on collaboration and teacher efficacy is included as well.

Inquiry Based Approach

John Dewey (1916), a theorist and a philosopher, strongly believed that inquiry-based scientific approach could enhance education. Dewey advocated that teachers should always let children use their natural activity and curiosity when learning about a new concept (Vandervoort, 1983). Dewey advocated for a structure in education that provides a balance between delivering knowledge while also taking into account the interests and experiences of the student. He noted, “The child and the curriculum are

simply two limits which define a single process” (Dewey, 1964, p. 344). The teacher can create the learning environment to motivate the child and bring the real life experience to the class. Students also get more involved in critical thinking when they see the teacher as the model (Wrenn & Wrenn, 2009). Like Dewey, Vygotsky (1962) believed that learning was socially constructed. “By viewing learning as an active process, taking students prior knowledge into consideration, building on preconceptions, and eliciting cognitive conflict, teachers can design instruction that goes beyond rote learning to meaningful learning that is more likely to lead to deeper, longer lasting understandings” (Brader-Araje & Jones, 2002, p. 4). These are the foundational beliefs of constructivism and directly link to the methodology of inquiry-based instruction.

Much of the research gathered for the purposes of this thesis spoke mainly to the perceptions of increased engagement and heightened achievement. According to Lipka et al. (2005), the positive teacher perceptions of inquiry-based learning are due in part to “the long-term positive relationship between teacher and students that contribute to a classroom environment in which trust and mutuality were constructed” (p.382). Teachers who have a positive perception of the power of strong instructional programs often have increased job gratification and are far more likely to use emerging instructional technologies to further the learning gains possible through inquiry-based instruction (Dawson, Cavanaugh & Ritzhaupt, 2009). In particular, Hernandez-Ramos and De La Paz (2009) provide some insight into the benefits of inquiry-based instruction. They compared teacher-directed learning and inquiry-based learning among nearly 800 students in one middle school and roughly the same number of students in a neighbouring middle school with comparable student demographics and teacher credentials. The

students who received inquiry-based instruction performed better compared to those in the control group in the areas of content knowledge recall, intrinsic motivation and also experienced gains in the ability to think critically in the content area. Although not quantified, Hickey, Moore and Pellegrino (2001) assert that inquiry-based instruction methods are more effective than traditional teacher-directed methodologies even when employed by teachers opposing the implementation of initiatives supporting inquiry-based learning.

Lesson Study

Lesson Study is similar to many instructional collaborative strategies. One feature that makes lessons study distinct is the “observation of live classroom lessons by a group of teachers who collect data on teaching and learning and collaboratively analyze it” (Lewis, 2002a, 2002b; Lewis & Tsuchida, 1997; Wang-Iverson & Yoshida, 2005). Many characteristics of effective professional development programs incorporate Lesson Study. These characteristics include the following: it is site-based, practice-oriented, focused on student learning, collaboration-based, and research-oriented (Murata, 2011). During a Lesson Study, teachers come together with a shared question regarding their students’ learning, collaboratively plan a lesson to make student learning visible, and examine and discuss what they observe (Murata, 2011). Teachers have multiple opportunities to discuss student learning and how their implementation affects it.

Lesson Study can take place within just one school or can be opened to teachers and educators from a local school district. The frequency of Lesson Study group meetings can vary depending on the need, resources, and time available. It varies from several times a year to a more intensive schedule of meeting once a month or even once a week.

Researchers Lewis and Tsuchida (1997) and Yoshida (1999) have described the major elements of the Lesson Study cycle. These elements are explained briefly in the paragraphs below (Lewis, 2002a).

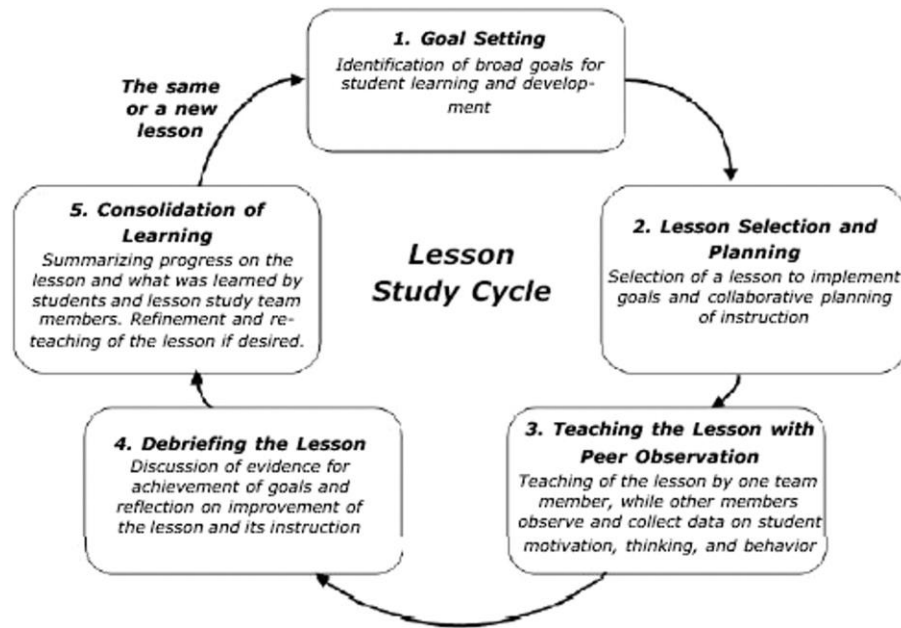


Figure 1. Lesson Study Cycle adapted from Lewis, 2002a

Goal Setting. The learning goal is the backbone of a lesson and provides the “reason” for teaching and observing the lesson. Study begins with the setting of long term goals for improvement that connect with desired forms of student learning, thinking, engagement, and behaviour. Teacher teams also discuss the concepts and topics of a specific subject matter on which their lesson will be based. When setting the goals for Lesson Study, teachers might think about the biggest gap between what they perceive as students’ actual qualities and those that are ideal. Some examples of these broadly stated goals include “to develop instruction that ensures that students achieve basic academic abilities while fostering their individuality,” or “for students eyes to light up when learning science,” or “for students to become problem-solvers” (Lewis, 2002a). The

Lesson Study group then interprets these broadly specified learning goals into the context of a particular grade level or subject matter theme.

Lesson Selection and Planning. The Lesson Study group then identifies a unit of study and choose a specific topic. The chosen unit and topic are aligned with both overarching goals and the more specific grade or subject matter goals (Lewis, 2002b; Research for Better Schools, 2003). The Lesson Study group members then meet once or on regular basis to collaborate on the planning of the specific lesson and how it will be taught. During this phase of lesson selection, teachers may suggest resources such as textbooks, websites, and materials to strengthen the lesson preparation process. In addition, the Lesson Study group members might invite an outside expert (a so-called knowledgeable other) to help enhance content knowledge about the subject matter, discuss ideas about how students think and learn, or otherwise support the planning of the research lesson (Research for Better Schools, 2003).

Teaching the Lesson with Peer Observation. After agreement is reached about the best strategies for the lesson and its instruction, one of the teachers who participated in the planning teaches it to an actual class. Any one of the teachers that participated in the planning of the lesson might do the teaching. Lesson Study is different from any other lesson in that the teaching is observed by fellow teachers in the Lesson Study group, along with the knowledgeable other(s) and the lesson is sometimes videotaped. The observers might collect data on student learning, thinking, and problem solving (Lewis, 2002a). In Japan, the Lesson Study is sometimes observed by teachers from other schools, even teachers traveling from other regions of the country. Although the teacher delivering the lesson may feel some trepidation, this is minimized because the lesson is

collaboratively planned and because the focus of the observation process is on the lesson, not on the teacher.

Debriefing the Lesson. After the Lesson Study, participants meet to debrief the lesson. This research colloquium typically begins with the teacher who taught the lesson speaking first about his or her perceptions of what went well or went poorly. The other members of the Lesson Study group then explain the goals for the lesson and how it was designed to achieve them. The group will then watch the videotape together. The entire group will discuss the evidence gathered during the lesson, using either a structured or more open-ended format. Observers report on what students did during the lesson, on evidence of student learning, and on the level of students' engagement, persistence, and/or frustration. The discussions are often lively and not formal since the lessons by their design evoke the different perspectives that individuals hold about how children learn and develop (Lewis, 2002a). All discussions serve not as a criticism of the teacher's technique, but as an appraisal of the whole group's efforts to create a lesson that addresses the goal established at the beginning of the Lesson Study cycle (Lewis, 2002).

Consolidation of Learning. The Lesson Study group reviews the artifacts they have collected throughout the process. The group then identifies evidence of student learning. In addition, teams begin identifying areas where students are struggling with achieving the learning goals. Based on the analysis of the data, the group identifies needed changes in the research lesson and continues to improve the lesson. The lesson is often retaught by a new teacher after incorporation of the modifications (Lewis, 2002a).

Lesson Study in Teacher Training

In one published study conducted at Georgia State University by McDowell (2010) graduate students were working toward a teaching certificate in middle and secondary science and a Master's degree in education. Graduate students enrolled in a required course that focused on theory and pedagogy in science education, which coincided with a ten-week practicum teaching experience. It was in this course that McDowell (2010) worked with sixteen pre-service teachers. The purpose of McDowell's study was to explore pre-service teachers' use of Lesson Study as they transition in teaching nature of science (NOS) curriculum. Through data analysis, the outcomes indicated that the pre-service teachers' experiences with Lesson Study supported the transfer of NOS understandings into classroom practice (McDowell, 2010).

Japanese teachers who are involved in Lesson Study see Lesson Study as a way to bring into the classroom the country's universal educational vision (Lewis, 2002a). They say that the most powerful facet of Lesson Study is "that you develop the vision to see children. So you're really watching how children are learning, and learning to see things that you didn't see before: their thinking and their reactions" (Lewis, 2002a, p. 5).

One of the major goals of Lesson Study is to share practically originated knowledge to improve teaching and learning in a collaborative environment (Takahashi, 2005). This type of approach with pre-service teachers is of great interest to researchers who strive to improve teacher education programs.

Video Taping in Lesson Study

According to the Center of Educational Policy Research (CEPR) at Harvard, the subject of effective teaching is at the front of educational research, which includes large national projects, like the National Center for Teacher Effectiveness, and program evaluations. The CEPR conducted the Measures of Effective Teaching (MET) project, a \$52 million study sponsored by the Bill and Melinda Gates Foundation. The project involved 3000 teachers from six different school districts across the United States. The MET project's goal was to build and test measures of effective teaching to find out how evaluation methods could best be used to tell teachers more about the skills that make them most effective and to help districts identify and develop great teaching (www.metproject.org). The outcomes of the research were numerous. Teachers were able to use the videos for self-reflection, feedback from peers, and tracking professional growth (Gates Foundation, 2010).

Teacher reflective behaviour is encouraged by use of tools such as video recording and analysis (Rich & Hannafin, 2009). According to Orlova (2009), Hennessey and Deaney (2009), the permanence and objectivity potential of video can allow educators to repeatedly and closely examine classroom practice and sustain professional development. Goodlad (1984) further emphasized that with “the availability of resources for videotaping lessons for purposes of self-examination, teachers can engage successfully in a considerable amount of self-improvement” (p. 127).

Reflection as educational practice can be traced back to Dewey. In *How We Think*, Dewey (1933) expressed the importance of reflection as a holistic methodology for problem solving. He viewed reflection as action that is important for better teaching

practice and an innovative consideration of attending to teaching challenges and student learning.

Professional Development

Formal teacher education has seen few changes over the years, despite a steady stream of new educational theories, constant refinement and updating of degree plans at faculties of education, and additional qualifications (Diez, 2007; Flake, 2001). Teachers are doing the same thing in their classroom that was done generations ago. A study conducted for the Third International Mathematics and Science Study, in which teachers were videotaped in the classroom, concluded that teachers continue to use very traditional teaching methods, regardless of the structure of the school or the culture of the community (Roschelle et al., 2010; Stigler, Gonzales, Kawanaka, Knoll, & Serrano, 1999).

The school boards need to give teachers the opportunity through high-quality professional development, to learn new strategies for teaching, and in turn change their teaching in the classroom to meet the needs of the 21st century learners (Alexander, Heaviside, and Farris, 1999; Smith, 2008). High quality professional development comes in many different shapes and forms. One of the highlights of Lesson Study as a professional development is the change in teachers' beliefs. Changes in teachers' beliefs are more likely to occur in settings in which teachers consider learning a shared activity (Joyce & Showers, 2002). When teachers have the time to interact, co-plan lessons, discuss teaching, they grow and their students' behaviours improve accordingly. This is because social persuasion is a powerful means of changing beliefs, as has been suggested by a number of researchers (Bandura, 1995; Hardin, 2010; Schunk, 1981; Zimmerman &

Ringle, 1981). A sense of community provides supportive coaching that is necessary not only to bring about changes in beliefs, but to help teachers and retain a sense of efficacy regarding new teaching strategies (DuFour, DuFour and Eaker, 2010; Ellwood, 2013; Showers & Bennett, 1987). Professional development should be predicated on curricular and instructional strategies that have a high probability of affecting student learning, and just as important as students' ability to learn (Joyce and Showers, 2002). Professional development should (1) deepen teachers' cognizance of the subjects being taught; (2) hone teaching skills in the classroom; (3) keep up with developments in education; (4) generate and contribute incipient knowledge to the profession; and (5) increase the ability to monitor students' work, in order to provide constructive feedback to students (The National Commission on Mathematics and Science Teaching for the 21st Century, 2000).

In-service teachers are constantly being asked to meet the demands of increasingly diverse student populations. Although ample research documents the specific needs of students, insufficient investigation is being done at the pre-service teacher level to prepare them to recognize and meet these needs (Bangel, Enersen, Capobianco, & Moon, 2006). In order for teachers to make more grounded judgments about what is going on and what teaching strategies may be helpful, they need to know how to take the steps necessary to gather additional information. Primarily, teachers need to keep what is best for the child at the center of their decision-making (Bransford, Darling-Hammond, & LePage, 2005).

The use of action research and Lesson Study methodologies at school sites are only some of the approaches to professional development that have been undertaken. There is no unanimity in the literature regarding outcomes and clearly no universal

remedy despite the fact that these methods appear to have some efficacy in professional learning and development (Zeichner, 1991).

Teacher Collaboration

Teachers who work together to set goals, plan lessons, and reflect on and improve their teaching practice, develop a culture of collaboration (Eaker, DuFour, & Burnette, 2002). Such a culture emphasizes the importance of both the individual and the social context of learning. Teachers in North America have a long history of collaboration, but the idea of observing a colleague's classroom and engaging in reflective dialogue with partner teachers is not common and somehow frowned upon by teachers. This has led the teaching culture in North America to become isolating because the majority of teachers spend their days in their own classroom, often with the door closed (Stigler & Hiebert, 1999).

Usually, the vast majority of the teaching time is spent with students in the classroom. Collaboration among teachers makes the teaching process easier since it provides perspective, diversity, and space for teachers to consider questions about student learning. This approach can provide opportunity for professional growth on many levels. Studies have shown that teacher collaboration improves teacher's self-efficacy as well as student learning (Williams, 2010).

Many studies have indicated that teacher effectiveness increases when teachers work together with other teachers (Garmston & Wellman, 1999; Graziano & Navarrete, 2012; Hawley & Valli, 1999; Hiebert & Stigler, 2000; Sparks, 2013). Synergies are usually created when interactions between people happen. The synergies make the work stronger than the collection of the individual talents (Bandura, 2006). There are multiple

facets of teacher collaboration that have shown support for teacher effectiveness including: observing new strategies being modeled (Garmston & Wellman, 1999; Hawley & Valli, 1999), planning lessons together (Hiebert & Stigler, 2000), and engaging in peer coaching (Garmston & Wellman, 1999; Hawley & Valli, 1999). Garmston and Wellman (1999) report that teachers who have a collective shared responsibility for improving the practice of teaching and learning, they form a culture of collaboration where both teachers and students benefit. Garmston & Wellman (1999) further report that in high schools where collaboration was a collective responsibility of the teachers, students significant gains in many areas such as mathematics, science, and reading than in schools where the collective sense was weaker.

Teacher Efficacy

In 1977, Albert Bandura a Canadian psychologist proposed a theory of self-efficacy in which the generalized behaviour of an individual is dependent on two factors, a belief about action and outcome, and a personal belief about one's ability to cope with a task. In his seminal work, Bandura defined self-efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). Researchers Tschannen- Moran and Woolfolk Hoy (2001) defined teacher efficacy as a teacher's "judgment of his or her capabilities to bring about desired outcomes of student engagement and learning, even among those students who may be difficult or unmotivated" (p. 783).

Teacher efficacy emerged as a worthy variable in educational research. Woolfolk and Hoy (1990) noted that researchers have found some consistent relationships between characteristics of teachers and the behaviour or learning of students. One of the emerging

findings of Woolfolk and Hoy research is that teachers' self-beliefs are determinants of teaching behaviour. Many studies by Woolfolk Hoy (2003), Bandura (1977), Fencil and Scheel (2005) show that teachers who have an easier time motivating their students and improving their cognitive development, are teachers with a high sense of efficacy about their teaching abilities. These teachers may also be able to recover from impediments and more eager to try new ideas or techniques. Low efficacious teachers may rely more on a controlling teaching style and may be more critical of students (Bandura, 1977; Woolfolk Hoy, 2003).

In a self-efficacy study (2007), the researchers Tschannen-Moran and Hoy concluded that when teaching resources and interpersonal support were available to the less experienced teachers, a significant increase in teacher's self-efficacy was noted.

Science Teaching Self-Efficacy

The problem of efficacy is relevant to science teaching, particularly science teaching with a novel method such as inquiry. In general, science teachers are apprehensive about their capability to apply an innovative teaching method and about the adequacy of their own professional training in science content and science teaching. This is especially true for elementary teachers who tend to lack content knowledge in the science area. A research conducted by McComas and Wang in 1998 concluded that low self-efficacy is likely to make science teachers less motivated and less effective in teaching. In most cases, science teachers' training consists of only content knowledge and pedagogy. There is little or no attention paid to increasing teachers' self-efficacy. Thus, it is not likely to transform science teaching in the desired manner. The question then arises how to develop and strengthen self-efficacy in science teachers generally and

elementary science teachers in particular (Cooper, Kenny & Fraser, 2012; McComas & Wang, 1998).

It is convincingly argued that inquiry approaches are very reliable means of efficacy development (Ashton and Webb 1986; Cervone, 2000; Gibson & Dembo, 1984; Woolfolk & Hoy 1990). The reasoning behind the inquiry approach is that people learn best through personal experience and by making connections to prior knowledge. As Bhattacharyya and Lumpe (2009) and Westbrook (as cited in Flick et al. 1997) observed, the inquiry approach enables students to understand data. More than a procedure or a method, it is a process of investigating how or why or what and then making sense of the resultant findings.

Action Research

Action research offers a systematic way for individuals to explore issues and determine potential resolutions through collaborative inquiry, reflection, and dialogue (Mills, 2003; York-Barr, Sommers, Ghore, & Montie, 2006). This self-directed approach to professional growth is well documented as a rewarding professional learning experience for those who engage in the process (Gillis, Wilson and Elias, 2010; Somekh, 2005; West, 2011). Action research results in thoughtful action aimed at improving practice based on the careful examination of evidence. It is collaborative in nature and fosters an environment of shared responsibility for student growth and well-being. Furthermore, it promotes self-reflection, which is an essential component of lifelong learning (Furlong & Salisbury, 2005).

Discussion

After reviewing the literature, it is indicative that Lesson Study should foster a collaborative teaching culture and might increase the efficacy of pre-service teachers. Scientific thought and concepts build on a base of understanding scientific inquiry. Therefore, when pre-service teachers do not learn how to use inquiry in science lessons, their students' science experience is compromised (National Research Council, 1996). I believe that the incorporation of lesson study into pre-service teacher education allows beginning teachers to engage meaningfully with inquiry into teaching.

Wilms (2003) observed that Lesson Study provided an opportunity to learn how other teachers teach particular subject matter. This might foster collaboration among teachers and especially pre-service science teachers. Paulo Freire (1972, p.109) reminds us that “knowledge is not extended from those who consider that they know to those who consider that they do not know; knowledge is built up in the relations between human beings.”

CHAPTER 3
METHODOLOGY

Introduction

In this chapter, I will provide a thorough articulation of the methods used in this study. Included in this chapter are the purpose of the study, demographics of the participants, variables, research design, a detailed review of the instruments, history of the usage of the instruments, data analysis, and the internal and external threats to the validity and reliability of the study.

To maximize richness and accuracy of data, as well as transferability of the findings, I decided that case study approach would be the best methodology. Case studies allow the researcher to become familiar with the data in its natural setting and fully appreciate the context (Punch, 1998). This correlational case study involved collecting quantitative and qualitative data. Accordingly, two questionnaires were utilized to collect descriptive data. Data collected from the quantitative questionnaires were analyzed to gauge pre- service teachers' self-efficacy and knowledge about science inquiry-based instruction. The qualitative data were coded, categorized, analyzed and triangulated with researcher observation of the pre-service teachers' classroom practices to determine the effectiveness of Lesson Study.

Participants and Setting

In the Fall 2013 semester, 48 pre-service teachers, $N = 48$, were enrolled in the intermediate-senior Biology, Chemistry, General Science and Physics Methodology courses. At the beginning of the Winter 2014 semester, the first twelve prospective participants for this study who responded to a call for participation were chosen purposefully based on a provided consent. Only 12 participants were required to form three groups of four for the Lesson Study. This purposeful type of sampling is based on convenience, since initially, the researcher wanted to recruit the 12 participants in the intermediate-senior chemistry methodology course. All of the 12 students in the chemistry course had either general science or biology as their second teachable. Additionally, the availability of the pre-service teachers, the study's objectives and subject discipline area were factors for the selection process. Participants were divided into three groups of four each. They were grouped based on mixed genders and education background. The remaining 36 pre-service students composed the control group.

To conduct Lesson Study in real settings, a formal request for participation was sent out to the superintendent of education at the public secondary school board in a city in Southwestern Ontario. Six secondary science teachers that I had a professional relationship with were sent a single email inviting them to participate in the research study. In-service teachers provided information about the topic of the lesson to be implemented in their grade 10 science classrooms. Three of the in-service teachers' role was to videotape the first lesson.

I met with the six secondary science teachers at two of the secondary schools. The in-service teachers were selected based on their teaching experience, at least five

years, and their teaching assignment. That is, every in-service teacher was teaching science at the current time of the research. All six teachers consented to participate and provided the timelines for pre-service teachers to meet with them in order to set up time for conducting the research lessons.

I introduced the participants (pre-service teachers) to the Lesson Study idea by thoroughly explaining the approach and providing examples of how it has been used. I focused the discussion on the Lesson Study process and emphasized how it works to help connect the different methods of teaching. At the end of the first session, the pre-service teachers were given the choice of topics suggested by the classroom teacher to work on in the Lesson Study. Two groups chose the Biology inquiry based activity, “How does the body make feces?” The third group chose the Physics inquiry based activity, “Jello Optics.” All activities were implemented in grade 10 applied, academic, and enriched science courses.

I met with each group of participants and co-planned the lessons during the second research session. I led the second session. This is a crucial assignment as pre-service teachers often lack experiences determining or assessing gaps in students' science inquiry skills, and how to decide on the relevant science/biology topics. Thus, their cooperating teachers' knowledge plays an important role in their development (Clark, 2007).

Participants were placed at the two local high schools based on the proximity of their practicum placement. One participant from the group initiated the teaching, while the other three participants observed their group member and took field notes. Three research participants volunteered to be the first to teach and be videotaped. The

classroom teacher video recorded the lesson for review during post lesson colloquium. During the post lesson colloquium, each group met with me in order to watch the videotape and discuss potential modifications for the activity. The remaining three participants, who did the observations, were then placed in different classrooms and carried on the same lesson but with modifications. The other two groups followed the same procedure. At the end of the Lesson Study, the STEBI-B and ASTQ surveys were completed and focus group interviews were conducted. This data was recorded and organized electronically.

Instrumentation and Data Collection

The Demographics questionnaire is a self-reported questionnaire that collected information regarding the following variables: gender (female or male), age group, and science education background (number of years completed). All 12 participants completed the questionnaire (developed by the researcher) only once on the first day of agreement to participate in the research. For each participant, a profile was created. In these profiles descriptions about past experiences relating to science education including years of science education are provided. No demographic posttests were administered.

STEBI-Form B

The experimental group participants completed the Science Teaching Efficacy Belief Instrument (STEBI), at two intervals, before the Lesson Study commences and after the Lesson Study was completed. Enochs and Riggs (1990) developed the STEBI in order to measure science teaching self-efficacy and outcome expectancy in pre-service elementary teachers. This was devised based on Bandura's work on self-efficacy. The STEBI-B consists of 23 statements rated on a five point Likert scale; strongly agree (SA),

agree (A), uncertain (UN) which was changed to neither agree nor disagree, disagree (D), and strongly disagree (SD). The STEBI-B is divided into two subscales; Personal Science Teacher Efficacy (PSTE) subscale, which reflect science teachers' confidence in their ability to teach science and Science Teaching Outcome Expectancy (STOE) subscale, which reflect science teachers' beliefs that students learn by being influenced by effective teaching. PSTE was measured with 13 questions and STOE was measured by 10 questions. Positive statements were coded as 5-4-3-2-1, and negative statements were coded as 1-2-3-4-5. Negative question items, 3, 6, 8, 10, 13, 17, 19, 20, 21, and 23 were scored inversely. Scores acquired from the two subscales indicate the belief level in science teaching about that factor. The possible range of PSTE scores is 13 to 65 while that of STOE scores is from 10 to 50. A high score indicates high level of self-efficacy and a low score indicates low level of self-efficacy. It should be noted that the PSTE and STOE do not add up to a total score as they measure two different aspects of science teaching self-efficacy.

History of Using STEBI-Form B

Through the access of Educational Resources Information Center (ERIC), Dissertation Abstracts, and Education Research Complete databases using the keywords STEBI, over 15 studies were found that used the STEBI to conduct research in the science education field. The STEBI-B is used in studies with pre-service teachers, while the STEBI-A is used with in-service teachers. These studies were published during 1995-2004.

ASTQ

Participants also completed a survey (Attitude towards Science Teaching -ASTQ) about their familiarity with science-inquiry based activities. This instrument was used as pre and post study survey. It was used to find out what the pre-service teachers' views of inquiry science teaching practice are especially perceptions and willingness toward inquiry based teaching. The questionnaire consisted of 19 questions all based on a five-point Likert scale. Response categories were accomplished by assigning a score of 5 to "strongly agree", 4 to "agree", 3 to "neither agree nor disagree", 2 to "disagree", and 1 to "strongly disagree". Out of 19 items, 11 were worded positively (Items 4, 5, 6, 8, 10, 11, 13, 15, 16 and 18) and 8 were worded negatively. The scoring was reversed for the negative statements. Consequently, the possible range of score of the ASTQ is 19 to 95.

The Science Teaching Attitude Scale has been stated to be a reliable, valid instrument useful in determining attitudes toward science teaching (Thompson & Shrigley, 1986). Appendix B displays The Science Teaching Attitude Scale.

Focus Group Interviews

One of the first characteristics of a qualitative research study is that researchers strive to understand the meaning people have constructed about their experiences (Merriam and Associates, 2002). The interview is central to a valuable case study research design (Yin, 2009). Experimental participants spent many hours together planning, teaching, observing, debriefing and modifying their inquiry based lessons. Therefore, the shared experiences lent itself to a shared interview, the focus group interview. Janesick (2004) stated that focus group interviews can have disadvantages, the unnatural social settings and often limited to verbal interaction. Additionally, it was

critical to explore how these lived experiences in a lesson study contributed to shared and individual perspectives about teaching specifically using science inquiry based approach. Therefore, a final focus group interview was conducted in a small group that represented each of the lesson study teams that were purposefully selected to participate in this dissertation. There was three-lesson study teams purposefully selected based on criteria further expounded upon later in this chapter. One interview was conducted with representation from all three groups, where six participants were selected. Generally, six to seven members are adequate to form a focus group (Botherson, 1994). The focus group interview with six participants lasted approximately an hour and a half. The interview was conducted outside of class time, in a school where the participants had their third practicum, therefore based on convenience. Field notes were taken during these final interviews and the interview was audiotaped.

CHAPTER 4

FINDINGS

Data sources included a survey/questionnaire, video recordings, and focus group interviews. Self-efficacy was measured with a pre and post internship format using the Science Teaching Efficacy Belief Instrument form B [STEBI-B]. Attitudes towards scientific inquiry were assessed using a pre and post study format using the ASTQ. Lesson Study video recordings and focus group interviews were transcribed. Constant Comparative Analysis was applied in this study. It is more often used as an analysis method in qualitative research (Glasser, 1965). Glasser (1965) further explained that this method requires the researcher to take one piece of data, such as an interview and compare it to all other pieces of data that are either similar or different. The researcher then looks at what makes this piece of data different and/or similar to other pieces of data. The method becomes inductive once the researcher begins to draw new meaning from the data.

The focus group interview typed transcripts were analyzed by looking for frequent themes regarding the participants' standpoints of Lesson Study and science inquiry-based instruction. Miles and Huberman (1994) devised a data analysis model (Figure 2) that aids the researcher by providing a visual reference as to how data can be tackled.

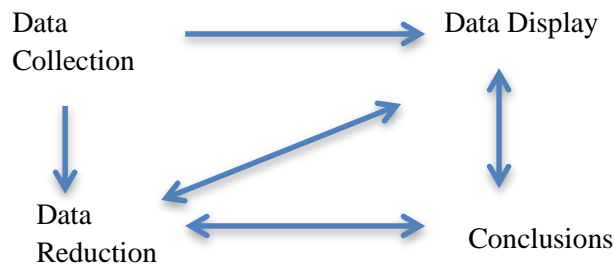


Figure 2. Components of Data Analysis: Interactive Model adapted from Miles and Huberman(1994)

Table 1

Research Questions and Data Sources

Research Question	Data Sources	Data Analysis
Does Lesson Study influence teacher preparation for inquiry-based instruction?	Pre-test and post-test questionnaire, researcher field notes.	Constant comparative analysis on interviews, triangulation with other data sources, descriptive statistics.
Does Lesson Study improve teacher efficacy?	STEBI pre-test and post-test, researcher field notes, teacher reflections, focus group interviews.	Descriptive statistics, paired two sample t-test, constant comparative analysis, triangulation of data.
Does Lesson Study impact teachers' aspiration to collaborate with colleagues?	Researcher field notes, teacher reflections, focus group interviews.	Constant comparative analysis, triangulation of data, member checking.
What are the attitudes and perceptions of pre-service teachers to the Lesson Study idea in Science?	Teacher focus group interviews, reflections, researcher field notes.	Constant comparative analysis, document review, triangulation of data and sources.

Note. Table 1 presents the four research questions. For each question, it indicates how the variables will be measured and analyzed in coordination with each research question.

Null Hypothesis was set up for research question number two. The null hypothesis stated that that there is no significant difference between science teaching self-efficacy of pre-service teachers before and after the intervention of Lesson Study. The

alternative hypothesis stated that there will be an increase in science teaching self-efficacy of pre-service teachers before and after the intervention.

Triangulation of the data in the form of surveys, focus group interviews, and field notes was used to see whether there were benefits that the pre-service teachers themselves attributed to the process. The credibility of the findings will be dependent on obtaining multiple perspectives of Lesson Study through interviews of the multiple participants and triangulating their comments with quantitative results and the researcher field notes.

Quantitative Results

Means (*M*) and standard deviations (*SD*) for each item in the ASTQ were calculated. The mean higher than 3.0 was interpreted as positive attitude, while the mean lower than 3.0 was interpreted as negative attitude.

I) Results of the Pre-Study Attitude Scale

Table 2 shows that the range of means of the participants' attitudes toward science teaching was 3.08 to 4.67. The overall mean and standard deviation of attitudinal scores were 4.01 and 0.96, respectively. Table 3 shows the range of means of the control group participants' attitudes toward science teaching from 2.78 to 4.67. The overall mean and standard deviation of control group attitudinal scores were 3.78 and 0.97 respectively. Since both attitudinal means were over 3.00, this indicates a positive attitude towards science teaching.

II) Results of the Post-Study Attitude Scale

Table 2 shows that the range of the means of the participants' attitudes toward science teaching was 3.67 to 5.00. The overall mean and standard deviation of attitudinal

scores were 4.29 and 0.72, respectively. In comparison, the control group participants' attitudes toward science teaching showed a range of 2.60 to 4.30. The overall mean and standard deviation of control group attitudinal scores were 3.48 and 1.14 respectively.

Table 2

Pre-service Science Teachers' Attitudes Toward Science Teaching

Statement	Pre-Study		Post-Study	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
1. I will feel uncomfortable teaching science.	4.25	1.13	4.67	0.49
2. I fear that I will be unable to teach science adequately.	4.00	1.12	4.33	0.65
3. Teaching science takes too much time.	4.00	1.12	4.17	0.94
4. I feel comfortable with the science content that will be taught in the future.	3.92	1.24	3.75	1.42
5. I will enjoy teaching science.	4.58	0.51	4.83	0.39
6. I would be interested in working in an experimental science curriculum	4.08	1.31	4.42	0.90
7. I dread teaching sciences.	4.50	0.90	4.83	0.39
8. I am not afraid to demonstrate science phenomena in the classroom.	3.67	1.23	3.92	0.79
9. I am not looking forward to teaching science in my elementary classroom.	3.08	1.51	4.08	0.90
10. I will enjoy helping students construct science equipment.	4.17	0.72	4.42	0.51
11. I am willing to spend time setting up equipment for a lab.	3.92	1.08	4.50	0.52
12. I am afraid that students will ask me questions that I cannot answer.	3.25	1.42	3.83	1.03
13. I enjoy manipulating science equipment.	3.75	0.87	4.33	0.65
14. In the classroom, I fear science experiments won't turn out as expected.	3.25	1.06	3.67	1.07
15. Science would be one of my preferred subjects to teach if given a choice.	4.67	0.65	4.75	0.62
16. I hope to be able to excite my students about science.	4.58	0.51	5.00	0

17. Teaching science takes too much effort.	4.00	0.58	3.75	1.06
18. I feel that I can teach science effectively.	4.00	0.79	4.50	0.52
19. I will not enjoy teaching science by doing an experiment.	4.42	0.51	4.67	0.78
Total	4.00	0.96	4.29	0.72

The overall finding from the ASTQ indicated that the participants had positive attitudes toward science teaching since none of the scores were below 3.00. However, there were two items that the participants had a decline in attitudes toward science teaching, that is, Item four “I feel comfortable with the science content that will be taught in the future” and Item 17 “Teaching science takes too much effort.”

Table 3

Control Group- Pre-service science teachers’ attitudes toward science teaching

Statement	Pre-Study		Post-Study	
	M	SD	M	SD
1. I will feel uncomfortable teaching science.	4.00	1.22	2.80	1.33
2. I fear that I will be unable to teach science adequately.	3.67	1.12	3.20	1.48
3. Teaching science takes too much time.	3.89	1.27	3.00	1.32
4. I feel comfortable with the science content that will be taught in the future.	3.56	1.24	4.10	0.88
5. I will enjoy teaching science.	4.44	0.53	4.00	0.67
6. I would be interested in working in an experimental science curriculum	3.78	1.39	3.20	1.55
7. I dread teaching sciences.	4.33	1.00	3.80	0.79
8. I am not afraid to demonstrate science phenomena in the classroom.	3.33	1.22	3.80	1.03
9. I am not looking forward to teaching science in my elementary classroom.	2.78	1.56	3.10	1.52
10. I will enjoy helping students construct science equipment.	4.00	0.71	4.10	1.20

11. I am willing to spend time setting up equipment for a lab.	3.56	1.01	3.80	0.79
12. I am afraid that students will ask me questions that I cannot answer.	2.78	1.30	2.60	1.43
13. I enjoy manipulating science equipment.	4.00	0.71	3.40	1.07
14. In the classroom, I fear science experiments won't turn out as expected.	3.56	1.01	2.70	1.42
15. Science would be one of my preferred subjects to teach if given a choice.	2.78	1.30	3.80	0.92
16. I hope to be able to excite my students about science.	4.56	0.53	4.30	0.48
17. Teaching science takes too much effort.	4.00	0.47	2.80	1.55
18. I feel that I can teach science effectively.	3.89	0.82	3.60	1.07
19. I will not enjoy teaching science by doing an experiment.	4.22	0.44	4.00	1.15
Total	3.78	0.97	3.48	1.14

The overall finding from the ASTQ indicated that the control group participants, who did not receive the intervention of Lesson Study, had mostly positive attitudes toward science teaching since most of the scores were over 3.00. However, there were three items that the participants expressed negative attitudes toward science teaching, that is, Item 9 “I am not looking forward to teaching science in my elementary classroom”, Item 12 “I am afraid that students will ask me questions that I cannot answer” and Item 15 “Science would be one of my preferred subjects to teach if given a choice.” There were 12 items that the participants expressed a decline in attitudes toward science teaching. These are Items 1,2,3,6,7,12,13,14,16,17,18 and 19, which are shown in bold in table 3.

III) Results of the Pre-Study and Post-Study Science Teaching Efficacy Scale

The overall findings from the STEBI-B indicate an increase in self-efficacy among the experimental group of pre-service teachers as seen in Table 4. A mean increase from 3.86 to 4.18 supports the conclusion that the intervention of Lesson

Study improved teacher self-efficacy. Item 10 “The low achievement of some students cannot generally be blamed on their teachers” and Item 13 “Increased effort in science teaching produces little change in some students’ science achievement” demonstrated low mean values in both the Enoch and Riggs (1990) and this current study.

Table 4

Pre-service Science Teachers’ Self-efficacy Item Means

Item	Pre-Study <i>M</i>	Pre-Study <i>SD</i>	Post-Study <i>M</i>	Post-Study <i>SD</i>
1	3.58	0.90	4.17	0.72
2	4.67	0.49	4.75	0.45
3	4.50	0.80	4.58	1.00
4	3.92	0.29	4.42	0.51
5	3.92	0.51	4.17	0.39
6	4.00	0.60	4.50	0.67
7	3.25	0.79	3.58	0.67
8	4.42	0.51	4.33	1.23
9	4.00	0.60	4.58	0.51
10	2.83	0.94	2.92	1.00
11	3.17	0.94	4.17	0.72
12	4.25	0.45	4.75	0.90
13	3.58	0.67	3.00	1.35
14	3.25	0.97	3.58	0.90
15	3.33	0.78	3.67	0.98
16	3.92	0.90	4.58	0.51
17	4.42	0.51	4.42	0.67
18	4.25	0.45	4.17	0.83
19	3.58	0.90	4.08	1.38
20	3.83	0.94	4.08	1.24
21	4.00	0.74	4.58	0.51
22	4.25	0.87	4.58	0.51
23	3.92	0.67	4.42	0.67
Total	3.86	0.70	4.18	0.80

Scores on the PSTE may range from 13 to 65, and STOE scores may range from 10 to 50. High scores on the first scale, relative to other respondents indicate a strong personal belief in one’s own efficacy as a science teacher, and high scores on the second scale indicate high expectations of the outcomes of science teaching which means the confidence in how students will do in science. The dependent variables in this study were

self-efficacy and outcome expectancy measured by the STEBI-B. The dependent variable is “an attribute or characteristic that is dependent on or influenced by the independent variable. They may be called the outcome, effect, criterion, or consequence variables” (Creswell, 2002, p. 136).

Table 5

Experimental Group Self Efficacy and Outcome Expectancy Means

N	PRE-STEBI PSTE	PRE-STEBI STOE	POST PSTE	POST STOE
1	61	37	64	41
2	53	42	63	37
3	56	37	57	39
4	48	32	50	38
5	52	36	56	42
6	52	33	55	39
7	48	32	40	29
8	58	38	59	44
9	61	28	62	44
10	61	32	62	43
11	47	34	56	32
12	50	37	55	39
Mean	53.92	34.83	56.58	38.92

A descriptive analysis of the experimental group of pre-service teachers’ data indicates generally positive self- efficacy beliefs regarding science teaching (Table 5). Mean increase from 53.92 to 56.58 in the PSTE indicates an overall increase in self-efficacy. Overall pre-service teachers generally had high science teaching outcome expectancy scores, with an increase from 34.83 to 38.92, which meant, that participants had expectations that their science teaching would influence student science learning.

Paired-sample t-tests were conducted to analyze teacher efficacy differences between pre- and post-test using both PSTE and STOE scales. Prior to the analyses, *a priori* statistical significance alpha levels were set to $p < .05$. The results from the pair-

sample t-test for PSTE were significant ($t = 2.03, p = 0.03$) indicating that there was a statistically significant increase in teacher efficacy from pre-test to post-test as seen in Table 6. The STOE t-test revealed a significance increase in the outcome expectancy ($t = 2.39, p = 0.01$) as shown in Table 7.

Table 6

t-Test: Paired Two Sample for Experimental Group PSTE (pre and post) Means

<i>N</i>	df	t Stat	<i>p</i>
12	11	-2.03	0.03

Table 7

t-Test: Paired Two Sample for Experimental Group STOE (pre and post) Means

<i>N</i>	df	t Stat	<i>p</i>
12	11	-2.39	0.01

The control group, $N=10$, completed the ASTQ and STEBI-B before their practicum placement and again after their practicum was completed. The 10 participants did not receive the intervention of Lesson Study. Table 8 shows the PSTE and STOE scores.

Table 8

Control Group Self Efficacy and Outcome Expectancy Means

<i>N</i>	PRE-STEBI		POST-STEBI	
	PSTE	STOE	PSTE	STOE
1	39	36	49	34
2	57	38	56	34
3	46	37	43	32
4	55	30	55	30
5	45	37	49	34
6	52	21	60	34
7	47	30	48	30
8	51	34	57	36
9	50	34	51	34
10	25	24	27	24
Mean	46.7	32.1	49.5	32.2

A descriptive analysis of the control group of pre-service teachers' data indicates generally positive self-efficacy beliefs regarding science teaching (Table 8). Mean increase from 46.7 to 49.5 in the PSTE indicates an overall increase in self-efficacy that is significant ($t = 2.14, p = 0.03$) as seen in Table 9.

Table 9

t-Test: Paired Two Sample for Control Group PSTE (pre and post) Means

<i>N</i>	df	t Stat	<i>p</i>
10	9	-2.14	0.03

Overall pre-service teachers had high science teaching outcome expectancy scores, but the mean increase was very minimal from 32.1 to 32.2, therefore no significance seen ($t = 0.07, p = 0.48$) as seen in Table 10. This meant that the participants' expectations that their science teaching would influence student science learning before and after their practicum placements did not change.

Table 10

t-Test: Paired Two Sample for Control Group STOE(pre and post) Means

<i>N</i>	df	t Stat	<i>p</i>
10	9	-0.07	0.48

Qualitative Results

Emergent themes from the analysis of focus group interviews were based on highest frequency of occurrence of ideas and opinions. These themes included understanding the use of inquiry-based teaching, collaboration with teachers, reflective practice through videotaping, empowerment and self-efficacy. The interviews and reflections of the teachers revealed multiple perspectives. Researcher observations of the lesson study group at various stages of the process, and reflective researcher memos from

field notes were used for validation of the findings.

Understanding the Use of Inquiry-Based Teaching (IBT)

Science inquiry-based teaching is a new strategy for all of the experimental group members. Several of the research participants revealed that the Lesson Study experience helped them understand the process of Lesson Study and science inquiry-based teaching. Many participants were hesitant about this type of teaching for the fact that it is new to them and requires the teacher to be very comfortable with inquiry questions. Focus group interview responses included:

“Inquiry based activities can be intimidating, but through Lesson Study, one can be more of an effective teacher when it comes to IBT.”

“This method of delivery has an impact on students’ learning.”

Inquiry-based approaches through Lesson Study encouraged the pre-service teachers to develop their own inquiry activities. Relevant quotes included:

“It allowed the students to be engaged and make sense of what they are learning.” “The making poop activity helped me create analogies to implement in my lessons.”

“I developed activities involving skits in a unit that is difficult to make engaging.”

Collaboration

One of the repetitive words in the focus group interviews was collaboration. The pre-service science teachers felt that collaborative lesson planning and modification during Lesson Study made it easier to teach a difficult concept. Practicing science teachers are often challenged to find time in their busy schedules to collaborate with peers. The Lesson Study approach allowed practice of collaboration and for dialogue back and forth with teachers.

“I did not mind the different perspective of other teachers on the development and conduction of my lesson.”

“Developing the lesson and modifying together made me feel comfortable teaching. Now I know what collaboration is all about.

Reflective Practice through Video

Having opportunities to reflect on their practice through interactions with each other and watching themselves teach was another theme that emerged from focus group data. Systematic reflection helped participants target strategies to improve their own teaching by discussing the research lesson and making modifications to their practice and inquiry-based activities prior to subsequent implementations. Furthermore, some participants commented that through reflection they made changes to their teaching practices.

A few pre-service teachers were not receptive to the idea of being videotaped. During the post-lesson colloquium, they realized how important it was for one to be videotaped while teaching. The Lesson study approach changed the perception about being watched. The idea of being watched while teaching was something of a sensitive issue. Now that the pre-service teachers have done it themselves, they have become receptive to the idea. This experience allowed the pre-service teachers to become reflective and self-critical of their own practice. The following excerpts describe the shifting beliefs about being videotaped:

“While watching someone else teach through video or in class observations, modifications of the lesson come easily to mind.”

“My colleague watched me teach and then we were able to discuss what worked and what didn't work.”

“Viewing the video of me teaching made me realize that I focused on a few of the students and not everyone.”

“Feedback from other pre-service teachers has a more profound effect on your own teaching.”

“Watching yourself teach opens up your eyes to what you could have done to be more effective.”

“Peer observation in the classroom and the video of me teaching made me realize that I focused on a few of the students and not everyone.”

Empowerment

Despite the fact that classroom practice is often a lonely activity, many teachers acknowledge in the midst of their own isolation that learning itself paradoxically is a social or communal process (Fishman and McCarthy, 2000). Pre-service science teachers felt that understanding Lesson Study process instilled a sense of empowerment and professionalism. The following are excerpts from pre-service teachers:

“Lesson Study empowered me as a novice teacher. I feel that now I have so much to offer and know exactly what professional development is.”

“I feel empowered because this endeavour made me realize how much support a teacher can have from his or her colleagues.”

“When I referred to the inquiry-based activity, the students were able to

remember all the visuals and what they meant. I felt empowered since the purpose of our teaching is to improve student achievement and inquiry-based teaching can do just that.”

Self-Efficacy

An improvement in self-efficacy may lead to positive attitudes towards teaching a subject or a specific topic. During the focus group interview, the participants indicated that their self-efficacy has increased since the intervention. Some student teachers felt the need to implement Lesson Study in the pre-service program. One stated

“It improves self-efficacy and comfort level in delivery of material that is usually hard to implement in the classroom.”

The participants noted in the interviews that their collaboration during the Lesson Study process allowed them to “bounce ideas” off peers. It was a way to hear other viewpoints in order to modify the lesson and in turn benefit students with what was learned. Their collaboration reassured them with the belief in their abilities as teachers who try their best to help students in the learning process. All the participants concurred that an increase in teaching self-efficacy is due to the Lesson Study intervention. Although these themes are consistent with the research on Lesson Study in Japan and elsewhere in the world, they also extend the research on self-reflection and self-efficacy.

CHAPTER 5

DISCUSSION

A review of the literature pertinent to this research established this study's theoretical framework of analysis. Literature relevant to the construct of science inquiry-based teaching, self-efficacy, science teaching self-efficacy, professional development, and Japanese Lesson Study are reviewed. The review of literature in Chapter 2 supports the theoretical framework of constructivism and self-efficacy. As discussed in Chapter 3, in addition to using a quantitative self-efficacy instrument, the overall research methodology aligns with qualitative research using a case study design. Using this approach, the purpose of this research is to describe and interpret the experiences of the teacher participants with the Lesson Study approach to teach inquiry-based science. The insights of pre-service teachers' experiences are the basis for the findings of this study in determining the whether Lesson Study has an impact on their self-efficacy beliefs.

The data collected in this case study of 12 pre-service science teachers engaged in Lesson Study propose insights into the practices of Lesson Study as a form of professional development that could improve teachers' self-efficacy, and in turn improve teaching practice. The twelve teachers all expressed positive perceptions of their experiences engaging in the collaborative planning, modification and teaching science using inquiry-based approaches.

Referring back to the ASTQ, the overall mean increased from 4.01 to 4.29. This indicates that there was an increase in participants' attitudes toward science teaching. By triangulating the data with personal reflections as well as focus group interviews, the results from ASTQ were valid. Participants indicated that their attitudes towards teaching

inquiry-based teaching have become more positive with the Lesson Study intervention. However, there were two items on the ASTQ that participants expressed a decline in attitude toward science teaching. Item four “I feel comfortable with the science content that will be taught in the future”, and Item 17 “teaching science takes too much effort.” Possible explanation for this decline could be the fact that some of the student teachers that participated in the study have a minor in science. As a matter of fact, three of the participants had biology as a second teachable subject. General science courses in grade nine and ten have four different strands; Biology, Chemistry, Physics and Earth and Space Science. It may be a rarity to be proficient in teaching two or more strands, unless a teacher has a strong science background. For example, a biology teacher who teaches grade ten science will have to teach optics in the physics strand.

Looking at this demographic data with a more focused lens, one can reason that for someone who does not have a full science background, teaching science using inquiry-based approaches can be intimidating. In fact, teaching science using inquiry-based approach may be challenging to many science teachers regardless of their strong science education background. Some participants felt that science inquiry based activities can take too much effort. Time has been identified as the reason why science teachers may not be pushing for inquiry-based lessons in their classroom (Colon, 2010).

The control group mostly had positive attitudes towards science teaching, but in three items their attitude was below 3.00 indicating negative attitude. Item nine “I am not looking forward to teaching science in my elementary classroom” had a low mean score of 2.78 with the control group and 3.08 with the experimental group. The experimental participants indicated that it was difficult to answer this question. With a mean score of

3.08, it is indicated that most of them indicated neither agree nor disagree on the Likert scale. Almost all of the experimental participants were not placed in an elementary school for any of their placements. Therefore, at the time when the research study was conducted, they could not reflect on any elementary school experience. The one participant who had an elementary placement experience was not looking forward to teaching science in an elementary classroom. The mean score increased for the experimental group after the intervention. The participants have strong attitudes towards in that they do not wish to teach science in an elementary setting. There could be many reasons for that attitude. The research capacity did not allow for further investigation into this field. It can be concluded though that teaching in an elementary school does not guarantee the science teacher to be teaching only science. This may put fear into the pre-service teachers and therefore their answers to item nine were dependent on the schema that they already have. As for the control group, it cannot be determined whether the pre-service teachers who completed the surveys were placed in elementary schools for their practicum. It can be deduced from the increase in the mean attitudinal score that maybe some pre-service teachers had a good experience at an elementary placement.

Item 12 in the ASTQ “I am afraid that students will ask me questions that I cannot answer” showed a decline in the attitudes of only the control group participants. This decline was directional towards negative attitude. Through Lesson Study approach, the experimental participants reflected on the experience being empowering and with watching one another and how the students handle a certain inquiry activity. It was mentioned during post lesson colloquium that a teacher might anticipate some of the

questions that might be asked. In addition, a teacher with a strong science background might not encounter the same issue with answering questions.

Referring back to the STEBI, Items 10 and 13 had the lowest means. These items were found to be problematic due to the wording used. These were the only items on the STEBI-B that used the word “some” to qualify the word “student.” The use of “some students” instead of “students” as used in all other items seemed to affect how respondents interpreted these two statements. These items were not deleted or modified for this study. These were the only items on the STEBI-B that used the word “some” to qualify the word “student.” The use of “some students” instead of “students” as used in all other items seemed to affect how respondents interpreted these two statements. This effect was verified by interviewing students about these items. It became clear in these interviews that the qualifier “some” was confounding their responses to items 10 and 13. As one pre-service teacher said, “The statement was misleading.”

The overall findings from the STEBI-B indicate an increase in self-efficacy among the experimental group of pre-service teachers. A mean increase from 3.86 to 4.18 is strong enough to conclude that the intervention of Lesson Study improved teacher self-efficacy.

Scores on the PSTE may range from 13 to 65, and STOE scores may range from 10 to 50. High scores on the first scale, relative to other respondents indicate a strong personal belief in one’s own efficacy as a science teacher, and high scores on the second scale indicate high expectations of the outcomes of science teaching which means the confidence in how students will do in science. The dependent variables in this study were self-efficacy and outcome expectancy measured by the STEBI-B. The dependent variable

is “an attribute or characteristic that is dependent on or influenced by the independent variable. They may be called the outcome, effect, criterion, or consequence variables” (Creswell, 2002, p. 136).

A descriptive analysis of the experimental group of pre-service teachers' data indicates positive self-efficacy beliefs regarding science teaching as shown in Figure 3 (p.57). Mean increase from 53.92 to 56.58 in the PSTE indicates an overall increase in self-efficacy. Overall pre-service teachers generally had high science teaching outcome expectancy scores, with an increase from 34.83 to 38.92, which meant in general, that participants had expectations that their science teaching would influence student science learning. The self-efficacy part of the study was analyzed with the use of statistical tool SPSS (Statistical Package for Social Sciences). Paired sample one tailed t-test for the difference in the mean scores for PSTE and STOE was performed and showed a significant increase in efficacy ($p = 0.03$) and outcome expectancy ($p = 0.01$). Recall, question two hypothesized that teacher efficacy would increase from pre-test to post-test. The results from the paired-sample t-test indicated statistically significant increase since p in both cases is less than 0.05. The increase in efficacy and outcome expectancy could be due to the intervention of Lesson Study using inquiry-based activities or it could be due to the fact that the school placements were very successful for the pre-service experimental participants. A decisive feature in the body of discourse throughout the Lesson Study reflections, researcher notes and focus group interview data was the pre-service teachers heightened sense of self-efficacy as their participation in the Lesson Study process evolved. They reiterated feeling privy to the objective perspectives that experienced researcher shared, and expressed an appreciation for this intervention. As

one individual stated, "I can't tell you how great it is to have someone who is able to show us what true inquiry-based activities are and how they can be used in the classroom because that knowledgeable other was a classroom teacher." The experimental group participants did not resign themselves to the assistance of the in-service teacher to intervene during the inquiry lesson; instead, they consistently noted how "it was just that I felt so confident after watching someone else teach the same topic and carry out the inquiry-activity." On multiple occasions, pre-service teachers stated how they "felt so much more confident" because their professional aptitude was validated not only by the autonomy afforded to make their own decisions in lesson modification, but by the fact that such decisions were respected by their colleagues and the researcher.

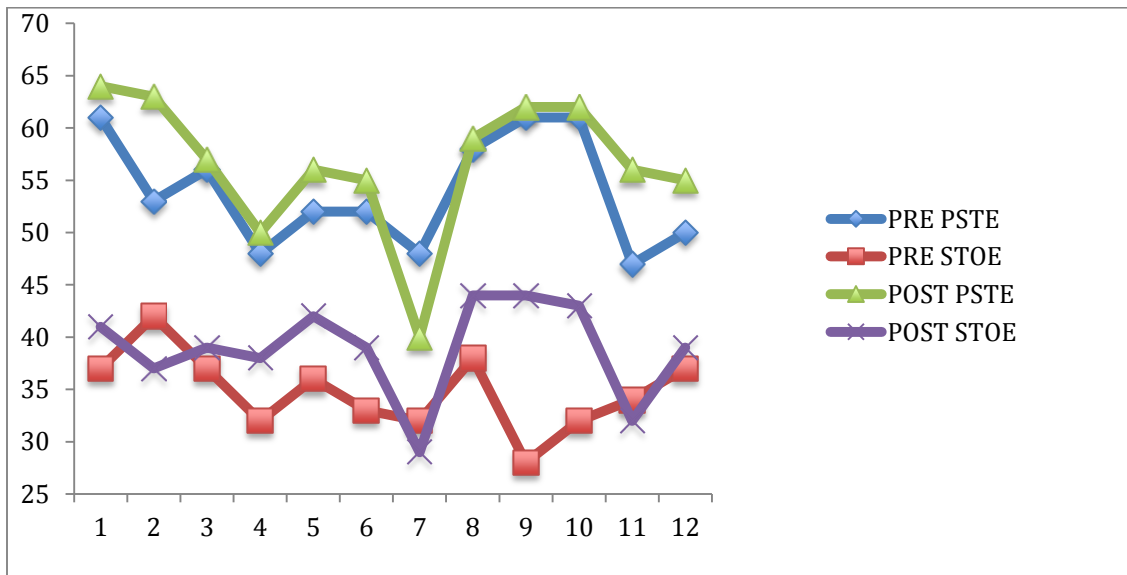


Figure 3. Experimental Group Pre and Post Study Efficacy and Outcome Expectancy Means

A descriptive analysis of the control group of pre-service teachers' data indicates generally positive self-efficacy beliefs regarding science teaching. As seen in figure 4 below, there was an overall increase in the means of the PSTE and STOE indicating an

increase in self-efficacy and outcome expectancy, which meant in general, that participants had expectations that their science teaching would influence student science learning before and after their practicum placements. However, the increase is not as significant as the increase with the experimental group. The experimental group pre-study means for PSTE and STOE were higher than the control group means. One can hypothesize that the participants who volunteered for this study have more confidence in their own teaching abilities and who believe that effective teaching can influence student science learning.

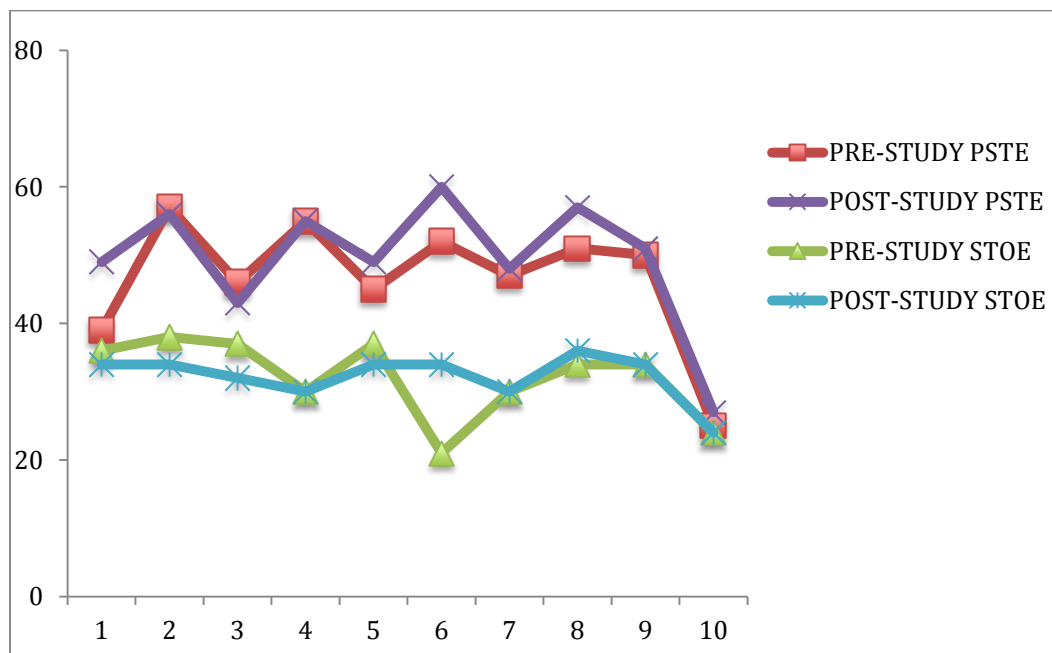


Figure 4. Control Group Pre and Post Study Efficacy and Outcome Expectancy Means

Practicing science teachers are often challenged to find time in their busy schedules to collaborate with peers. This was reflected upon from the questionnaires and the focus group interview. Pre-service teachers indicated time was a barrier that could prevent in-service teachers from participating in future Lesson Study. I found time to be

a major challenge, both in scheduling time to meet with in-service teachers, pre-service teachers and the amount of time needed to devote to the whole Lesson Study process.

Science Inquiry teaching may be difficult to implement in a classroom if the group of students are not critical thinkers or take ownership of their own learning. In addition, the teacher should be very confident with the content. From my previous experiences as a science teacher, some inquiry-based experiments required more time, effort, and determination. After the engagement part of the inquiry cycle, the students are supposed to formulate their own questions and explore possible answers. The exploration part of the inquiry cycle could take multiple attempts and possibly over many days depending on the level of student participation and commitment to the process. The research participants enjoyed the questions asked by the students and the heightened level of student participation during the activities. The pre-service teacher who was placed with the same class for her full practicum was able to monitor the progress of the learning from the activity. She indicated how the inquiry-based approach kept the students engaged and they were able to elaborate more on the outcomes of the lesson.

Recall the purpose of this study was to explore qualitatively the extent and way in which the Japanese practice of Lesson Study encourages pre-service teachers to start to guide their professional development and growth. The quantitative data and the qualitative data strongly indicated that Lesson Study does in fact influence teacher preparation for inquiry-based instruction. In addition, the pre-service teachers agreed that this process has been rich in providing them with opportunities to grow professionally.

Voluntarily selecting to be part of this study indicated that the pre-service teachers already had confidence in their teaching abilities and were willing to engage in a science

teaching community that might improve their practice. Their self-efficacy beliefs increased possibly due to the intervention and the interviewed participants concurred with the generalization. They felt more confident in their science teaching abilities and the inquiry-based approach. Due to the collaborative constructs of Lesson Study, it allowed the opportunity for dialogue. This active process of socially constructing new meanings of the concepts that will be taught and learning science-inquiry approaches required that the pre-service teachers were engaged in a collaborative practice. This process of collaboration turned into an empowering safe environment where it left them with the aspirations to collaborate with colleagues in their teaching career. The six pre-service teachers interviewed indicated that they would participate in Lesson Study in the future. The pre-service teachers felt that Lesson Study is a “powerful” professional development opportunity should be offered in the pre-service programs at the faculties of education.

There was no indication of variability in the level of Lesson Study experience since all participants had the same amount of teaching experience but different amount of science education. There was variability in the level of reflection before the study began in that some participants were reflective of their own teaching and others did not find the need for ongoing reflection. That variability dissipated during the process of Lesson Study. More participants felt the necessity to videotape the lesson in order to reflect on their own teaching using a different lens. Friere (1972) believes in the liberating potential of education, especially when critical scrutiny of an experience is combined with action. Harrison, Lawson and Worley (2005) further explain that critical reflection on practice involves a challenge to prevailing beliefs and thoughts, therefore suggesting change. The

participants who indicated that their method of teaching science has been positively influenced by the intervention of Lesson Study reflected upon the change.

Upon completion of the research, all participants showed at least some increase in their attitude toward science teaching as indicated in their post attitude instrument score and their description of their attitude in the final focus group interview. All attributed the increase in their self-efficacy to their experiences in the Lesson Study process in this research study as well as the opportunity to work with students and teach their lessons during field experience. Their experiences in the Lesson Study intervention had allowed them to better understand the true nature of inquiry-based science and realize that science can be fun, interesting, relevant, and tangible in that it intrigues the interest of many students.

CHAPTER 6

CONCLUSION

Despite the fact that classroom practice is often a lonely activity, many teachers acknowledge, in the midst of their own isolation that learning itself ironically is a social or communal process (Eckrich, 1999). The 12 pre-service science teachers concurred with McGraw (1992) who stated teacher empowerment could be defined as teacher autonomy to make decisions. Teachers need certain levels of autonomy and professionalism in order to be empowered. Teachers who are usually engaged, focused, with positive attitudes towards student learning had tremendous impact on student achievement (Desimone, 2011). Participants indicated a feeling of empowerment due to the collaboration during the process of Lesson Study. An increase in self-efficacy and an increase in positive attitudes towards science teaching were evident after the intervention. The results show preliminary evidence that the intervention can be used successfully to enhance teaching efficacy cognitions. Due to the small population size ($N=12$), trends illuminated in this research are not generalizable. Future study should be conducted with more participants to allow for more generalizability.

Although the attitudes of the in-service teachers were not a factor in this study, two of the in-service teachers who provided the participants with teaching in their classroom indicated that the Lesson Study experience has changed their perception about reflection. The idea of videotaping the lesson to reflect on their own practice has spiked their interest. Three in-service teachers sought extra explanation of the inquiry cycle and how they can implement more inquiry-based activities in their science classroom. This

shows that there is an increased interest among teachers in implementing inquiry-based activities in science.

The findings of this case study are consistent with some earlier studies but this study was unique in that it combined inquiry-based teaching with Lesson Study. In order to improve 21st century skills in science amongst our students, educators need to provide them with opportunities to think deeply and critically. This strikes on the core of this thesis, in saying that if teachers are required to have students think deeply and engage critically about science in their learning, then there can be no barriers or lack of preparation reported by teacher candidates. Therefore, the bulk of the responsibility lay on the shoulders of teacher preparation programs to give teacher candidates not only the knowledge and tools to teach science inquiry, but also the strategies on how to collaborate with their colleagues when designing their curriculum and lesson plans.

Necessary for the success of our students, is the success of our future teachers who need to be given the opportunities of personal reflection and professional growth. The implications of such experiences further promote the social constructivist goal of social transformation.

This case study supports the notion of improving self-efficacy of pre-service teachers when Lesson Study serves as a conduit for collaboration among teachers in building science-learning communities. Paulo Friere (1972, p. 109) reminds us that “knowledge is not extended from those who consider that they know to those who consider that they do not know; knowledge is built up in the relations between human beings.”

Limitations

There are a few limitations to this case study. First, there is a lack of Canadian content in the literature review since Lesson Study is fairly new in Canada. Lesson Study can be time consuming due to its structure of constant meetings, co-planning, reflections, video analysis, and lesson modification. Since Lesson Study is a fairly new type of professional development in Canada and many pre-service teachers are not familiar with this type of professional development, the case study called for a small number of participants. The small number of participants did not allow for generalizability. One of the major limitations was to coordinate the type of lessons as well as the time of delivery with in-service teachers. The research was conducted during the pre-service practicum placements. It was difficult to schedule 12 pre-service teachers with six in-service teachers at two secondary schools while the participants had a placement at other schools. Time was a huge obstacle in this study but it was overcome by the flexibility of the experimental group participants.

As the researcher, I was not able to observe the 12 pre-service teachers during their teaching sessions at the two secondary schools. Examining pre-service teachers' teaching experiences and interactions with students in the practicum would be a great next step.

Recommendations for Further Study

Despite the limitations, the findings of this research support the need of building communities of learning in the pre-service teaching programs. A professional learning community should include an authentic science inquiry experience as a needed component in order to provide support for teachers who lack pedagogical knowledge of inquiry teaching. The inquiry PD would provide a structure to challenge the teachers to

examine their knowledge, beliefs and reflect on their teaching. Second, continued research into this subject would also include repeating this experience with a larger group of pre-service science teachers and a larger control group. Third, a study could be conducted in a school willing to allow Lesson Study as its school's form of professional development for Science teachers. Although this study did not attempt to delve into the psychological empowerment of the intervention, future study should take into account the interpersonal, interactional and behavioural components of psychological empowerment by looking at pre-service teachers and in-service teachers who are reluctant to participate in Lesson Study. Understanding the interpersonal barriers to participating in lesson study is worth further investigation, either qualitatively or quantitatively.

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APPENDICES

Appendix A

Demographic Questionnaire

Name: _____

Gender: _____

Age - please check

_____ 20-24 _____ 40-44

_____ 25-29 _____ 45-50

_____ 30-34 _____ Above 50

_____ 35-39

How many years of post-secondary science have you completed? _____

In which discipline? _____

Appendix B

The Attitudes toward Science Teaching Questionnaire (ASTQ)

Revised Science Attitude Scale for Pre-service by Thompson & Shrigley

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA = STRONGLY AGREE

A = AGREE

N = NEITHER AGREE NOR DISAGREE

D = DISAGREE

SD = STRONGLY DISAGREE

- | | | | | | |
|---|----|---|---|---|----|
| 1. I will feel uncomfortable teaching science. | SA | A | N | D | SD |
| 2. I fear that I will be unable to teach science adequately. | SA | A | N | D | SD |
| 3. Teaching science takes too much time. | SA | A | N | D | SD |
| 4. I feel comfortable with the science content that will be taught in the future. | SA | A | N | D | SD |
| 5. I will enjoy teaching science. | SA | A | N | D | SD |
| 6. I would be interested in working in an experimental science curriculum | SA | A | N | D | SD |
| 7. I dread teaching sciences. | SA | A | N | D | SD |
| 8. I am not afraid to demonstrate science phenomena in the classroom. | SA | A | N | D | SD |
| 9. I am not looking forward to teaching science in my elementary classroom. | SA | A | N | D | SD |
| 10. I will enjoy helping students construct science equipment. | SA | A | N | D | SD |

11. I am willing to spend time setting up equipment for a lab.	SA	A	N	D	SD
12. I am afraid that students will ask me questions that I cannot answer.	SA	A	N	D	SD
13. I enjoy manipulating science equipment.	SA	A	N	D	SD
14. In the classroom, I fear science experiments won't turn out as expected.	SA	A	N	D	SD
15. Science would be one of my preferred subjects to teach if given a choice.	SA	A	N	D	SD
16. I hope to be able to excite my students about science.	SA	A	N	D	SD
17. Teaching science takes too much effort.	SA	A	N	D	SD
18. I feel that I can teach science effectively.	SA	A	N	D	SD
19. I will not enjoy teaching science by doing an experiment.	SA	A	N	D	SD

Appendix C

STEBI – Self-efficacy tool adapted from Riggs, I.M., & Enochs, L.G. (1990)

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA = STRONGLY AGREE

A = AGREE

N = NEITHER AGREE NOR DISAGREE

D = DISAGREE

SD = STRONGLY DISAGREE

1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	SA	A	N	D	SD
2. I will continually find better ways to teach science.	SA	A	N	D	SD
3. Even if I try very hard, I will not teach science as well as I will most subjects.	SA	A	N	D	SD
4. When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach.	SA	A	N	D	SD
5. I know the steps necessary to teach science concepts effectively.	SA	A	N	D	SD
6. I will not be very effective in monitoring science experiments.	SA	A	N	D	SD
7. If students are underachieving in science, it is most likely due to ineffective science teaching.	SA	A	N	D	SD
8. I will generally teach science ineffectively.	SA	A	N	D	SD

9. The inadequacy of a student's science background can be overcome by good teaching.	SA	A	N	D	SD
10. The low achievement of some students cannot generally be blamed on their teachers.	SA	A	N	D	SD
11. When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher.	SA	A	N	D	SD
12. I understand science concepts well enough to be effective in teaching science.	SA	A	N	D	SD
13. Increased effort in science teaching produces little change in some students' science achievement.	SA	A	N	D	SD
14. The teacher is generally responsible for the achievement of students in science.	SA	A	N	D	SD
15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	SA	A	N	D	SD
16. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.	SA	A	N	D	SD
17. I will find it difficult to explain to students why science experiments work.	SA	A	N	D	SD
18. I will typically be able to answer students' science questions.	SA	A	N	D	SD
19. I wonder if I will have necessary skills to teach science.	SA	A	N	D	SD
20. Given a choice, I will not invite the principal to evaluate my science teaching.	SA	A	N	D	SD

21. When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand it better.	SA	A	N	D	SD
22. When teaching science, I will usually welcome student questions.	SA	A	N	D	SD
23. I do not know what to do to turn students on to science.	SA	A	N	D	SD

Appendix D

Interview Questions- After completion of Lesson Study

1. Has the Lesson Study process helped your ability to decide how to more effectively teach children in your class? If yes, Please give an example. If no, why do you think it didn't help?
2. Did the process of Lesson Study improve your ability to assess how much students understood during the lesson? If it did, can you give an example? If it did not, please explain why not.
3. Have you developed any new instructional strategies as a result of your participation in Lesson Study? If so, please describe them.
4. Was Lesson Study an effective form of professional development? Yes or No.
5. Was the Lesson Study process appropriate for enabling you to grow professionally?
6. To what extent do you feel it is necessary to improve or adapt on the Lesson Study process to make it more appropriate for your school, classroom, and personal context?
7. To what extent do you feel more or less empowered to collaborate with other teachers on developing lessons?
8. Could you see yourself trying another Lesson Study? (Why/Why not?)

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