September 2015

The Learning of Human Ingenuity Within a Formal, Environmental Education Program: A Case Study of Two Secondary School Programs

Brian D. Smith
The University of Western Ontario

Supervisor
Dr. Ronald Hansen
The University of Western Ontario

Graduate Program in Education

A thesis submitted in partial fulfillment of the requirements for the degree in Master of Education

THE LEARNING OF HUMAN INGENUITY WITHIN A FORMAL, ENVIRONMENTAL EDUCATION PROGRAM: A CASE STUDY OF TWO SECONDARY SCHOOL PROGRAMS

(Thesis format: Monograph)

by

Brian Douglas Smith

Graduate Program in Education

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Education

The School of Graduate and Postdoctoral Studies
The University of Western Ontario
London, Ontario, Canada

Abstract

This thesis explores the implementation of creative pedagogies to determine how creativity as a disposition and learning outcome is pursued in Ontario classrooms. Its focus falls within a broad context of growing interest in Environmental Education and increasing demand for problem-solving skills in the workforce and beyond. The study draws upon participant experiences to examine how creative problem-solving is realized. A case study approach was employed, using multiple data sources in two High School Environmental Leadership Programs. Findings from this research suggest that teachers prioritize the building, comprehension and application of facts and concepts over the use of instructional strategies that develop creative problem-solving and higher-order thinking skills such as synthesis, analysis and evaluation. Students preferred creative instructional strategies and wanted them more often. The study calls for renewed teacher commitment and additional professional development for instructional strategies that nurture student creativity and expand teachers' pedagogy. Furthermore, policy recommendations call for environmental education to become a multidisciplinary subject of its own, considering the broad scope of content and skills from which it draws and the urgency to solve environmental problems.

Keywords

Creativity, Human Ingenuity, Environmental Education, Experiential Learning, Problem Based Learning, Inquiry Based Learning, Constructivism, Environmental Leadership

Acknowledgments

I would like to specially thank my thesis advisor, Dr. Ron Hansen, for many years of guidance, interest and patience. You made a huge difference and I am grateful that you were on this journey with me. I would also like to thank Dr. Robert Sandieson and the other members of the examination committee for their recommendations that strengthened this thesis.

A few teacher colleagues deserve thanks and recognition: Chris Q., who started me on this constructivist leadership path with his inspiration, professionalism and energy for teaching; Sharon, for modelling a passionate commitment to protecting our environment, and for your contagious exuberance; and The Moderns – Shannon, Heather, Celeste and Judi – who were always welcoming, fun and engaging, and made 214 my workday refuge.

Dad, Julie, Wendy and Ma: Thank you for your ongoing encouragement and support, and everything else that a loving family provides.

To Maria and Kira, the lifelong learners at home, who patiently listened to my theorizing, challenged my ideas, discouraged my frequent "tangentalizing" and did so much more than words can ever say. I can't do any better than "As Big As The Sky."

And, finally, for Mom and Pa, who were constant, always available to talk and so supportive of my endeavours. I wish you were here to see me finish.

Table of Contents

Abstract ii

Acknowledgments iii

Table of Contents iv

List of Tables vii

List of Appendices viii

Chapter 1 1

1 Introduction and Context 1

1.1 The Importance and Place of Formal Education 7

1.2 Research Questions 8

1.3 Summary 9

Chapter 2 10

2 Literature 10

2.1 Theoretical Framework 11

2.1.1 Constructivist Pedagogies 12

2.1.2 Problem Type 14

2.1.3 Group Creativity 15

2.1.4 Bloom's Taxonomy 16

2.2 The Current Times in Ontario Education 18

2.2.1 The Ministry of Education 18

2.2.2 Key Education Stakeholders 20

2.3 Summary 21

Chapter 3 23

3 Methodology 23

3.1 Research Design 23

3.2 Project Participants 26

3.2.1 Urban Site ... 26

3.2.2 Rural Site ... 27

3.3 Data Collection ... 28

3.3.1 Stages of Data Collection ... 30

3.4 Data Analysis ... 31

3.5 Summary ... 31

Chapter 4 ... 32

4 Compilation of Data ... 32

4.1 Questionnaire Data ... 32

4.2 Creativity and Creative Problem-Solving ... 39

4.3 Student Outcomes in Creative Problem-Solving Challenges ... 42

4.4 Instructional Strategies ... 44

4.5 Creative Activities ... 58

4.6 Questioning the Status Quo and Critical Thinking ... 62

4.7 Innovation and Real Environmental Event Activities ... 63

4.8 Influences on Teachers to Develop Creativity ... 65

4.9 Bloom's Taxonomy ... 67

4.10 Rural and Urban Comparison ... 69

Chapter 5 ... 71

5 Interpretation and Synthesis ... 71

5.1 Introduction ... 71

5.2 Theme 1: Teaching Methods That Promote Creativity ... 72

5.2.1 Subtheme 1: Creative Instructional Strategies ... 72

5.2.2 Subtheme 2: Higher-Order Thinking ... 78

5.3 Theme 2: The Importance of Creative Problem-Solving ... 81

5.4 Theme 3: Exploring Innovations and Real Events ... 82

5.4.1 Environmental Innovations and Technologies 82
5.4.2 Contextualizing Learning With Real Environmental Events 84
5.5 Summary 87
Chapter 6 88
6 Reflections and Discussion 88
6.1 Understanding Creative Problem-Solving 88
6.2 Implications 90
6.2.1 Implications for Practice 90
6.2.2 Implications for Policy 91
6.2.3 Implications for Future Research 94
6.3 Summary and Recommendations 95
References 97
Appendices 106
Curriculum Vitae 133

List of Tables

Table 1: Participant Demographics (School Sites A & B) 27

List of Appendices

Appendix A: Comprehensive Questionnaire Data 106

Appendix B: Letters of Information and Consent; UWO Ethics Approval 116

Appendix C: Student Questionnaire 123

Appendix D: Teacher Questionnaire 128

Chapter 1

1 Introduction and Context

My thesis is that the ingenuity needed to solve existing and future environmental challenges may require the purposeful implementation of creative pedagogies in formal education systems in North America. In 2008, the Human Ingenuity Research Group (HIRG) conducted a case study of six inventors in southern Ontario. That preliminary study led to a series of inquiries into the role of formal education and its association with creativity and culture (www.edu.uwo.ca/hirg). Human ingenuity was defined as the aptitude and ability to solve problems through experience with originality and imagination. The purpose of this HIRG-inspired study was to determine how Ontario schools are addressing the need for creative thinking skills in adolescents in a Specialist High Skills Major – Environment (SHSM-E) program if, indeed, the schools are addressing the need.

Environmental Crisis

No longer is the question asked whether an environmental crisis exists. The world has far surpassed this often-asked question of the 1990s when strong anti-environmental efforts by "conservative think tanks, political commentators, and political elites" openly downplayed scientific evidence of the seriousness of issues (Dunlap, 2008, p. 14). Subsequently, the widespread public scepticism resulted in delayed action to remediate the issues. Since that time, the number and potency of these issues has been exacerbated to the point that a litany of global and domestic issues is now part of our global consciousness. Considering the number, interdependence and urgency of environmental issues, the enormity of the overall global environmental situation can seem overwhelming. Macy (1989; as cited in Clover, 2002) speculates that a duality between powerlessness and high awareness may be hindering action. Some experts believe that the situation is grim and that the time to act is now, even suggesting that waiting for more environmentally active younger generations to reach adulthood is too late (National Institute of Adult and Continuing Education, 1993, p. 12, in Clover, 1995).

It is now accepted that human activities (e.g., the overuse of carbon producing fossil fuels, uncontrolled pollution, poor waste management, and the destruction of nature) have contributed to this dire situation. The controversy is to what degree. Whereas some posit it to be minimal, others have swung to the other extreme, indicating that the extent of our influence on the environment has led to the identification of a new age on the Geological Time Scale, the Anthropocene Age, in which human activity has been deemed to be changing the Earth, permanently (Zalasiewicz, Williams, Steffen, & Crutzen, 2010). The scope of human activity is considered to be on par with such Age-defining events as full glaciation, a dinosaur extinguishing meteor strike and continent colliding earthquakes of millennia past.

Two serious issues, global warming and fresh water shortage, demonstrate that human actions are changing the environment. These pressing issues have negative environmental effects as well as socio-political ramifications.

The availability of clean drinking water is fast approaching a crisis, primarily through the pollution of surface water (for instance, 80% of China's surface water is polluted beyond use), the paving over of green space that cleanses water through transpiration, and the failure of some urban centres to clean their used municipal water which is simply dumped into seawater (Barlow, 2008). According to Maude Barlow (2008), the Canadian founder of the Blue Planet Project, "pollution, displacement and mismanagement" of water is not only a result of climate change but it is contributing to it. Globally, most governments and communities are failing to see their involvement in this causality. The State of California, for instance, has planned a massive increase in bio-fuel production to reduce the use of greenhouse gas-producing fossil fuels without recognizing the incredible demand on its scarce water supply (Barlow, 2008).

Global warming, the alarming increase in temperature of the earth's atmosphere and oceans as a result of the greenhouse effect of airborne pollutants, has been part of our lexicon for decades. The results of global warming are far ranging, from the melting of glacial ice, causing ocean levels to rise and the loss of sea ice for polar bear survival (Lovgren, 2004), to the need for air-conditioners for indigenous peoples of the Arctic (Zabarenko, 2007), and the deterioration of vital coral reefs (Handwerk, 2003). Dyer (2009) believes that the severe drought brought about by global warming will eventually result in human conflict as nations attempt to protect and hoard precious upstream fresh water for their own populations.

The brief description of these two issues is only a part of the environmental crisis. Our anthropocentricism – seeing humanity as the centre of all things – has brought us to the point that we take and take without noticing the effect (Russell & Bell, 1996). We see the environment solely as a resource (Clover, 1999). Yet, the environmental crisis is forcing some of us to realize our responsibility and the need to respond to it.

Positive environmental actions are in their primacy. Until now, these actions have been largely downloaded to and borne by individual citizens in the form of behaviour and attitude changes. In North America, well accepted and media-promoted practices include Blue and green box recycling, reducing water and other utility usage, and taking alternative transportation. Other technologies and actions, such as the use of wind turbines and solar panels, are novelties, often shunned by "not in my backyard" attitudes.

Business, industry and government have begun to take action, primarily for economic gain and positive public relations. However, insufficient changes have been made to products, services and policies to address increasingly serious environmental challenges. While the lack of environmental action and accountability may be attributed to factors such as low profitability, minimal regulation without enforcement, and sparse public demand beyond special interest groups, it may instead be due to inability. In other words, it may be that environmental problems are not being addressed because the creativity and innovation required to find solutions is lacking in the workforce. Business, industry and government may be motivated to act in an environmentally conscious way but the people working in these organizations may not be able to act without the creative aptitude and ability to critically solve micro, let alone macro, level environmental problems across a vast array of economic, social and environmental possibilities. Human creativity may be the missing catalyst that translates interest in environmental responsibility into action.

Defining Creativity

Creativity is a commonly bandied about term in society and K-12 schools. In academia, a search of scholarly literature reveals extensive and ever-increasing interest and importance. Yet, a widely accepted, operational definition, its assessment and teaching have been elusive for decades (Treffinger, Renzulli, & Feldhusen, 1971; Baldwin, 2010). A starting point to begin this discussion must be to define creativity. Perusing educational research literature reveals a plethora of definitions situated in numerous theories and models, correlating to a mixture of factors (such as intelligence, adaptability, discovery, and serendipity, among others) and varying according to pervasiveness and expected outcomes. The result is much overlap and ambiguity (Runco, 2007), often with only the minutest distinctions. However, the focus of this study is not to investigate, explore or evaluate definitions and theories but to critically examine how Ontario schools are addressing the need for creative thinking skills in adolescents in an environmental program. In order to do so, though, a definition of creativity is required. For the purpose of this study, then, creativity is defined as the process of problem-solving or thinking that constructs useful and original outcomes (Runco, 2008).

This definition recognizes four characteristics of creativity. It also needs to be framed within this study's educational context; that is, for children who are developing their creative potential (Runco, 2003). Firstly, *outcomes* are the result of creativity, and are primarily tangible products or performances (Runco & Kim, 2011). For students who cannot yet create products, Runco (1996) suggests that all students are capable of constructing "original interpretations of experience"; that is, they can make meaning and understanding of their experiences. Original interpretations are intangible and independent of a measurable product. The second and third characteristics are that these outcomes must be *useful* and *original*, which are the key determinants common to most definitions of creativity (Barron, 1955; Runco, 1988, as cited in Runco, 2008). In order to assist teachers and students to understand and identify student originality, a tripartite categorization can be employed. Originality can be: "individual" in comparison to a student's previous outcome; "relative" in comparison to outcomes of a student's peers; and "historic" if an outcome is new in comparison to any originator (National Advisory Committee on Creative and Cultural Education [NACCCE], 1999, p. 30). The fourth characteristic, *problem-solving* or *thinking*, addresses the process of creativity. For students who are developing their creative potential, problem-solving and thinking focus on the method which underlies creative ideation, which will be the same process that they may use later for constructing tangible creative achievements (Runco, 2008). By instructing all students in this process, teachers signal the inclusion and participation of students with a wide range of visible and latent ability, unlike theories which recognize creativity as the purview of geniuses (Simonton, 2004) and creative artists in music, dance, literature and visual arts, among others (NACCCE, 1999; Runco, 2008). Developing creative potential in children does not guarantee that students will eventually create useful and original outcomes to some extent, or any at all, but it does develop the necessary skills and knowledge to implement and participate in the process in school and the workplace.

The use of the terms *creative problem-solving* and *creative thinking* occur throughout this thesis. The inclusion of the adjective *creative* differentiates creative and non-creative problem-solving or thinking. That is, not all problem-solving is creative (Runco, 2007), nor is all thinking creative (Runco, 2011). Consider, for example, thinking that is useful, but not original: following instructions, routinized tasks, and habitual behaviours of everyday life. Problem-solving or thinking must construct both useful and original outcomes to be creative. For this reason, I refer to *creative* problem-solving and *creative* thinking to distinguish them from non-creative problem-solving and non-creative thinking.

Another term used throughout this thesis is human ingenuity, which Hansen (2008) defines as "the aptitude and ability to solve problems through experience, with originality and imagination." Homer-Dixon (1995) refers to human ingenuity as ideas that solve practical problems. Hansen (2008) distinguishes the two terms by stating that creative problem-solving/thinking "contemplates" and human ingenuity "acts." This distinction is much more complex, but for the purposes here, it is sufficient. Human ingenuity implies physical, hands-on actions such as *doing*, *building*, *fixing*, or *dismantling*. In an educational context, teachers plan and present lessons and learning activities for students to develop the knowledge and skills of thinking (creative problem-solving/thinking) and acting (human ingenuity). Students are expected to demonstrate both thinking and acting, particularly in the formal, environmental program examined here. Because of this strong connection between creative problem-solving/thinking and human ingenuity, the two terms interchangeably headline different sections of this study.

Current Interest in Creativity

There is evidence to suggest that creativity is in serious decline and without significant acknowledgement by public institutions of its importance, particularly in North America. In a sample of almost 300,000 children and adults from K-12, Kim (2011) discovered a significant decline, or the start of a significant decline, in creativity scores, particularly for K-3 students, across all subscales of the Torrance Tests of Creative Thinking (TTCT) from 1990 to present. Interestingly, Flynn (2007, as cited in Kim, 2011) reported that intelligence scores are consistently rising. Assuming IQ tests measure what they purport to measure, intelligence may not be a factor in the lack of environmental solutions.

Globally, large scale efforts have signalled a raised awareness of the need for greater creativity. In the United Kingdom, British secondary school curriculum was revamped in 2008 to emphasize creativity, idea generation and the assessment of progress with Torrance Test scores (Bronson & Merryman, 2010). Reforms were based upon a highly publicized white paper by the NACCCE (1999) outlining the development of a national strategy for creative and cultural education, formal and informal. The European Union designated 2009 as the European Year of Creativity and Innovation to promote creativity and build capacity for innovation. For formal education, this meant responding to calls for the replacement of traditional, direct instruction with student-focused teaching approaches that actively involved students in order to develop creativity and innovation skills (see http://www.create2009.europa.eu/index_en.html). China, too, is implementing a similar approach to instruction as part of extensive educational reform (for instance, see Chan, 2010; Song, Kwan, Bian, Tai, & Wu, 2005).

Northern Ireland has taken creativity a step farther. “Unlocking Creativity,” the first paper of a three-part strategy, asserts that “the future prosperity and well being of Northern Ireland will depend increasingly on the creativity and adaptability of all of its people” (DCAL, DE, DETI, DHFETE, 2000, p. 6). Responding to the business community’s needs, the availability of technology and the demands of a new knowledge-based global economy, the importance and learning of creativity has been raised to a complete, systems-wide approach rather than a few extra lessons tacked onto the end of the current curricula. The goal in Northern Ireland is not only economic but to “unleash [our] personal potential” (DCAL, DE, DETI, DHFETE, 2004, p. 5).

A large, 2010 IBM study, surveying 1,541 international CEOs and business leaders from small to large-sized companies across 33 industries, further articulates the need for creativity. These business leaders recognize “escalating complexity” as their primary business challenge because more and more frequent “events, threats and opportunities” are less predictable, converging towards interdependence and becoming unique situations that require unique solutions (IBM, 2010, p. 4). As a result, 65% of CEOs identified creativity as the most important leadership quality, outranking integrity (52%) and global thinking (35%) (IBM, 2010, p. 24). According to the CEOs, creative leaders move beyond the status quo by experimenting and innovating – despite ambiguity – with ideas, leadership styles and communication. They take more calculated risks and assist others to eliminate outdated methods. Overall, the CEOs find their businesses in a situation that demands “unprecedented degrees of creativity,” yet they struggle to find leadership to meet this demand (IBM, 2010, p. 4).

1.1 The Importance and Place of Formal Education

The need for more creative solutions to current environmental issues, combined with the widespread recognition that more creative workers are required, leads to the question: What role is education to take in embracing these macro- and micro-level needs in the classroom? How do current learning experiences nurture creativity in Ontario students, if they do at all?

On the surface, Ontario educational priorities appear to complicate, rather than facilitate, the development of student creativity. In classrooms, standardized testing compels educators to focus efforts on content driven curricula, ostracizing the development of creativity. All elementary and secondary subject specific curriculum documents expressly stipulate the use of creative thinking skills and/or processes (i.e., problem-solving and inquiry) throughout, but informal teacher discussions reveal it is seldom considered, or even known to be documented. Strategies that inspire creativity, like problem based learning and experiential learning, appear to be rarely used. Furthermore, teacher attitudes about classroom management and the flow of a classroom seem to contradict the compelling need for creativity. Davis (1999) and Torrance (1963) found that teachers dislike some characteristics of creative students (as cited in Aljughaiman & Mowrer-Reynolds, 2005). Highly creative students cause more disruption in comparison to other students (Scott, 1999). On a school district level, directives to assess creativity are essentially non-existent. Yet, a number of assessment tools are available, including the TTCT, the most popular of divergent thinking tests, considered the “gold standard” (Clapham, 2011, p. 460). In summary, it is unclear how the teaching of creativity is pursued in Ontario classrooms despite the acknowledged importance of developing innovative approaches to meet challenges (Ontario. Ministry of Education and Training [MET], 2010).

1.2 Research Questions

The main question that I pose is: “To what extent do educational programs (e.g., the Specialist High Skills Major – Environment (SHSM-E) program) address human ingenuity?” Issues that more specifically focus and structure my research are:

a. What “school-based” pedagogies and instructional practices, such as problem-based learning, divergent thinking and inquiry, are being used as methods in formal education?

b. What field-based, experiential learning practices such as outdoor education, local field trips and co-ops are being used?

c. What limitations and curriculum supports/barriers, professional development, procedures and leadership do teachers encounter in trying to address human ingenuity?

d. Do students have opportunities to develop Bloom’s higher levels of learning (i.e., Analysis, Synthesis, Evaluation) for creative thinking (see Shaunessy, 2000)?

e. Are learning conditions, such as collaboration or independence to explore personal interests, encouraged for students?

f. Are human ingenuity-fostering attributes, such as the valuing of experience, ambition, independence, norm doubting, autonomy, non-conformity (see Weisberg, 2010, p. 244) being nurtured?

g. Is creative problem-solving or human ingenuity acknowledged in provincial and school district documents as an educational outcome?

1.3 Summary

Calls for greater and more universal creativity skills which respond to pressing economic, political, social and environmental issues, are growing. Evidence of declining creativity on standardized assessments and weak creative problem-solving skills in the workplace have raised concern from leaders across sectors. Increased demands have been placed on the formal education system for an appropriate response. Educators from the Ministry of Education, school districts, administration and classrooms all have differing roles to play in assessing the current state of creativity development and, then, implementing reforms. The focus of this study is school-based, examining the creative potential and human ingenuity among adolescents in an environmental program. The following chapter will outline the theoretical foundation of the study and the current situation in Ontario.

Chapter 2

2 Literature

In Chapter 1, creativity was defined as the process of problem-solving or thinking that constructs useful and original outcomes (Runco, 2008). K-12 students can learn the creative process to develop their creative potential, even if they cannot or may not yet be able to construct useful and original outcomes. Human ingenuity, too, was defined, as "the aptitude and ability to solve problems through experience, with originality and imagination" (Hansen, 2008). Simply put, creative problem-solving/thinking is "contemplative"; human ingenuity is "action." Both concepts may be required to prepare students for the 21st century.

With definitions of creative problem-solving/thinking and human ingenuity clarified, the teaching and learning of them needs to be addressed. In the literature, propositions abound as to how to develop creative abilities (see, for instance, Lin, 2011). The intention of this thesis is to narrow those myriad propositions by focusing exclusively on examining the learning activities that engage students in developing creativity and creative potential, in an environmental program context. Choices about those instructional activities, in formal education, are the teacher's responsibility, as are appropriate decisions about curriculum. In the context of this study, two related questions are investigated: What instructional activities were implemented by the teachers, and how did teachers and students respond to those choices? The aim is to enhance understanding of classroom practice, through the experiences of teachers and students in the development of meaningful creative problem-solving.

In this chapter, a theoretical framework will be established, starting with Constructivism. This will be followed by a discussion of the teaching and learning of creativity and how it is made operational through student-centred, constructivist instructional strategies. The location of instructional strategies on a continuum of ill-structured vs. well-structured problem type will also be examined. Bloom's Taxonomy will be briefly discussed as a model of classifying thinking and how its utilization for effective questioning nurtures creative problem-solving. And finally, the study will be situated in the current educational times within the Province of Ontario.

2.1 Theoretical Framework

This thesis draws on Constructivism as a theoretical framework. In its simplest form, Constructivism is a student-centred approach whereby students actively participate in the construction or discovery of knowledge (e.g., Bruner, 1961; Phillips, 1995; Piaget 1967). In contrast, a direct instruction approach depends on the teacher to provide all required concepts and procedures (Kirschner, Sweller, & Clark, 2006). Constructivist learning can be characterized as inductive, in that students make broad generalizations from their specific observations. It is incremental, by building on *a priori* knowledge; socially interactive by virtue of the sharing of ideas and the interplay of conflicting interpretations from within a specific context; and authentic, meaning realistic or useful in a student's life (Good & Brophy, 1991).

Minimal guidance from the teacher surrounding disciplinary or procedural knowledge seeks to encourage student participation, an internal locus of control and self-efficacy. The importance of the student participating in forming the purposes of learning activities (Dewey, 1938) is emphasized in the sharing of learning decisions between the teacher and student. Minimal teacher guidance and greater student involvement can also encourage creativity, as students must use problem-solving to determine original (individual or relative) and useful procedures, required knowledge and purposes of learning. It is uncertain how direct instruction approaches deal with student originality. Baer & Garrett (2010, p. 18) assert that an idea cannot be creative if it has been "moved into the student" by the teacher. In this sense, direct instruction may severely limit the creative problem-solving/thinking that can occur when the teacher supplies all required concepts, procedures and purposes of learning without student involvement.

This is not to say that all instruction should be constructivist. Direct instruction is highly appropriate for some purposes, such as the learning of factual information, effectively correcting misconceptions, organizing knowledge and addressing incomplete information (Kirschner et al., 2006). Where on the constructivist-direct instruction continuum that teaching is most appropriate depends on the teacher's understanding of the "capacities, needs and past experiences" of students and the degree of freedom students are given to suggest and develop the purposes of a learning activity (Dewey, 1938, p. 71). A teacher's suggestions may initiate planning, but students and the teacher together need to negotiate the development of the learning plan.

As an epistemology, Constructivism – the creation of knowledge through the interaction of experience and ideas – underlies the pedagogies of experiential learning, inquiry learning and problem-based learning.

2.1.1 Constructivist Pedagogies

Experiential Learning Theory

Experiential Learning Theory states that learning is a process of creating knowledge through the "transformation of experience" (Kolb, Boyatzis, & Mainemelis, 1999, p. 2). Ideas are created then re-shaped with each experience (Kolb, 1984). Dewey (1961) maintained that active learning through experience made education personally meaningful by allowing students to reflect on the consequences of their actions. According to Dewey, a valuable experience must have continuity, linking it to a past experience and affecting an experience in the future, and interaction, linking learners and their environments. While Illeris (2007) acknowledges that these two principles are necessary for experiential learning, a more exacting definition is required, whereby experiential learning involves "content, incentive and interaction . . . in a subjectively balanced and substantial way" (p. 94). Thus, experiential learning occurs when students, who are ready and willing to learn, strongly connect with interesting and personally significant content, which leads to emancipation (Illeris, 2007). Self-direction and student centeredness are important requirements that strengthen that connection.

Kolb's Experiential Learning Theory (Akella, 2010) describes a sequential and cyclical four-stage model in which students engage in a Concrete Experience (CE), reflect and make observations on the experience (Reflective Observation - RO), connect the observations to curricular concepts using reasoning and logic to understand the experience (Abstract Conceptualization - AC) and finally, test their generated theories for future use and prediction (Active Experimentation - AE). Reflection is a necessity, as Boreham (as cited in Healey & Jenkins, 2000, p. 89) clarifies: "The term 'learning from experience' really means learning from reflection on experience." Kolb (1984) stated that, ideally, learners would engage in the "experience, reflect, think and act" process repeatedly to create new knowledge.

Problem Based Learning

The distinguishing feature of Problem Based Learning is an authentic problem, case or scenario that is presented to students prior to conceptual learning, a reversal of typical formal education which demands mastery of basic concepts as a foundation of learning before application to problems (Hung, Jonassen, & Liu, 2008). In K-12 education, varying degrees of conceptual learning are presented to, and acquired by, students prior to engaging in Problem Based Learning, depending on the skills and needs of learners. Younger students are commonly taught many concepts prior to a Problem Based Learning activity while secondary students are provided with few concepts, if any.

Problem Based Learning generally follows a series of steps. The teacher presents a rich, concrete problem with basic background information to groups of students, who individually assume roles as real stakeholders to enhance ownership in the authentic task. Together, they decide how to tackle the problem by extracting key information, searching for connections to other disciplinary and prior knowledge, and defining the problem. Students generate and evaluate hypotheses, engage in task-specific research to determine missing information and determine their best possible solution. Student self-direction and self-assessment are ongoing and essential, with teacher guidance available to assist as needed, for issues such as group dynamics and task management.

Inquiry Based Learning

Inquiry Based Learning involves experimentation and hands-on investigations in which the majority of procedural components (e.g., topic, hypotheses, procedures, data collection, data analysis, conclusions) are determined by students. Students are introduced to Inquiry Based Learning by controlling and completing a single component. More components are added as students develop pertinent skills and knowledge, until control over the entire process is suitable and beneficial.

Students learn to brainstorm areas of interest and then choose a single topic; determine and formulate hypotheses; enumerate and communicate a sequential procedure; collect, compile and organize data and analyze it; and finally draw conclusions. The Inquiry Based Learning process used by professionals in various disciplines can be similarly implemented by students to discover and build new student knowledge: This similarity gives real meaning to a learning activity as an authentic experience. Inquiry Based Learning is frequently used in science education (Pedaste et al., 2015), but can be utilized for any query across the curriculum that can be answered through student experimentation or hands-on investigation.

2.1.2 Problem Type

Instructional strategies and pedagogies are presumed to provide students the opportunities to develop their creativity. Pedagogies that inspire creativity, according to Stokes (2010), can be linked to ill-structured, or non-structured, tasks while well-structured task are linked with traditional methods that inspire less creativity. An ill-structured problem is a task in which the problem statement, process or solution may not be immediately apparent and the learner must identify it in addition to tackling the task, whereas a well-structured problem provides all the necessary information required to solve a problem, uses one evident algorithm and results in a single, correct solution (Jonassen, 2000). Contrasting the simplicity of well-structured problems is the potential for variability of ill-structured problems: Learners require various skills and abilities. Concepts and processes to be used are unclear. Solutions and paths to those solutions can be multiple and divergent. Beyond these basic components of the two types of problem, Jonassen (2000) identifies other dissimilar characteristics. Firstly, well-structured problems are often associated with a single subject knowledge base while ill-structured problems are multidisciplinary. Secondly, ill-structured problems are situated in everyday issues and events as “typically emergent dilemmas” (p. 68). As a result, they are thought to hold greater interest, relevance and meaning for students. Thirdly, the transferability of skills for well-structured problems is limited to similar types of problems and not to solving problems situated in everyday contexts, as is commonly assumed. Finally, ill-structured problems call for students to make judgements and defend them, analyze information and data, and synthesize new information.

Ill-structured and well-structured problems can also be seen as endpoints on a continuum with overlapping characteristics. Both types of tasks are needed in order to address different needs of learners. Well-structured problems are prolific in schooling: They are commonly found at the end of textbook chapters and readings as a means of assessing students' ability to apply recently learned concepts, algorithms and procedures. Ill-structured problems are rarely found, particularly in K-12 settings, as a result of their complexity and uncertainty, the difficulty in designing instruction to develop the skills to solve them (Jonassen, 2000), and the need for students to experience real life situations (Hong, 1998). The benefits of ill-structured problems outweigh the challenges, in Stokes (2010) view, particularly if students are to learn creativity. Stokes (2010, p. 91) states that creativity is "only possible with incompletely defined, ill-structured problems." The skills required to solve well-structured problems are not sufficient and "preclude" the learning of creativity (Stokes & Fisher, 2005, as cited in Stokes, 2010).

Specific teaching strategies and instructional formats that are ill-structured and can lead to improved creativity include hands-on projects (Shymansky & Penick, 1981; Mackin, 1996), open ended tasks (Schamel & Ayres, 1992), and investigations (Sallam & Krockover, 1982). For purposes of this study the ill-structured, creative instructional strategies include Experiential Learning, Problem Based Learning, and Inquiry Based Learning.

2.1.3 Group Creativity

Another instructional strategy that has been included in this analysis of creative instructional strategies does not have an ill-structured nature. Class Discussion, also known as group creativity, is thought to inspire creativity because students work together to stimulate, positively criticize and build on creative ideas voiced by others in the group. Paulus (2000) states that most people believe group creativity is effective, generates more ideas than when people work alone and is perceived more positively by participants who work together than when they work alone (Simonton, 2004; Paulus, Dzindolet, Poletes, & Camacho, 1993, as cited in Paulus, 2000). In other words, more people working together will produce more ideas and, subsequently, more creativity. However, strong opposition to group creativity identifies many potential issues, including groupthink, diminished accountability and peer pressure by students who monopolize idea input and make harsh judgements (Plucker & Dow, 2010). Additional opposition to group creativity stems from the long standing belief that creativity is the product of the solitary genius (Weisberg, 2010). Individualism continues to be the fundamental assumption of more current research such as Simonton's (2004) proposition of creativity as a combination of logic, chance, zeitgeist and genius, and Weisberg's (2010) CHOICES model, among others. Group creativity research acknowledges a social component to the theory that individuals are creative, noting that the "group" comes from connections to an intellectual community rather than individuals physically gathering.

In short, group creativity continues to be a highly contested concept. However, sufficient supportive research, which is "increasing" according to Nijstad and Paulus (2003, p. 5), and the prevalence of a common belief that discussion within a group inspires creativity, suggests it be investigated in this study.

2.1.4 Bloom's Taxonomy

Bloom's Taxonomy is a model of classifying thinking. It has been utilized pervasively pedagogically and is the "de facto standard" to classify thinking (Forehand, 2005, p. 3). The model orders thinking in the cognitive domain according to multi-tiered levels of complexity from concrete to increasingly abstract (Krathwohl, 2002). The six levels – Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation – are hierarchical, most often represented in a tower-like formation, in which each level is built on the proficiency of the previous lower levels. The three lower levels have been grouped as lower-order thinking; the remaining three levels, higher-order thinking. The profound importance of higher-order thinking is that it calls for the transformation and manipulation of ideas in order to construct knowledge (Queensland. Department of Education, Training and Employment as cited in Ramos, Dolipas, & Villamor, 2013). Without these higher-order skills, in this view, creative problem-solving cannot occur.

Bloom's Taxonomy is thought to order the effective questioning that is essential to the development of creativity and higher-order thinking (Pollack, 1988; Shaunessy, 2000; Wilhelm, 2014). In oral and written formats, questions need to be utilized at all six levels, particularly for higher-order thinking in order for useful and original student ideas can be constructed. For teachers, thorough coverage of the Taxonomy begins with purposeful inclusion throughout unit and lesson planning, and continues with effective oral questioning and task assignment with students. For students, Schwartz and Millar (1996, p. 2) petition for the "deliberate teaching of questioning" as a means to improve self-questioning, which reinforces the importance of learning the process of creative thinking, not just arriving at answers. Because of the complexity of each level of the Taxonomy, question cues in the form of sentence starters greatly assist teachers and students in the formation of effective questions. These prompts, with the corresponding levels of the Bloom's Taxonomy (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956) are:

a) Knowledge: observation and recall of information; knowledge of dates, events, places; knowledge of major ideas; mastery of subject matter. *Question Cues: define, describe, identify, label, list, name, quote, show, tabulate*

b) Comprehension: understanding information; grasp meaning; translate knowledge into new context; interpret facts; compare; contrast; order; group; infer causes; predict consequences. *Question Cues: associate, contrast, describe, differentiate, discuss, distinguish, estimate, extend, interpret, predict, summarize*

c) Application: use information; use methods, concepts, theories in new situations; solve problems using required skills or knowledge. *Question Cues: apply, calculate, change, complete, classify, demonstrate, discover, examine, experiment, illustrate, modify, relate, show, solve*

d) Analysis: seeing patterns; organization of parts; recognition of hidden meanings; identification of components. *Question Cues: analyze, arrange, classify, compare, connect, divide, explain, infer, order, select, separate*

e) Synthesis: use old ideas to create new ones; generalize from given facts; relate knowledge from several areas; predict; draw conclusions. *Question Cues: combine, compose, create, design, formulate, generalize, integrate, invent, modify, plan, prepare, rearrange, rewrite, substitute, what if?*

f) Evaluation: compare and discriminate between ideas; assess value of theories, presentations; make choices based on reasoned argument; verify value of evidence; recognize subjectivity. *Question Cues: assess, compare,* *conclude, convince, decide, discriminate, explain, grade, judge, measure, rank, recommend, select, summarize, support, test*

In 2001, an updated version of Bloom's Taxonomy was published as the Revised Bloom's Taxonomy (Anderson & Krathwohl, 2001). Amongst other changes, each level was renamed from a noun to a more action-oriented verb. The relevance of the revision for this thesis was the re-ordering and renaming of the top two levels of higher-order thinking (Forehand, 2005) [1] into Evaluate and Create. The required complexity and abstraction moved Create to the top level of the cognitive processes. The change in terminology to Create from Synthesis broadened the definition to include the "active processes of constructing meaning" (Krathwohl & Anderson, 2010, p. 64). The top-level change complements this study's definition of creative problem-solving/thinking as an active process of constructing useful and original outcomes and elevates the importance of creativity in classroom instruction. It may also speak to the distinction between being contemplative and action-driven.

2.2 The Current Times in Ontario Education

2.2.1 The Ministry of Education

Ontario provides elementary and secondary education for over 2 million students and employs about 123,000 teachers, early childhood educators and administrators in 4,891 schools. While not the largest school system worldwide, several international assessments have recently ranked Ontario as one of the best (Fullan, 2013). McKinsey & Company's "How the World's Most Improved School Systems Keep Getting Better" gave Ontario public education its highest ranking, "Great to Excellent," only one of five education systems globally to receive such a ranking (Mourshed, Chijioke, & Barber, 2010). According to the report, Ontario's consistent increases in student performance across multiple curriculum areas for over five years made it a "sustained improver" (Mourshed et al., 2010, p. 17). Fullan (2013, p. 1) calls Ontario "the best school system in the English-speaking world." Ontario's journey began in 2003 when its newly elected

[1] The nomenclature and ordering of the original Taxonomy will continue to be used as it was utilized in student and teacher questionnaires as well as for interviews.

provincial government embarked on strong educational reform that continues today. At the outset, improving teaching practice was identified as the key to success so reform centred on nurturing a process at the school level in which educators determined and then enacted the instructional changes required (Mourshed et al., 2010). Standardized testing, still disparaged by some teachers due to perceived validity issues of early tests, monitors progress in student achievement and informs instructional practice in a milieu of collaborative practice and improvement. This low-stakes testing environment pales in comparison to the uncertainties and complexities of high stakes' punishment, reward, compensation and grade promotion. Some practitioners have difficulty recognizing the value of testing and how it can inform their practice.

Declining enrolment is a recent issue that is expected to continue indefinitely due to a reduced provincial birth rate (Ontario. Declining Enrolment Working Group 2009, p. 4). Ongoing Ministry adjustments, unpopular with education stakeholders, are required to re-think funding and re-allocate resources. The fears are that fewer programming options will be available for students, staffing changes will result in job loss, and schools may be closed in some communities. Meanwhile, the supply of new teachers exceeds the demand created by teacher retirements by about 7,200 annually and, as a result, 80% of new teachers cannot even find supply work (Ontario College of Teachers, 2013). Factoring in the cumulative effect of oversupply for longer than a decade, a large cohort of new teachers faces years of unemployment and extensive underemployment prior to full employment. Some new teachers find jobs in private schools, in other provinces, internationally, or leave teaching altogether (Ontario College of Teachers, 2013).

Creativity in Ontario Ministry of Education Curriculum Documents

The development of creativity is supported within the educational reform that has been occurring in Ontario. All Ontario Ministry of Education, subject area curriculum documents make frequent reference to creative/critical thinking skills, problem-solving and inquiry skills. However, creative/critical thinking skills are conceptually disparate and never discussed separately or formally defined.

Examining the recently revised Grade 11 and 12 Geography curriculum (Ontario. Ministry of Education, 2015), the basis of senior level environmental education, reveals that the instructional strategy of inquiry is well documented. A model representing the investigation process is outlined and teachers are responsible for helping students approach inquiry "with openness and creativity" (p. 20). Perhaps, the most revelatory comment comes from a statement about instructional approaches:

> Students must be given opportunities to see that inquiry is not just about finding what others have found, and that they can use the inquiry process not only to uncover knowledge but also to construct understandings and develop their own positions on issues. Learning should be seen as a process in which students monitor and reflect on the development of their knowledge, understandings, and skills (Ontario. Ministry of Education, 2015, p. 45).

The words *construct understandings* do not address the concept of creative problem-solving but imply self direction. Although originality or usefulness are not expressly mentioned, a teacher who utilizes inquiry as an instructional strategy could interpret this statement as an endorsement of creativity and pursue the development of creative problem-solving. Alluding to self-monitoring also supports the notion that students could learn the process of creative problem-solving as they move towards the eventual construction of tangible creative achievements (Runco, 2008).

2.2.2 Key Education Stakeholders

Teachers

In addition to a positive collaborative environment and a politically supportive government, teachers are generally pleased with their influence on and relationships with children, excellent wages and benefits, and the availability of professional growth and leadership opportunities (Jamieson, 2006). However, they are cautious and uncertain about parental support of their efforts and public opinion of the profession. Some teachers are significantly stressed by other issues, such as parental interaction, politics at work and teacher performance appraisals (Ontario College of Teachers, 2006). Formal and informal discussions with my teacher colleagues indicate that many feel overwhelmed by perceived curricular overload. The need to engage in meaningful, self-directed professional learning and to implement employer provided updating, along with the continual demands to address non-pedagogical issues such as mental health, anti-bullying and safe schools, is extensive.

Students

From Junior Kindergarten to Grade 12, students are keen to engage in exciting, meaningful learning opportunities that include social interaction and developing peer relationships. Attitudinally, students display an increasing sense of entitlement and have high expectations for the future, which are sustained by adults, including educators, and media messages around them. As they approach high school graduation, students face new pressures surrounding the dichotomy between an abundance of career opportunities and the stress in making a career path decision that meets parental, societal and personal expectations of valuable work for excellent compensation. Some senior students begin to gain a sense of the obstacles that they could potentially encounter – extensive training or post-secondary education, stiff competition, poor job prospects, etc. – but believe they can personally overcome or avoid these obstacles (Kolm, 2013).

2.3 Summary

This literature review has focussed on establishing the theoretical framework of Constructivism in the teaching and learning of creativity/human ingenuity. From within this framework, teachers are asked to implement this theory into classroom instruction in two ways. Firstly, the continuum of well-structured to ill-structured problem type proposes that more creativity results when students must solve tasks in which part of the problem, process or solution is not apparent. Particular instructional strategies, such as Inquiry Based Learning or Problem Based Learning, are ill-structured. The strategy of Classroom Discussion, while not ill-structured, suggests that group creativity also inspires creativity/human ingenuity, although there are critics of this claim. Secondly, the hierarchical classification of Bloom's Taxonomy divides thinking into lower-order and higher-order, the latter of which teachers can develop by engaging students in the analysis and evaluation of ideas and, ultimately, in the construction of knowledge. Thus, creativity is the highest level of the Revised Bloom's Taxonomy.

The development of creativity/human ingenuity is referenced, albeit indirectly, within the educational reform that has been occurring in Ontario for more than a decade.

Ranked as one of the best school systems worldwide, the current educational climate strongly encourages the improvement of teacher instruction through school-based initiatives.

Chapter 3

3 Methodology

In this chapter, the case study research design will be outlined, including an explanation of its application to this thesis. The rationale for site location and a general description of the project participants will follow. The chapter concludes with details of data collection and, finally, the method of analyzing the data.

3.1 Research Design

The case study approach for this naturalistic study was chosen for several reasons. The purpose of case study research is to discover, understand, and interpret (Merriam, 1988) by concentrating on a single phenomenon; in this case, the development of creativity/ human ingenuity. Case studies examine a "bounded system" (Smith, 1978, as cited in Merriam, 2002, p. 178), characterized by clear boundaries that define what is included and what is excluded in the study (Stake, 1978). The case is purposefully selected because particular characteristics that pique the interest and curiosity of the researcher have been identified. Subsequently, the researcher acts as the "primary instrument of data collection and analysis," employing inductive investigation in order to provide a rich description of the case (Merriam, 2002).

The aim of case study research is to explore a topic in depth and with completeness (Birley & Moreland, 1998), not determine cause and effect. This exploration examines the process – the interaction of significant factors – rather than the outcome. These factors, or variables, are not manipulated or controlled in an attempt to evaluate. Whereas identifying many of the variables is possible, it is difficult if not impossible, to identify all of them in advance.

The failure of qualitative research to generalize findings is often raised as a weakness. In particular, case studies focus on one, single unit of analysis (Merriam, 2002). They do not attempt to represent larger populations as quantitative research does. Analytic generalization, a popular but under-recognized practice, is utilized though (Yin, 2011). In this two step process, researchers demonstrate how the results of their research add to the body of knowledge and then apply the theory in similar situations where the research might be pertinent. In other words, analytic generalization addresses the implications that case study findings may have on other similar cases in a field of study. In response to statistical generalization comparisons, Merriam (2011) suggests that generalization occurs as a result of the reader's interpretation, application and contextualization of the findings. Readers determine and transfer the knowledge garnered from the case study that will inform understanding and practice in their own similar situation.

The approach of this study, then, aims to increase understanding of education policy and practice through discovery, while improving educational practice as an important underlying goal. My basic assumption is that participants in this study bring multiple realities, based on each individual's perception, rather than one single, objective reality. Perceptions are based on beliefs, not on measureable and constant facts. This subjective understanding of reality requires the researcher to discover participants' perceptions in order to understand and interpret the phenomenon in context. The participants' understandings of the phenomenon and how they make sense of their experience must be mediated through the investigator, thus making the researcher indispensable to collecting and analyzing data (Merriam, 1988). Subsequently, individual understanding and meaning can be used to construct the phenomenon through induction, propositions and theoretical categorizations.

In order to determine the learning of human ingenuity/creativity in a formal environmental education program, case studies were conducted in two high schools, purposefully selected to determine innovative practice and explore pedagogical and program ingenuity. Choosing the two sites was based largely on evidence from an earlier study that showed statistically significant differences between children's creativity scores in rural and urban elementary schools (Dishke Hondzel, Hansen, Sørebø Guilliksen, & Lindfors, 2014). This HIRG research study investigated how the creativity of 8-year old students was influenced by culture; that is, a student's home environment, nationality, and community structure. A Torrance Test of Creative Thinking (TTCT) was given to Canadian, Norwegian and Finnish children who attended schools in rural, town and urban communities that represented small, medium and large population sizes. The results showed that community size was related to the students' TTCT scores. While my research design compares two programs rather than the individual creativity scores of 8 year old children in rural and urban settings, I was intrigued to see if HIRG's findings could be substantiated among adolescents at the secondary school program level where daily, observable environmental education was certain to be occurring.

Because rural high schools with an environmental program were much more uncommon than urban schools, finding a rural school willing to participate in the study became the main priority. Once that rural school was found, an urban school within the same school district seemed most desirable as it would allow for the comparison of local environmental issues, educational policy and instructional practices of creative problem-solving. Unfortunately, no urban and rural environmental schools existed within the same school district. An urban, environmental school within the co-terminus school district became a viable alternative. The lead teacher at each school was eager to participate in the study and expressed a willingness to fully accommodate the scheduling, data collection and time commitment of the research. Ethics approvals were obtained from the UWO Non-Medical Research Ethics Board (NMREB) and the two school districts invited to engage in the study.

The two schools offered students a specialty program in Environmental Education. The Ontario Ministry of Education launched the Specialist High Skills Majors (SHSM) in September 2006 to allow students to earn a high school diploma and focus their learning on a particular economic sector in order to gain specific skills and knowledge in leading to a post-graduation pathway of apprenticeship training, college, university, or the workplace. The Specialist High Skills Major – The Environment program (hereafter called SHSM-E) was created due to an increasing number of environmental jobs as well as real and projected labour shortages. As of 2012, eighty-six SHSM-E programs were located in Ontario high schools across the province, according to the Ontario Ministry of Education (see http://www.edu.gov.on.ca/ morestudentsuccess/SHSM.asp). The SHSM-E program is a senior level program, consisting of a bundle of Grade 11 and 12 credits including four environment major credits, certifications and training courses (e.g., First Aid, GPS, WHMIS), experiential learning activities, and career exploration in a chosen pathway. Students develop essential sector-specific skills and work habits, and can “access resources, equipment, and expertise that may not be available in their school" (Ontario. Ministry of Education, 2010, p. 106).

Several advantages emerged to suggest studying the participants in the SHSM-E program was preferred. Firstly, ingenuity would have an opportunity to be used and to flourish within a program that had such a specific environmental focus. Secondly, the students, presumably, were interested and committed to Environment Studies having had to apply and be admitted to a restricted program. Thirdly, the timetabling of classes in high schools was regimented so data collection opportunities were more manageable, which maximized the use of my time when visiting a school site. Environmental Studies at the Elementary level are embedded in other subject areas rather than being taught as a distinctive subject. As a result, Elementary environmental studies may have been sparse, intermittent and limited in scope. And lastly, the SHSM-E program included experiential learning and older children, which connected with my interest in Adult Education learning principles.

3.2 Project Participants

3.2.1 Urban Site

Site A was an inner-city high school located in a conservative, well-established city of approximately 500,000 residents. This site was considered urban because it was located within a Larger Urban Centre as designated by Statistics Canada (n.d.). The school population was over 1,000 students and drew most students from a geographical area of approximately 55 km^2, excluding specialty programs. Families at this school had modest wealth, although out of boundary students in specialty programs brought greater affluence and influences from the outlying areas to this downtown core school.

The SHSM-E program was well-established, running for over ten years as the Environmental Leadership Program. Teacher A had taught the program for over 5 years. Students were together as a group for the whole day for one semester. Class enrollment was 20 students. An application process was required to enter this program due to the demand and in order to determine the suitability of candidates.

3.2.2 Rural Site

Site B was located in a small town of approximately 1,500 residents, within a municipality of just over 5 000 residents, which was designated a Rural and Small Town (RST) area by Statistics Canada (n.d.). This high school drew both rural and small town students from boundaries covering an area over 600 km^2. The community was stable and family wealth, in general, was modest. Driving through the town felt like a rural community; the streets were typically quiet and deserted. The occasional car, pickup truck or farm vehicle was controlled at one main, all-way, flashing red traffic signal. Farms surrounded the 18 blocks of buildings that comprised the town.

The SHSM-E program was in its first year of existence and, as a result, interested students were scarce and guidance counsellors actively recruited from the school population in order to enroll enough students to make the course viable. Students chose to enter the program, but no application was required. In the end, nine students were enrolled in the class. Similar to Site A, the course was also known as the Environmental Leadership Program. Teacher B was an experienced teacher. Students took other credit courses in the morning and joined together as a group for the last two periods of the day for both semesters.

Table 1 presents the participant demographics of each site.

Characteristic	**School Site A**	**School Site B**
Location	Urban (pop >500,000)	Rural (pop <3,000)
School Boundaries	55 km^2	600 km^2
History of School's SHSM-E Program	>10 years	1st year
Teacher	Experienced	Experienced
Total Student Enrollment	20	9

Table 1: Participant Demographic (School Sites A & B)

3.3 Data Collection

This study drew upon multiple sources of information: documents/archival records, teacher and student questionnaires and interviews, and direct and participant observation of classroom activities (Yin, 2003). Multiple sources of data allowed for triangulation of the data in order to corroborate the evidence. When data from different sources conflicted, interview data took precedence over all other sources, following the dominant-less dominant model of Creswell (1994 , as cited in Creswell, Plano Clark, Gutmann, & Hanson, 2003). First-hand participant accounts and the opportunity for me to clarify responses during interviews provided the most accuracy and detail.

The documents/archival records examined were teacher unit and lesson plans, student workbooks and assignments, the textbook, and student work displayed around the classroom. In-classroom observation occurred during regular class time over five days, for periods of 2-4 hours. Both document examination and observation were looking for similar evidence. Evidence of instruction in the process of creative problem-solving, creative thinking, or the construction of useful and original outcomes, was sought. I also searched for additional evidence on the use of Bloom's Taxonomy, ill-defined and well-defined problems, contextualized learning in real events, questioning the status quo, and learning activities synonymous or well-associated with creativity, such as divergent thinking or being an inventor (which I called *creative activities*). From a student's perspective, the search for evidence focused on demonstration of creative problem-solving or thinking, and its outcomes, as well as self-directed learning of the creative problem-solving process and self-questioning using Bloom's Taxonomy.

Two questionnaires were used at each site in this study in order to explore the experiences of both student and teacher participants. A teacher questionnaire was designed to retrieve information associated with environmental leadership, instructional decision making, and general citizenship. A survey by Wideen, O'Shea, Pye and Ivany (1997), which tracked classroom practices, formed the basis of the teacher questionnaire. To this survey, three constructivist instructional strategies were added. Two items were removed and one open-ended question was included. Completing the five-page teacher questionnaire were questions exploring constraints and supports, activities synonymous or clearly associated with creativity, the use of Bloom's Taxonomy, and environmental learning activities. All questions utilized a 5-point Likert scale to measure various criteria; namely, effectiveness, frequency, importance and level of support. One teacher at each site completed the teacher questionnaire, which is provided in Appendix D: Teacher Questionnaire.

Many items on the student questionnaire were modifications of teacher questions with the educational lexicon removed. Additional questions explored personal creative problem-solving experiences, self-confidence, and group creativity. The 13 questions of the student questionnaire used a combination of 5-, 4-, 3- and 2-point Likert scales. Scales with an even number of responses were intentionally designed to exclude a neutral option. This was done in order to avoid respondents making an easy, indecisive choice that would require little thought and provide little useful information to the researcher. Questions with 3- and 2-point Likert scales were designed for greater simplicity. Nineteen students at the urban site and eight students at the rural site were surveyed. The student questionnaire is provided in Appendix C – Student Questionnaire.

Once the questionnaires were designed, they were scrutinized by a faculty member and then pilot tested by two faculty members and two teacher colleagues prior to use.

Interviews were conducted in private locations with each teacher, 11 students at Site A, and five students at Site B. Individual questionnaire responses that required elaboration had been marked prior to the start of interviews and were followed sequentially unless the direction of the interview was altered by participant responses. Interview rapport with some students was minimal. Some interviews required frequent probing to provide more detailed information. Other student interviews flowed like a friendly conversation. Interviews were recorded using digital computer software and were transcribed verbatim at a later date.

Interview transcriptions, questionnaire responses, and archival records/researcher observations were corroborated through triangulation to increase credibility (Yin, 2003).

3.3.1 Stages of Data Collection

Drawing on multiple sources of data had its benefits but also presented challenges, particularly when data was gathered across two sites. Careful and methodical collection of data was required and occurred in the following stages:

1. Informal discussion with the classroom teacher to discuss the nature of the class, the school's delivery model of SHSM-E, current learning opportunities, and future learning that promoted the development of creativity/ingenuity.
2. Direct observation of classroom activities to acquire a broad understanding and familiarity with the participants and the setting, as well as to allow participants to become familiar with me.
3. Completion of student questionnaires.
4. Completion of the teacher questionnaire.
5. Completion of selected student interviews to elaborate on and probe distinctive questionnaire responses and investigator observations, including written notes taken by the investigator.
6. Participant observation of classroom activities to gather data from participants working, interacting and collaborating in groups, and using the creative problem-solving process.
7. Examination of documents and archival records (e.g., teacher unit and lesson plans, student workbooks, textbooks and other materials) to gather detailed evidence of actual learning and teaching of creative problem-solving, to examine planning prior to my arrival, and to examine available classroom resources.
8. Interviews to clarify student questionnaire responses and to further question students in light of new findings from participant observation and document examination.
9. Interview to clarify teacher questionnaire responses and to further question the teacher in light of new findings from participant observation and document examination.

10. Completion of the teacher interview, which was open-ended and audio recorded.

3.4 Data Analysis

An analysis of the Ontario Ministry of Education policy on Environmental Studies was conducted**.** Furthermore, through a literature review, current research on creativity was documented. In order to gain some understanding of the participants' context, the school website was perused, including the SHSM-E program, its admission requirements and course description. At each high school site, my questionnaire data on attitudes and instructional, learning activities was collated and tabulated for students and teachers, separately. Subsequently, transcribed interview data, questionnaire data, observational data and archival notes were used to identify themes and patterns within each case, and a thematic analysis across cases was carefully documented (Merriam, 1988). Assertions and interpretations derived from the cross-case thematic analysis were critically examined.

3.5 Summary

The case study research methodology is employed in this study to examine the development of creative problem-solving/thinking in a rural and urban setting of the Specialist High Skills Major – Environment program. Four data sources – a questionnaire for teachers and students, student and teacher interviews, archival notes, and observations – were used to gather information from participants about classroom activities in the development of creativity and to corroborate findings through triangulation. Interviews yielded a rich tapestry of detailed and relevant data about participant experiences. The themes identified within and across cases added further depth and completeness to the understanding of the topic. This case study did not set out to determine causation or generalize research findings to larger populations. Instead, it sought to explicate and better understand the teaching of creativity/ingenuity in two SHSM-E classrooms, and to pose questions for future research.

Chapter 4

4 Compilation of Data

Key data and findings are presented individually according to School Site A or B, and type of participant (student or teacher). The presentation order follows the Student and Teacher Questionnaires (see Appendices C and D). Comprehensive questionnaire data can be found in Appendix A. In this chapter, questionnaire data is presented in section 4.1, followed by interview data in sections 4.2 to 4.10 inclusive.

Students were asked to rate instructional strategies based on the frequency with which they were used currently, which ones were preferred, and which ones they desired and would like to use more often. Instructional strategies were later divided into Creative and Non-Creative for analysis. Participants were not informed ahead of time which instructional strategies were creative or non-creative. Instructional strategies were deemed “creative” if the strategies provided students with an opportunity to engage in the process of problem-solving or thinking, or human ingenuity, that resulted in useful and original outcomes. Typically, these opportunities had a higher probability of occurring during the construction of knowledge, the use of Bloom’s higher-order thinking skills, the solving of ill-defined problems, and greater student control over the learning process. Non-creative instructional strategies were those strategies that did not engage students in creative problem-solving, creative thinking or human ingenuity, and were characterized by the use of Bloom’s lower-order thinking, well-defined problems or teacher-centred control, or by the lack of knowledge construction. This division into creative and non-creative included the possibility that either a) creativity may occur during non-creative instructional strategies or that b) creativity may be minimal during creative instructional strategies. The key feature of creative instructional strategies is student engagement in the process of problem-solving or thinking that constructs useful and original (individual, relative or historic) outcomes.

4.1 Questionnaire Data

As mentioned in Chapter 3, a student and teacher questionnaire were employed to explore the experiences of participants in this study. The questionnaires were designed, scrutinized and field tested prior to use with participants. All questions but two, which were open-ended, used Likert scales. In this section, data is reported as percentages of the total number of participants at a site (for Site A, *n*=19 and for Site B, *n*=8) and as criteria (e.g., effectiveness, frequency or importance) with a qualifier, such as *never*, *rarely*, *sometimes*, *often*, or *always*.

4.1.1 Site A Student Data

Attitudes about Creativity (see Table 2)

Using a Likert scale (*never*, *rarely*, *sometimes*, *often*, *always*), students indicated that they could come up with creative solutions to a challenge in an area that they identified as a personal strength *often* (47%) and *always* (37%) but when asked if they could come up with imaginative ideas, the values dropped to *often* (37%) and *always* (26%). When asked if a partner of equal strength worked with the student to come up with creative solutions to a challenge in the area of personal strength, students indicated that they could *often* (32%) and *always* (47%).

Students indicated that they had *often* (47%) and *always* (42%) worked with a partner in class to solve a challenge. They reported that they would like to work with a partner *more often* (42%) and the *same amount* (58%).

When asked if they creative "problem" solve by themselves other than in an area of personal strength outside of the SHSM-E class, students *often* (37%) and *always* (26%) could do so.

When asked if they were given opportunities in this SHSM-E class to creative "problem" solve, students indicated *often* (37%) and *always* (21%). Asked if the SHSM-E program helped develop their creative problem-solving abilities, they responded *often* (53%) and *always* (16%).

Instructional Strategies

a) Current Usage (see Table 3): Students indicated that the Creative instructional strategies of Problem Based Learning, Experiential Learning and Class Discussion were used frequently while Inquiry Based Learning was rarely used. Of the Non-Creative instructional strategies, Teacher Instructing, Teacher Demonstration and Seatwork were the most frequently used.

b) Preference (see Table 4): Students indicated that they *strongly liked* the Creative instructional strategies of Problem Based Learning, Experiential Learning and Class Discussion whereas none of the Non-Creative instructional strategies were rated as *strongly liked*.

c) Desired Future Use (see Table 5): Student responses clearly indicated that they *more often* wanted all Creative instructional strategies and the Non-Creative instructional strategy of Teacher Demonstration. Also notable is that students wanted Seatwork *less often* (47%) and Lecture *less often* (37%).

Creative Activities (see Table 6)

Responses by students indicated that Working with a Partner/Group in Solving a Challenge was the most frequently used Creative Activity. With regard to desirability for future use, students positively responded that they would like to continue all Creative Activities *more often*, indicated by the following frequencies: Divergent Thinking - 37%, Become an Expert - 47%, Exploring Topics of Personal Interest - 63%, Learning by Trial and Error - 42%, Working with a Partner/Group on Solving a Challenge - 42% and Being an Inventor - 53%. Only 5% of students wanted Convergent Thinking *more often*, with 95% wanting to do it the *same amount.*

Using Creativity in Solving Challenges in Class (see Table 7)

When students were given a challenge or problem in this class and had to come up with interesting and unique solutions, the most frequently reported answers were that they *often* (47%) enjoyed it, *often* (58%) successfully found solutions, *sometimes* (63%) had difficulty, *rarely* (37%) or *sometimes* (42%) preferred to learn facts rather than coming up with their own interesting and unique solutions, and *rarely* (37%) or *sometimes* (47%) depended on ideas of experts.

Questioning the Status Quo (see Table 8)

Students reported that they *often* (47%) questioned why things were done the way they were and whether they could be done in a more environmentally friendly way. Eighty-nine percent reported that they would like to do so *more often*.

Innovation and Current Environmental Events (see Table 9)

Sixty-eight percent of students reported that they *often* or *always* (combined) examined actual environmental events, such as the Gulf Oil Spill, discussed what happened and suggested possible solutions or ways to prevent it while 74% indicated they would like to do this *more often*. Fifty-eight percent of students reported that they *sometimes* or less frequently explored new environmental ideas and solutions while 95% indicated they would like to do this *more often*. The students indicated that they *often* (58%) and *always* (11%) discussed improvements to existing technology to make it more environmentally friendly while 95% indicated they would like to do this *more often*.

4.1.2 Site A Teacher Data

Attitude/Perception of Creative Problem-Solving/Human Ingenuity (see Table 10)

Using a Likert scale ranging from 1 (*unimportant*) to 5 (*very important*), the teacher reported that developing student human ingenuity/creative problem-solving rated a 4 (*important*).

When asked about perceived support, Teacher A indicated that Department Heads or Divisional/Subject Area Teachers, School District Professional Development, and Other Educational Organizations he dealt with *encouraged* the development of human ingenuity/creative problem-solving while School District Consultants/ Superintendents/Director and Ontario Curriculum Documents (Ministry of Education curriculum) *discouraged* its development. All other influences on the teacher (School Administration, Ontario Ministry of Education, parents, other curriculum in use and school-based professional development) were considered neutral; that is, *neither discouraging nor encouraging* the development of human ingenuity/creative problem-solving.

Effectiveness of Instructional Strategies in Fostering Creative Problem-Solving Skills (see Table 11)

The teacher rated three Creative instructional strategies (Problem Based Learning, Inquiry Based Learning, Experiential Learning) as *very effective* and Class Discussion as *effective* in fostering creative problem-solving skills. For the Non-Creative instructional strategies, Teacher Instructing and Laboratory were rated as *effective* with the remainder

(Lecture, Teacher Demonstration, Assessment, Seatwork and Checking Work) deemed to be less effective.

4.1.3 Site B Student Data

Attitudes about Creativity (see Table 17)

Students indicated that they could come up with creative solutions to a challenge in an area they identified as a personal strength *often* (63%) and *always* (25%) but when asked if they could come up with imaginative ideas, the values changed to *often* (25%) and *always* (50%).

When asked if a partner of equal strength worked with the student to come up with creative solutions to a challenge in the area of personal strength, students indicated that they could *sometimes* (25%) and *always* (75%).

When asked if they creative problem-solve by themselves other than in an area of personal strength outside of this SHSM-E class, students *often* (88%) and *always* (13%) could do so.

When asked if they get opportunities in this SHSM-E class to creative problem-solve, students indicated *sometimes* (63%) and *often* (25%). Asked if the SHSM-E program helped develop their creative problem-solving abilities, they responded *sometimes* (50%), *often* (13%) and *always* (0%).

Students indicated that they had *often* (38%) and *always* (38%) worked with a partner in class to solve a challenge. Seventy-five percent (75%) reported that they would like to work with a partner *more often* and 25% the *same amount.*

Instructional Strategies

a) Current Usage (see Table 18): The Creative instructional strategies of Experiential Learning and Class Discussion were the most frequently used. For the Non-Creative instructional strategies, Lecture and Seatwork were used most frequently while Assessment was reportedly never used.

b) Preference (see Table 19): Students clearly indicated that they highly preferred all Creative instructional strategies. In particular, students reported that Experiential Learning was *liked* (38%) and *strongly liked* (63%). For the Non-Creative instructional strategies, Teacher Demonstration was *liked* (75%) and *strongly liked* (13%), and Laboratory was *liked* (50%) and *strongly liked* (25%).

c) Desired Future Use (see Table 20): Student responses clearly indicated that they wanted Creative instructional strategies *more often*. Students indicated that they wanted to continue with approximately the *same amount* of Non-Creative instructional strategies. The exception was Teacher Demonstration which 50% of students wanted *more often*. Also notable were the strategies that students wanted *less often*: Seatwork (37%) and Assessment (49%).

Creative Activities (see Table 21)

Responses by students indicated that Become an Expert and Working with a Partner/Group in Solving a Challenge were the only creative activities that had an *always* rating (38%). Convergent Thinking and Exploring Topics of Personal Interest had higher *often* ratings, at 63% and 50% respectively. With regard to desirability for future use, students positively responded that they would like to continue all creative activities *more often*, indicated by the following frequencies: Divergent Thinking - 38%, Convergent Thinking - 25%, Become an Expert - 63%, Exploring Topics of Personal Interest - 50%, Learning by Trial and Error - 38%, Working with a Partner/Group on Solving a Challenge - 75%, and Being an Inventor - 38%.

Using Creativity in Solving Challenges in Class (see Table 22)

When students were given a challenge or problem in class and had to come up with interesting and unique solutions, the most frequently reported answers were that they *sometimes* (63%) enjoyed it, *sometimes* and *often* (38% each) successfully found solutions, *rarely* and *sometimes* (38% each) had difficulty, *often* (50%) preferred to learn facts rather than coming up with their own interesting and unique solutions, and *rarely* (50%) depended on the ideas of experts.

Questioning the Status Quo (see Table 23)

Students reported that they *sometimes* (38%) and *often* (38%) questioned why things were done the way they were and whether they could be done in a more environmentally friendly way. Eighty-eight percent reported that they would like to do this questioning *more often*.

Innovation and Current Environmental Events (see Table 24)

Students reported that they *rarely* (38%), *sometimes* (38%) or *often* (25%) examined actual environmental events, discussed what happened and suggested possible solutions or ways to prevent it. Eighty-eight percent indicated they would like to do this *more often*. Sixty-three percent of students reported that they *often* explored new environmental ideas and solutions while 88% of them indicated they would like to do this *more often*. The students indicated that they *often* (25%) and *always* (25%) discussed improvements to existing technology to make it more environmentally friendly while 88% indicated they would like to do this *more often*.

4.1.4 Site B Teacher Data

Attitude/Perception of Creative Problem-Solving/Human Ingenuity (see Table 25)

Using a 5-point Likert scale from 1 (*unimportant*) to 5 (*very important*), developing student human ingenuity/creative problem-solving was reported by the teacher as a 4 (*important*).

When asked about perceived support, the teacher indicated that the Ontario Ministry of Education and Other Educational Organizations he dealt with *highly encouraged* the development of human ingenuity/creative problem-solving; Department Heads or Divisional/Subject Area Teachers, Ontario Curriculum Documents (Ministry of Education curriculum) and other curriculum in use *encouraged* its development; and School Administration, School District Consultants/Superintendents/Director, Parents, School District Professional Development and school-based professional development *neither encouraged nor discouraged* its development.

Effectiveness Of Instructional Strategies For Fostering Creative Problem-Solving Skills (see Table 26)

The teacher rated two Creative instructional strategies (Laboratory and Experiential Learning) as *very effective* and two (Problem Based Learning and Class Discussion) as *effective* in fostering creative problem-solving skills. For the Non-

Creative instructional strategies, Laboratory was rated as *very effective* with Teacher Instructing, Teacher Demonstration and Checking Work rated as *effective*. The remaining strategies (Assessment and Seatwork, Lecture) rated as having little or no effectiveness, respectively.

4.2 Creativity and Creative Problem-Solving

This section reports on interview data only. Interviews led off with a series of questions about creative problem-solving. The intentions of these student questions were to introduce the topic of creativity, as conversational icebreakers, and to activate prior knowledge about creativity and creative problem-solving. During interviews, some students were uncertain about what was meant by creativity or they perceived creativity as a singularly artistic endeavour; known as *art bias* (Runco, 2008). When prompted or necessary, I provided a definition of creativity as "any problem-solving using imagination and past experiences in the creation of original work."

4.2.1 Creative Problem-Solving in an Area of Personal Strength

Questionnaire data indicated that students displayed high confidence in their ability to come up with creative solutions to a challenge in an area that they identified as a personal strength, as expected. Students were then asked to come up with imaginative ideas in this same area of personal strength, as a means of determining if they had original, outlandish and possibly impractical ideas that were typically dismissed by others; that is, ideas that were extreme and may have been truly creative with relative or historical originality. Overall confidence in their ability to come up with imaginative ideas varied according to site. For the urban site, most students indicated that they were less able to come up with imaginative solutions than creative solutions whereas, for the rural site, an equal number of students indicated that they were able to come up with imaginative solutions as those who indicated that they were less able to do so.

Interview data confirmed this lack of confidence at the urban site. Numerous students indicated enjoying creative problem-solving but low confidence ranged from an incredulous, "we can't do that" (A18) to questioning the ability to come up with valuable (A13) or original ideas (A11). A18 expressed hope that someone else could take student ideas beyond discussion to "invention." On the contrary, A12 indicated that student ideas might be too crazy and be regarded as “joking,” but ultimately believed that these imaginative ideas would develop student creativity.

At the rural school site, two of the three students who indicated on the questionnaire that they could not come up with imaginative solutions as often as creative solutions had an issue with the term *ideas* that implied thinking without doing. B01 and B05 both valued hands-on manipulation and learning through trial and error. The exclusion of this active learning led them to indicate less ability to come up with imaginative ideas on their questionnaires. Once they realized that imaginative ideas could also be discovered through active learning, they recognized their own strong creative problem-solving ability.

Almost all students at both sites endorsed that working with a partner of equal strength would allow them to come up with more creative solutions to challenges. Perhaps this endorsement can be attributed to their adolescent stage of development in which they wanted to fit in or that the confidence in their abilities increased when working with a peer or group. The confidence building that may have accrued from partnerships was expressed consistently throughout this study.

4.2.2 Creative Problem-Solving Opportunities

Students were asked to recall opportunities in SHSM-E in which they had engaged in creative problem-solving. Answers varied according to site. Students at the urban school indicated having far more opportunities to creative problem solve than students at the rural school. Similarly, students at the urban site found that all their SHSM-E classes more often helped develop their creative problem-solving abilities whereas at the rural site this skill development occurred much less often. During interviews, students A13 and A17 at the urban site concluded that the class had more creative problem-solving opportunities than other high school courses, citing times in which they had been asked how to solve an issue, to think of alternatives (A12) or to use their imaginations (A13). Of note here is that some student responses implied that, by merely being asked for input or having been given the opportunity to be creative, the students were using creativity. For example, A12 explained that being given the choice of how to present group projects was a chance to be creative and A18 thought creativity was choosing the topic and information to use in projects and the personal control she had over the script of a class presentation.

Other student responses elicited mixed feelings about creativity. A02 wanted better teacher reception of creativity, expressing disappointment that teachers in general expected concrete rather than "outside the box" thinking. Conversely, A18 thought that there needed to be a limit on creative problem-solving because learning "couldn't be all about students solving problems."

The extent of student partiality to partnerships was unanticipated. Students at both sites indicated having worked very often with a partner or group in the past and wanted to work as frequently with a partner or group in the future. Interestingly, raw data showed that no student at either site wanted less partner work: Most students wanted the same amount at the urban site while most rural students wanted to work more often with a partner. My observations revealed that urban students regularly worked in dyads or triads. Rural students far less frequently worked in partnerships or groups and overall seemed much more isolated and disengaged from peers. They spoke quietly to one or two other students while at desktop computers prior to class. Before class started, most urban students gathered on a big couch to socialize, tease and talk about school or activities beyond SHSM-E: They clearly accepted one another and felt comfortable in each others' company. I concluded from these observations that the urban students had had many opportunities to work together whereas rural students had done so infrequently and, as a result, expressed wanting to work together more often.

Rural student interview comments indicated that partnerships benefitted them through acquiring improved ideas during brainstorming (B04, B05), and gaining additional self-confidence (B04) and independence from the teacher (B01). B04 had difficulty integrating others' new ideas into his own ideas but this did not diminish his desire to work more often with a partner or group. A11's concern about what his peers would think of him led him to withhold many imaginative ideas he said he had. During the interview, though, without the fear of judgement, he shared with me many of these ideas as well as an enthusiastic wonderment about others' imaginative ideas. He clearly had creative ideas and wanted to pursue them further, but felt uncomfortable sharing them even in a class that appeared so accepting of others.

4.3 Student Outcomes in Creative Problem-Solving Challenges

Both students and teacher at each site were asked about student outcomes of creative problem-solving. These student outcomes included their enjoyment, success at finding many solutions, the difficulty they experienced, dependency on expert opinion and preference for learning facts from experts rather than determining their own solutions. While student responses were similar across sites, comparison between student and teacher responses within each site revealed discrepancies that need to be explored.

4.3.1 Urban: Site A

Student and teacher responses on the questionnaires were quite similar for three student outcomes, revealing that students often enjoyed creative problem-solving, were successful in achieving learning goals and preferred coming up with their own innovative solutions rather than learning facts and ideas. Students indicated that they did not often depend on expert opinion from the textbook or the teacher when creative problem-solving. On the contrary, Teacher A responded that students often depended on expert opinion from presenters on- and off-site, and the internet. Examining raw student data revealed a wide range of dependency from *rarely* to *always*, unlike the first three student outcomes which indicated much more homogenous responses. When three skewed data points were omitted, student and teacher responses were much more closely aligned. It should be noted that the original question on the questionnaire did not include the internet as a source of expert opinion. Whether an unfortunate omission or an erroneous assumption on my part that the internet would be viewed as an obvious source of expert opinion, the validity of responses that students *rarely* or *never* depended on expert opinion may be called into question.

Low correlation existed between teacher and student responses around the amount of difficulty students experienced during creative problem-solving, which Teacher A reported having happened *often* while most students responded *sometimes*.

4.3.2 Rural: Site B

Student and teacher responses revealed general agreement that students preferred the learning of facts and ideas of others over coming up with their own and that they sometimes achieved the learning goals. Most students responded that they *sometimes* enjoyed coming up with creative and innovative solutions to challenges yet the teacher believed that students *rarely* enjoyed themselves. Teacher B attributed this rare enjoyment to two possibilities: Firstly, students lacked the skills to succeed and secondly, students had been placed in the class and were not interested in environmental issues. He stated that he had expected intrinsic motivation to override the lack of skills, which he admitted failing to teach. While a plethora of other explanations were possible, my observations of classroom activities, including those with and without creative problem-solving, revealed that students seemed to have little enjoyment, interest or motivation. Students confirmed my observation of their disinterest during interviews in which they took the opportunity to complain about boring and uninteresting class activities. When I suggested alternative activities that included a creative problem-solving component during interviews, students expressed some real enthusiasm.

As with the urban site, rural students underestimated, in relation to their teacher's perception, the difficulties that they had concerning their dependence on expert opinion. Most striking was the vast disparity between the students' perception that they infrequently depended on expert opinion and the teacher's perception that they *always* depend on it. Teacher B provided an example of dependency in which students uncritically accepted a guest speaker's expert opinion and another case when a Google search became *their* opinion. The incredulousness Teacher B expressed regarding their actions suggests that the impact of these two examples significantly altered his overall perspective. Of note is that these examples did not involve creative problem-solving as requested but, rather, focussed on the retrieval of information, so the students actions may have been justified. However, the questionnaire response by most students that they rarely used expert opinion appears equally extreme and unrealistic. Possible explanations for this response include student omission or poor recall of the source of their information or that they had internalized the ideas and made them their own. Nevertheless, the cause of such divergence between student and teacher responses remains unclear.

4.4 Instructional Strategies

Instructional strategies were rated by students according to the frequency with which the strategies were used currently, were preferred and were desired in the future. After the questionnaires were completed and prior to interviews, the strategies were divided into Creative and Non-Creative in order to focus the open-ended interview questioning. Participants were unaware of this division throughout all stages of data collection.

Instructional strategies were considered *creative* if the strategies provided students with an opportunity to engage in the process of problem-solving or thinking, or human ingenuity, that constructed useful and original outcomes, usually during the construction of knowledge, the use of Bloom's higher-order thinking skills, the solving of ill-defined problems or greater student-centred control over the learning process. For non-creative instructional strategies, students did not engage in creative problem-solving, creative thinking or human ingenuity. The use of Bloom's lower-order thinking, well-defined problems or teacher-centred control usually identified non-creative instructional strategies.

This division into creative and non-creative instructional strategies identified the two end points of a continuum of creative problem-solving opportunities. A caveat is required, in that some creativity may occur during non-creative instructional strategies and creativity may be minimal during creative instructional strategies. It was expected that creative instructional strategies would have the highest likelihood of creative problem-solving and non-creative instructional strategies would have the least likelihood of creative problem-solving.

Trends for frequency, preferentiality and desirability in questionnaires were discovered by rank ordering all eleven instructional strategies using mean scores and then using a *High*, *Moderate* and *Low* label to simplify the eleven instructional strategies quantitative ranking into a three level qualitative hierarchy. In the following sections, the comparisons between instructional strategies always include all instructional strategies, both creative and non-creative. For the teacher questionnaire, the same *High*, *Moderate* and *Low* hierarchy was used to order the effectiveness of each strategy in fostering creativity.

4.4.1 Creative Instructional Strategies: Site A

Summary of Questionnaire Data

1. Students ranked Experiential Learning as the instructional strategy most used currently and Classroom Discussion ranked as *high* use currently of all instructional strategies. Problem Based Learning ranked as *moderate* use currently and Inquiry Based Learning ranked as *low* use currently of all instructional strategies.

2. Students ranked Experiential Learning, Classroom Discussion and Problem Based Learning, respectively, as the top three most preferred instructional strategies. Inquiry Based Learning ranked as a *moderate* preference among all instructional strategies.

3. Students ranked Classroom Discussion, Experiential Learning, Inquiry Based Learning and Problem Based Learning, respectively, as the top four instructional strategies that they would like to use more often.

4. Teacher A ranked the creative instructional strategies of Problem Based Learning, Inquiry Based Learning and Experiential Learning as *very effective* in fostering creativity and Class Discussion as *effective*.

Experiential Learning

Defined as placing students into a real situation, even outside the classroom, in which they have to solve a challenge to meet a teacher-determined learning goal, Experiential Learning clearly ranked as students' preferred instructional strategy. Interview data confirmed the *high* questionnaire ranking. A litany of benefits, without any expressed complaints, clarified why it was so well-liked and wanted more often by students. Firstly, many students – either self-identified or determined by myself during individual discussion – were kinesthetic learners or preferred the active learning style of Experiential Learning, which A11 felt improved his learning. Secondly, students found learning locations outside the classroom, where Experiential Learning occurred, to be much more sensually stimulating and, consequently, much more motivating (A19). Thirdly, students stated that Experiential Learning was linked to memory. A06 felt that the interactive nature of Experiential Learning improved recall whereas when the teacher or others were just talking, he stated that "I don't connect." A02 identified the sequential nature of Experiential Learning experiences as assisting memory, in that actions taken could be recalled one step at a time so that, when a problem occurred, students could back track through previous steps to recognize and then correct an erroneous step towards achieving a desired outcome. Fourthly, several students spoke about the confusion that they experienced when others presented multiple, sometimes contradictory ideas and opinions in non-Experiential Learning situations. Instead of being overwhelmed, active learning led to a clear, single answer for, as A07 stated, “How could it possibly be wrong? This is what I'm seeing.” And finally, A02 saw Experiential Learning as an opportunity to apply existing knowledge to new learning situations, which is often difficult in the classroom where connecting knowledge to a real life situation is abstract and cannot be tested or observed.

Inquiry Based Learning

Students at the urban site indicated that they did not engage in Inquiry Based Learning but expressed an interest in it. In particular, the attractive quality of this instructional strategy was the ability for students to choose both the ideas to pursue and the actions they would have to take to find answers (A19), especially knowing that this type of learning would be necessary in the working world (A13). The similarity between Inquiry Based Learning and Laboratory, which lies primarily in whether the teacher (Laboratory) or students (Inquiry Based Learning) make key decisions, allowed students to understand the Inquiry Based Learning instructional strategy despite their lack of experience. A12 commented that the easy-to-follow, teacher-provided instructions of Laboratory made assignments easy to complete but minimized the challenge. She wished that she would have had more opportunity to “explore,” a central directive of Inquiry Based Learning.

Problem Based Learning: Learning Activity 1 – Proposed Dam

Students at the urban site engaged in a Problem Based Learning activity during my observation days. On the questionnaires, I provided a definition of Problem Based Learning that stated that the teacher presents a problem that might happen beyond the classroom in which the students work together to decide how to tackle the problem, come up with a plan, gather important information and determine their best possible solution while assuming a role of someone who might have had to actually solve the problem.

The proposed problem presented by Teacher B was the building of a large hydro-electric dam which would impact local townspeople, of whom the students assumed their roles. The buzz of excitement upon entering the classroom on the day of the debate was the stuff of every teacher's dreams: an eagerness to learn and palpable energy tempered by an impatience to begin a journey in someone else's shoes. Most students had come in costume, a testament to their comfort to be themselves in this particular class that would rarely happen in other high school courses. It also signalled a willingness to become fully immersed in their roles.

The debate itself, moderated by a student, began as a simple trading of perspectives between several stakeholders opposed and in favour of the dam. One student in particular, A18, explained her perspective and clearly attempted to integrate others' needs into a mutually agreeable solution. These problem-solving attempts fell on deaf ears and gained no apparent supporters, except for the moderator who overstepped his role by pleading her case. A few students then escalated the previously civil yet selfish exchanges into the stalwart maintenance of their positions, without compromise, in a shouting match, seemingly with the loudest being the "winner." The debate ended and students were assigned a personal reflection on the debate as homework.

As a Problem Based Learning instructional strategy, this activity can be broken down into two parts: the sharing of stakeholder positions and problem-solving in order to find a solution. Overall, the debate allowed many students to present their stakeholder positions and gain some understanding of others' issues. Yet, the argumentative and confrontational nature of this debate may have limited knowledge acquisition and feelings of empathy that are beneficial to this strategy. The moderator later expressed frustration with students who clearly wanted to argue for the sake of arguing rather than trying to understand others. A02 commented that the roles were so oppositional that this debate did not work and that it was easier to argue than "to come up with a compromise or solution." Less involved students later expressed mixed reactions about the nature of the debate: Some were accepting of it, others were surprised by it and many, such as A11, became non-participatory because of it. Unfortunately, this particular debate shut down some students from sharing knowledge and understanding others' positions.

This activity would not be deemed a success if assessed as a means to creative problem-solving. The activity strongly inspired two students to try to find solutions to conflicts between stakeholder positions. A18 attempted to problem solve during the debate. She stated that during the debate her comments focussed again and again on trying to understand others' positions, to acknowledge what was important to them and to try to solve the problems without trying to unduly promote her own position. During and after the debate, the mediator acknowledged support of A18 and her attempts to finding solutions. He, too, wanted to find solutions during the debate but was constrained by the rules set out for his role. When asked during interviews, almost all students felt that group creative problem-solving after the debate would have been desirable and would have provided valuable learning. Even the two loudest, most argumentative debaters, A06 and A14, who appeared close-minded during the debate, agreed that group-based solution seeking would have been beneficial. A02 suggested that opposing pairs of stakeholders could have met after debating to "figure it out" and then convene with a bigger group to work together. Immediately following the debate would have been the ideal time to outline problem-solving protocols and proceed with solving a real life situation. Instead, this opportunity was lost. The personal reflection homework assignment may have led students to some solutions but it is unlikely it would have provided the same depth and breadth of group-based brainstorming, real-time understanding of other stakeholder positions and convergent thinking. It can be concluded that this debate achieved only one of the two goals of Problem Based Learning: Students gained intimate knowledge of a stakeholder by assuming a role in a highly engaging simulation but it failed to go a step father in providing a rich opportunity to creative problem-solve that could have resulted in useful and original solutions.

Three insights can be drawn from this learning activity. Firstly, vocal students can monopolize the information sharing stage, relegating other students to mere bystanders, despite the engaging nature of the instructional strategy. Without a non-competitive, post-debate activity, an opportunity was lost for all students to work together to decide how to tackle the problem, come up with a plan, gather important information and determine their best possible solution, as a Problem Based Learning activity would typically provide. Secondly, the debate format inspired some students to begin problem-solving during the activity, suggesting that sharing perspectives of multiple stakeholders may naturally segue into problem-solving. Knowing that a problem-solving activity follows a debate may lead even more students to empathize with their counterparts and start considering solutions during a debate. Thirdly, most students expressed a clear interest in engaging in creative problem-solving after the debate finished, which had not been planned. Overall, then, a clear connection between a debate format and creative problem-solving would encourage the use of Problem Based Learning as an instructional strategy to not only share knowledge but to develop creative solutions for an issue with multiple stakeholders.

Problem Based Learning: Learning Activity 2 – Gulf Oil Spill

Students were asked if they had examined real environmental events, such as the Gulf Oil Spill, discussed what had happened and then explored possible solutions or preventions. During individual interviews, I focussed on the Gulf Oil Spill, as it was *the* environmental event dominating the mass media at the time. The Gulf Oil Spill, officially known as the Deepwater Horizon Oil Spill, was the largest marine oil spill in history, discharging almost 5 million barrels of oil into the Gulf of Mexico which killed or toxified wildlife and damaged the habitats of hundreds of species, including 26 endangered species, and impacted numerous indigenous tribes with shoreline interests, as well as the employment and recreational activities of non-indigenous peoples (U.S. Dept. of Homeland Security/U.S. Coast Guard, 2011).

All students reported a cursory class discussion about the Gulf Oil Spill when questioned. I expanded on their basic knowledge when discussing a “what-if” Problem Based Learning opportunity of building a scale model of the oil rig and its oil extracting piping in order for the students to simulate the spill with gushing water, to try to solve the problem and to retrospectively examine prevention. My hypothetical sought to elicit reactions to Problem Based Learning in a genuine and unique situation that would appeal to students of all learning styles, including the often forgotten kinesthetic style, with an added element of excitement and urgency of a real-time leak.

Students unanimously endorsed this proposed learning activity, with students expressing their enthusiasm using descriptors like “cool” and “fun” (A07), “awesome”

(A12) and "I'd love to do that" (A13). Some students indicated during interviews that they made an immediate connection to the idea of using a physical model to help transition from their difficulty with abstract discussions to a more sensory learning approach. A06 recognized that a model provided additional understanding, because "in words, you can't comprehend fully." A13 remarked that the inclusion of a "visual and physical" model propelled learning beyond his usual preference for learning through discussion, and allowed his learning to involve multiple learning styles. A07 immediately envisioned this activity as a "big project" that would be a defining piece of work with multidisciplinary learning and a significant time commitment. He had a plan in mind: Small groups would first build a model and use it to determine how they believe the oil rig might have broken, then engage in significant research to gather information and subsequently, brainstorm and agree on the group's best solution. After convening the whole class, the one best class solution would be determined, which could be explained in a letter to authorities. For a student who had not engaged in Problem Based Learning in his SHSM-E class, A07 demonstrated a thorough understanding of this instructional strategy, which entailed creative problem-solving, peer interaction, role-playing and discovery.

Creative Instructional Strategies - Teacher A

Teacher A's comments about creative instructional strategies centred on Experiential Learning, which he considered to be a unique opportunity and the "main focus" of SHSM-E program, due primarily to the creative problem-solving demanded by situations in which the steps to solve a problem were not obvious and students had no past experiences from which to draw. He observed students using "their noggins to sort of come up with solutions that work for them," by trying, watching, questioning and inventing. Attitudinally, students had been taught by Teacher A to approach new tasks as critical thinkers and problem solvers knowing that they could successfully navigate them, assisted by a self-regulating maxim of "are we doing this the right way?" Teacher A encouraged students to try to problem solve and to believe that they were problem-solvers.

Although Teacher A recognized Inquiry Based Learning in his questionnaire as a *very effective* instructional strategy in fostering creativity, he indicated that there were few opportunities and too little time for students to have “total or sole control over, start to finish, what happens.” He did foresee the possibility of partially implementing an Inquiry Based Learning “framework” which would allow students some choice in an activity.

4.4.2 Non-Creative Instructional Strategies: Site A

Summary of Questionnaire Data

1. Teacher Instructing, Checking Work and Teacher Demonstration ranked as *high* use currently. Seatwork and Lecture ranked as *moderate* use currently of all instructional strategies while Assessment and Laboratory ranked as *low* use currently of all instructional strategies.
2. Checking Work and Teacher Demonstration ranked as *moderate* preference of all instructional strategies. Students ranked Laboratory, Teacher Instructing, Lecture, Assessment and Seatwork as a *low* preference of all instructional strategies.
3. Teacher Demonstration ranked as a *high* desirability instructional strategy. All other non-creative instructional strategies ranked as *low* desirability of all instructional strategies.
4. Teacher A ranked the effectiveness of non-creative instructional strategies in fostering creativity as follows: *Effective* - Teacher Instructing and Laboratory; *moderate* - Teacher Demonstration, Lecture and Assessment; *little* - Seatwork and Checking Work.

During interviews, students discussed their desire for teacher guidance provided through Teacher Demonstration. This desire was of particularly concern to students A19 and A17 who excitedly considered the use of creative instructional strategies in which they could atypically take greater control over educational decisions. Simply put, students were willing to engage in creative instructional strategies provided the teacher was available for guidance. Students feared that, without Teacher Demonstration prior to engaging in creative instructional strategies, they would not know what they were supposed to do. For students who had little or no experience using creative instructional strategies, the assurance provided by Teacher Demonstration to physically demonstrate a task would result in students having greater certainty that they would understand what is required of them prior to beginning a task. Until they could gradually release their dependence on the teacher when engaging in creative instructional strategies, students required teacher guidance to be available.

Non-Creative Instructional Strategies - Teacher A

Teacher A commented on two non-creative instructional strategies: Teacher Instructing and Laboratory. Teacher A believed that Teacher Instructing fostered creativity because students actively learned a set of specific skills from a "toolbox" that he taught, which included thinking "outside the box," engaging in research when a question or interest arose, considering bias and being "creativity." The expectation was that students would use the toolbox when needed but without being directly told to do so. The link between this toolbox and creativity is primarily attitudinally in that it could inspire supplementary investigation and exploration. Teacher A rejected that students could identify bias during Laboratory or Inquiry Based Learning and instead, "they need to basically be told by an expert or someone in the know about how these things work," presumably through Lecture.

Laboratory was a non-creative instructional strategy that Teacher A wanted to do more often but felt constrained by cost and time to "still cover all your curriculum." Students worked on at least four major labs, which Teacher A was eager to discuss in detail. Firstly, in a provincial conservation area, student groups were assigned plots of land that had had a specific biological treatment. The students took various measurements, compared with student results from a similar treatment site, averaged them and then shared with the entire class. Secondly, in a plant identification laboratory assignment, each student used "a key to identify" an unknown plant by answering very specific questions about the plant's characteristics in order to eventually eliminate all plants but one. Local experts then assisted by verifying or rejecting each student's determination. Similar to these two aforementioned labs, the third lab activity was a stream assessment, completed with experts from the Ministry of the Environment, involving the collection of data through various tests and species identification using a key. These three labs were a precursor to the final lab at Envirothon, in which various specialists from provincial ministries and universities provided students with extensive knowledge and hands-on techniques as well as a competition against other schools, which Teacher A labelled "a reach-for-the-top for environmental studies."

The building of bird boxes was another activity that met this study's criteria for a Laboratory although Teacher A did not believe so. Students built bird homes from scratch, "a good hands-on experience" according to Teacher A, after researching designs and choosing the "best for their particular species." Later, the ability of the box to attract the desired species was assessed. Teacher A believed that creativity was involved in the building of bird boxes because students gained experience with hand tools, interpreting design plans, calculating material needs and correcting building errors.

4.4.3 Creative Instructional Strategies: Site B

Summary of Questionnaire Data

1. Students ranked Classroom Discussion and Experiential Learning as *high* use currently. Problem Based Learning and Inquiry Based Learning ranked as *moderate* use currently of all instructional strategies.
2. Students ranked Experiential Learning, Problem Based Learning and Inquiry Based Learning as *high* preference of all instructional strategies. Classroom Discussion ranked as *moderate* preference of all instructional strategies.
3. Students ranked Experiential Learning and Problem Based Learning as the top two *high* desired instructional strategies, respectively. Classroom Discussion and Inquiry Based Learning ranked as *moderate* desirability of all instructional strategies.
4. Teacher B ranked the creative instructional strategy of Experiential Learning as *very effective* in fostering creativity; Problem Based Learning and Class Discussion as *effective*; and Inquiry Based Learning as *moderate*.

Experiential Learning

Student questionnaire and interview data regarding Experiential Learning were contradictory. While questionnaire responses indicated that Experiential Learning was often used currently, the most preferred and the most desired instructional strategy, interviews reflected little excitement about it. Several students complained that very little outdoor learning occurred despite the description in the course calendar. B01 recalled the promotion of the class as being "outside all the time, working outside" but felt frustrated at the time of the interview that "for the last couple of months we've been sitting at our desks doing absolutely nothing." According to Teacher B, students engaged in additional Experiential Learning through industry recognized certifications and training programs such as First Aid, CPR, WHIMIS and GPS, as well as "Leave No Trace Camping" and Chainsaw Awareness programs. Some students also went on a multi-day camping trip to Algonquin Park. None of these experiences, though, were expanded on during student interviews.

Students expressed a desire to have an opportunity to be more creative during experiential learning. For instance, for the Farm Safety Day presentations to elementary-aged students, B05 would have liked to have been presented with a topic and then figured out what the group would do and come up with a solution rather than having so much decided for her by the teacher. B01 hoped to complete an Experiential Learning project similar to a project at another school that involved the conversion of a diesel fuel-powered car to use vegetable oil from fast-food restaurants. The appeal of such a project for B01 was the ingenuity and hands-on nature of the project.

At the outset, B01 presented himself as a "doer." He initially stated that he did not want anything to do with decision making, planning or creative problem-solving. He just wanted to be told what to do and then be let at it. The more that B01 talked, the more he related stories of how he used his hands and manipulated objects to solve problems. I suggested to him that he was a creative problem solver and he agreed, despite contradicting earlier statements. This self-discovery was made through discussion. He stated that his form of problem-solving was not "the way that school prefers you to act or work." He clearly thought that his way of functioning was different than most other students and he carried an air of a renegade or maverick as a result. His understanding of learning styles was polarized between those who thought and those who acted. This understanding was clearly divisive and he felt left out and misunderstood in class as he did not consider himself a thinker. He felt that assignments and assessments were not structured to allow him to use his preferred kinesthetic learning style. His culminating project was given as a prime example of the indifference to his learning style, in which his work required frustrating hours of research on the computer and contacting people rather than a hands-on project in an area of personal interest.

Problem Based Learning

According to B05, students did not get an opportunity to engage in Problem Based Learning in class. Without any concrete experience with this creative instructional strategy to reflect on, the Gulf Oil Spill hypothetical posed to Site A students was similarly posed to Site B students, who immediately reacted favourably. Two students in particular, B01 and B06, provided interesting dialogue. B01 could clearly not hide his excitement: His posture and tone changed dramatically from disinterested and distracted to inspired, attentive, contributory and talkative. He clearly recognized this scenario as an opportunity for learning that could be fun and engaging. He exhibited student participation in lesson design at its best as we bandied about different ideas. He identified challenges to the design and scale of the simulation, and suggested that using hands-on learning in real time would lead to ideas about how to deal with the problem as the actual stakeholders had: No pre-determined answers could be researched. Instead, a solution had to be discovered. B01 liked the idea that Problem Based Learning involved groups of people engaging in creative problem-solving, which showed him that environmental actions did not have to be individually based, a bias he felt was present in class.

Equally outspoken, B05 was also inventive, contributing and designing lesson components in a way that would help her learn, focussing more on the process of learning rather than on the hands-on learning that B01 addressed. She juxtaposed the benefits of active learning and the more passive learning that she felt was common in the class. She felt that hands-on, Experiential Learning would allow for in-depth learning, stating that she would learn “more about why it worked, not just that it did work, but how and why and how we got to that.” As opposed to B01’s exclusive desire to use hands-on learning to creatively problem-solve, B05 wanted to use both thinking and hands-on to solve a challenge, “to try something and make sure, try different ways and see what’s more efficient.” B02 maintained the same “thinking and acting” position, adding that hands-on learning would let her see what worked better, implying that her problem-solving was about continuous improvement and efficiency.

Inquiry Based Learning

Some students believed that they had engaged in Inquiry Based Learning with the Farm Safety Day workshops while others felt that the teacher had largely guided their ideas. I observed that almost all decisions had been determined by the teacher and communicated in class during Teacher Instruction and had not given students enough control to be considered Inquiry Based Learning. Student presentations took exactly the same format, but with different topics. During interviews, the Inquiry Based Learning strategy was explained in more detail and students immediately recognized the benefits of having the freedom to make choices, greater task attention (B03) and more fun (B02). B02 had an uncanny big picture understanding of Inquiry Based Learning and her conversation demonstrated a new appreciation for the idea that she, and not the teacher, could make the important decisions about the topic of study, the procedure and the outcomes rather than having them pre-determined.

Creative Instructional Strategies - Teacher B

As a Problem Based Learning activity, Teacher B provided a training scenario used at Envirothon of a proposed local subdivision in which students were to produce an implementation plan, including a stated rationale and a list of stakeholders and experts to consult from within and without the community. In the beginning, students objected strongly, with some refusing outright and others not wanting to participate. Students acquiesced when the task was simplified to brainstorming and, finally, one student "really stepped up" as a leader (Teacher B). Students also participated in Envirothon "interactive field trips and workshops" and ultimately in the team competition to promote "teamwork, critical thinking and problem-solving skills" (Ontario Envirothon Teacher's Guide, n.d.).

The implementation of two other creative instructional strategies, Inquiry Based Learning and Class Discussion, met with difficulty. Teacher B doubted the success of Inquiry Based Learning activities as he believed that most of his students would not make decision on their own, a necessity of the strategy. He based his doubts on general observations and cursory responses to open-ended, individual activities, such as field logs, that offered some student choice, similar to the Inquiry Based Learning strategy. Class Discussion also became a stumbling block, with students rarely engaged. Teacher B cited a frustrating activity debriefing in which a strong academic student said, "I don't know. I'm bored. I just want the stuff," and finally, "I don't want to talk about it." These types of experiences led Teacher B to limit or eliminate the use of these two creative instructional strategies.

4.4.4 Non-Creative Instructional Strategies: Site B

Summary of Questionnaire Data

1. Lecture ranked as *high* use currently of all instructional strategies. Teacher Demonstration, Teacher Instructing and Laboratory ranked as *moderate* use currently while Seatwork, Assessment and Checking Work ranked as *low* use currently of all instructional strategies.
2. Teacher Demonstration and Laboratory ranked as *high* preference of all instructional strategies. Checking Work, Teacher Instructing, Lecture, Assessment and Seatwork ranked as *low* preference of all instructional strategies.
3. Laboratory and Teacher Demonstration ranked as *high* desirability of all instructional strategies. Checking Work, Teacher Instructing, Seatwork, Lecture and Assessment ranked with *low* desirability of all instructional strategies.
4. Teacher B ranked the effectiveness of non-creative instructional strategies in fostering creativity as follows: *Very effective* - Laboratory; *effective* - Teacher Instructing, Teacher Demonstration and Checking Work; *little effectiveness* - Seatwork and Assessment; and *ineffective* - Lecture.

Students felt passionately about non-creative instructional strategies, expressing frustration around the passivity and lack of independence. My classroom observations confirmed these remarks. Students were clearly disengaged, non-communicative with anyone and isolated at desktop computers. B02 commented on the excessive teacher talking and over-explaining which, I observed, was exacerbated the longer student unresponsiveness continued. During these prolonged sessions, B05 stated that teacher instructions often gave away answers before students had a chance to engage in discovering them. B05 stated that if she and her classmates were told "what to think," then they were "never going to be able to come up with our own solutions."

Students commented on two individual non-creative instructional strategies. An immediate and unilateral dislike for Laboratory was expressed as a result of poor past experiences. However, students later recognized its merit once they understood that the instructional strategy could involve active, hands-on learning. Continued Teacher Demonstration was desired by students to clarify procedures, assignments and unfamiliar learning experiences. For example, B03 completed a personally engrossing project that frustratingly met with the disapproval of the teacher. B03 felt that more direction, such as a conference or a rubric to clarify criteria, would have provided what he needed. Other students requested more descriptive feedback and formative assessment as other forms of Teacher Demonstration. Similarly, having teacher guidance explicitly available could increase student willingness to venture onto new learning paths.

Non-Creative Instructional Strategies - Teacher B

Teacher B stated that Laboratory had been used for the aforementioned field logs to study various off-site properties, originally with an open-ended structure with suggestions to students that they record their activities and anything of interest. The result were typically sparse, “canned answers.” Teacher B then modified the field log assignment to include guided questions of what to observe and record, after which he got the kind of answers he wanted. Teacher B expressed frustration with students’ lack of understanding and lack of ability. In the future, he planned to provide structure for laboratories with a defined purpose, clear instructions and observational look-for’s, stating later that “I assumed that these kids would be able to do it” without providing so much guidance. Another lab involved identifying a source of pollution in a local area and then coming up with solutions. Teacher B proposed creating a hands-on model to visualize the effect of the pollution but the class did not show enough interest to proceed although he predicted that one student “would have just loved to do that.” The discussion with me that followed led Teacher B to conclude that creativity could happen with hands-on learning, contrary to his often-mentioned bias that creativity occurred in more academic settings.

4.5 Creative Activities

The activities in this section are all connected to creativity and, though they may seem disparate, can be grouped according to shared qualities. Divergent and Convergent Thinking are considered two sequential processes of creativity (Bronson & Merryman, 2010). Learning by Trial and Error and Exploring Topics of Personal Interest are about opportunities that allow some student choice and independence to be creative or to use creative problem-solving. Being an Inventor and Becoming an Expert were presented to excite student imagination about unique possibilities of creativity, either as an innovator or as a spokesperson with expertise, both popular, celebrated roles in today's media. And, finally, Working with a Partner/Group attempted to determine if a basis existed for group creativity, the commonly held notion that student partnerships increase creativity.

Students were asked about the current use of these activities and about future use, to address whether students wanted to pursue, increase or decrease the use of the creative activities.

4.5.1 Creative Activities: Site A

Summary of Questionnaire Data

1. Working with a Partner/Group in Solving a Challenge had the highest current use of all creative strategies, with almost half the class saying it was used *always*. Students indicated current use of the remaining creative activities as *sometimes*. Teacher A's rankings corroborated the student rankings.
2. Personally Exploring Topics of Interest was the highest ranked creative activity that students desired *more often*, followed by Become an Inventor and Working with a Partner/Group in Solving a Challenge. Convergent Thinking was the lowest ranked with almost all students wanting to use it the *same amount*.

Learning through Trial and Error occurred primarily and frequently during Experiential Learning. Most students did not discuss any connection between the two during interviews and it is unknown if this apparent disconnect affected questionnaire responses. Several students appreciated the opportunity to make mistakes through trial and error without being told by their teacher how to do something or how to correct it. Students commended Teacher A on refraining from doing so during Experiential Learning. A07 commented that people learned by making mistakes and even petitioned for teachers to let students make more mistakes, proclaiming that mistakes made are not forgotten. A17 recognized that Learning through Trial and Error was her best learning style even though she disliked it. A19's reflections on her experiences with this creative activity led her to think that the adjustments that were made to tasks to make them more efficient should be considered creativity. This definition of creativity, as completing tasks more efficiently, was a unique student perspective.

Being an Inventor was reportedly an activity not completed in class. A18 would have liked to have had an opportunity to use her creativity to design a bird box rather than simply be given a blueprint; surprisingly, she was concerned about how much time the design process would have taken, implying that engaging in creativity would not have been time well spent. Teacher A commented that students were given opportunities to develop original ideas, but cautioned that the frequency of these opportunities to be creative might not determine the quality of the end result. In other words, despite providing abundant opportunities, Teacher A was unaware of a student idea that was "particularly novel" or "uniquely different." He provided a *proviso*, though, that looking for creative solutions was never established as a learning objective at the beginning of a lesson. If students had come up with unique ideas, he stated, they did not realize it. Without this self-realization or the teacher available to acknowledge it, student originality could not be reinforced or cultivated.

Teacher A suggested another interpretation for the lack of creative problem-solving: Students had learned to not seek or share creative ideas. Over years of schooling, students may have unknowingly learned to look for solutions that teachers wanted. This possibility would be more likely if classroom activities had focussed, for instance, on a solitary, unambiguous answer, or that student responses were expected to follow the predictable patterns of well-structured problems.

4.5.2 Creative Activities: Site B

Summary of Questionnaire Data

1. Working with a Partner/Group in Solving a Challenge had the highest rank by students for the current use of creative activities while Become an Expert ranked second. The lowest ranking for current use were Learning through Trial and Error and Be an Inventor.
2. Students ranked Working with a Partner/Group in Solving a Challenge as the top creative activity that they wanted to do more often in the future whereas the lowest ranking for future use was Learning through Trial and Error. Almost all students wanted

to continue creative activities the same amount or more often, with less than 10% of all responses indicating a desire for less frequent use in the future.

3. Teacher B ranked the creative activities of Divergent and Convergent Thinking, and Becoming an Expert and Being an Inventor as significantly less frequently used than the student rankings. The three other creative activities were similarly ranked by Teacher B and the students for current use.

Interview comments reflected that students understood the basic processes and theoretical importance of Divergent and Convergent Thinking, but questioned the practical value of engaging in these two activities. They found that the same ideas were often rehashed and reworded (B01), or that the "great idea" that Divergent and Convergent Thinking promised, rarely emerged. Sometimes, students had difficulty with the skills required to complete these creative activities, whether it was listening (B02), integrating others' ideas with their own (B04) or comparing and discriminating between ideas (B02). The implication here is that Divergent and Convergent Thinking needed to be taught and monitored in order to be valuable: Simply engaging in the two processes did not necessarily lead to quality ideas.

Students indicated that they had many opportunities to Become an Expert. During interviews, it became clear that students believed building expertise was simply the retrieval of ideas from the Internet or people, including the teacher, without generating new ideas of their own. One student planned on becoming an expert. B05 embraced the big idea of developing expertise as her success criteria prior to the start of the course, sought to discover her own answers whenever possible, and refused to simply accept answers given to her. Further conversation with her revealed that this was the way she approached learning.

B05 also had a strong memory of "loving" Being an Inventor in elementary school and recalled the pride she felt in sharing with others. In a small town with only two elementary schools, other students may have had the same experience, implying that a history of invention could be built upon and an openness may have existed to engage in this creative activity. On the other hand, B05 expressed uncertainty in her ability to invent something valuable despite stating that she had strong creative problem-solving skills. Her low confidence would be consistent with a lack of recent practice in the inventing process.

Learning through Trial and Error is connected to creative problem-solving. A challenge that has a unique combination of variables and conditions may be solved by incrementally building knowledge as a student experiences repeated attempts at a solution until success is achieved. Active learner B05 was particularly vested in Learning through Trial and Error because this creative activity for her involved both thinking and doing, choosing her own method of solving the problem and then determining the efficiency of that method. B01, who made it clear that he abhorred a passive "sitting and thinking" approach, considered Learning through Trial and Error a physical process of trying and adjusting, until a solution was found. B01 said that, regrettably, trying something "before you know it's going to work" was not done in SHSM-E. B05 felt that students were capable of Learning through Trial and Error, saying that "we just have to let them." For kinesthetic learners like B01 and B05, opportunities for Learning through Trial and Error occurred minimally even though Teacher B reiterated support for Differentiated Instruction, which promotes teacher instruction for all student learning styles.

4.6 Questioning the Status Quo and Critical Thinking

Questioning the status quo asked students to determine why things are the way they are, in order to identify and make improvements to products, processes and power relationships. Dyer, Gregersen, & Christensen (2011) identify questioning and, in particular, questioning the status quo, as one of the five discovery skills of great innovation leaders. The questioning of assumptions is a commonly used method for engaging students in creative thinking (Adams, 1980; Runco, 1999).

4.6.1 Questioning the Status Quo and Critical Thinking: Site A

Students reported on their questionnaires that they often engaged in questioning the status quo. Despite this data, deeper exploration during interviews revealed that most students were confused by the question, thinking that it intended to determine their comprehension of knowledge rather than whether they had critically questioned assumptions and common ways of doing things. A18 was one of the few students who understood the question and discussed how asking “why” could lead to the discovery of innovative solutions.

Teacher A confirmed that some questioning of the status quo occurred on a number of occasions, though without in-depth exploration. He related one class discussion on consumer roles in society in which a strong corporate agenda concealed the environmental impact of consumption. The class also discussed small, positive, pro-environmental decisions that students could personally make without them becoming, Teacher A joked, “environmental terrorists.” A final homework assignment asked students to create a home action plan to reduce their ecological footprint. Teacher A commented that his instruction taught a set of specific skills from a critical thinking “toolbox” from which he expected, but did not direct, students to draw when necessary. These skills included thinking outside the box, investigating personal questions of interest, and considering bias in research.

4.6.2 Questioning the Status Quo and Critical Thinking: Site B

Rural students reported on questionnaires that they questioned the status quo in class. Contrary to her classmates, B02, who had proven to be insightful and reliable, indicated that questioning the status quo had happened in only one lesson. Teacher B reported a low use of questioning the status quo. Many of the students, like those at Site A, misunderstood the meaning of questioning the status quo, indicated by their inability to recall during interviews any class discussion at all about it.

When asked about questioning the status quo as a future activity, B05 showed enthusiasm, suggesting it could be integrated into each unit, believing that, as children who had not been “brainwashed” or influenced “by money, the economy or expectations,” students could come up with original and unbiased ideas. B05 believed that, because of their age, students had an advantage in questioning the status quo.

4.7 Innovation and Real Environmental Event Activities

These questions pertained to student learning about real environmental events, new environmental ideas and improvements to existing technology which would decrease the environmental impact of human activity. The commentary is combined here due to the similarities at both sites.

Questionnaire response about how often real environmental events had been examined revealed that urban students and their teacher felt that they had often discussed these events while students and the teacher at the rural site had sometimes discussed them. For both sites, deeper probing during interviews with students and teachers revealed that this examination involved brief dialogue about the facts of events and did not delve into possible solutions. My research interest in this question pertained primarily to the exploration of solutions but this did not happen at either site. When asked about their interest in studying real environmental events in the future, almost all students at both sites wanted this more often and some students were particularly eager to explore how to solve problems.

Students at both sites responded in their questionnaires that they had sometimes explored new environmental ideas and solutions, with almost all students wanting to do so more often in the future. Both teachers thought that they had often explored new ideas and solutions, and they each provided examples to support their response. Teacher A explained that the class had been on several field trips, university/community college campus tours – a requirement of SHSMs – and LEEDS certified private facilities, to tour environmental engineering modifications such as alternative/renewable energy technologies and Green Roofs, and to engage in a two-hour, computer-based, geo-technology activity. Teacher B discussed field trips to an alternative energy show and a bio-fuel plant. At the energy show, Teacher B asked the students to self-tour around displays of environmental innovations to gather brochures and information from conversations about topics in which they were interested, "hoping that they would get inspired." The bio-fuel plant tour included a preliminary classroom visit by a tour guide and an industry documentary, acknowledged by Teacher B to be biased but with "some really cool stuff in there."

The final question in this section asked students about the extent to which they had discussed improvements to existing technology to make it more environmentally friendly. Students at both sites responded that they had discussed improvements often, again with almost all students wanting to engage in this activity more often in the future. Teacher A agreed with the students while Teacher B felt that this activity had been done rarely. During interviews, students at the urban site contradicted their questionnaire responses, saying that improvements to existing technology were not discussed at all. A19 reasoned this was because of the experimental nature of innovation, implying that there was less value in the new and unproven. Arguing a need to examine improvements to existing technology, A18 strongly affirmed that improvements could stimulate thinking about new ideas but that students could not make the improvements, stating that "they are big projects, like you need companies."

4.8 Influences on Teachers to Develop Creativity

Both teachers were asked to identify positive, negative and neutral influences to developing the creativity of students in their professional environment which included department heads or divisional/subject area teachers; school administration; school district consultants, superintendents or director; the Ontario Ministry of Education; other educational organizations; parents; Ontario curriculum documents; other curriculum used; school-based professional development; and school-based professional development, for example, professional learning communities or action research.

4.8.1 Influences on Teacher A to Develop Creativity

Teacher A indicated that most of the influences to the development of human ingenuity/creative problem-solving in the SHSM-E program were neutral. He spoke of two discouraging influences. Firstly, he commented that school district administration – consultants, superintendents, director – discouraged creativity through their lack of involvement in SHSM-E. He was unaware of a consultant that could assist with environmental education, unlike his coterminous school board which employed a full-time environmental educator. Teacher A received periodic phone calls from a co-ordinator who offered reminders about upcoming certification deadlines and sought advice from him on school board environmental initiatives and practices. Teacher A concluded that there was no programming benefit for him from school district administration. Meetings of all Specialist High Skills programs offered throughout the school board focussed on program management and were not concerned with improving instruction or creativity.

Secondly, Teacher A had a strong opinion about Ontario curriculum documents. He explained that his questionnaire response, that curriculum discouraged the development of human ingenuity, was based on a perception that curriculum tends to be seen as “rigid and limiting.” After explaining his reasoning to me, he reconsidered his answer, concluding that the curriculum was designed to be open-ended and individually interpreted by teachers. With more teaching experience, Teacher A believed, came a decreased need for guidance and, subsequently, wider teacher interpretation of the documents. The subtext, though, was that prescribed Ministry documents dictated that “this is what you need to do.” When asked specifically about the role of ministry curriculum in developing creativity and problem-solving, Teacher A stated:

> We know we’ve got to cover this and this and this, and we have to meet these requirements and doing it in a way that’s a bit different or unique is going to take more time, more effort, and then I’m not sure that the results are going to be there. So, there’s probably a reluctance to try some of those things because you know you can do it other ways and the end result of what the student gets out of it might not be as rich, but you know you’ve done what you’ve had to do. In some classes to do something that’s novel and unique would be difficult for time, but also for personalities and class management, that it’s, you know, that I don’t think that there is as many opportunities to do those kinds of things as we’d like to do.

According to Teacher A’s candid comment, changing instruction to include creative strategies would take more time and effort, including potential conflicts with personalities and classroom management, without any assurance of improved learning. Conversely, using the established yet perhaps not optimal methods gave Teacher A the confidence that the essentials would be covered. Finally, creative opportunities were not as numerous as Teacher A would like.

4.8.2 Influences on Teacher B to Develop Creativity

Teacher B found that most influences to developing student creativity were neither discouraging nor encouraging and that there were no outright discouraging influences. Overall, Teacher B found positive influences to developing creativity. The Ontario Ministry of Education highly encouraged the development of creativity, an inference he made from a workshop, given to teachers from many school districts in various SHSM programs, that promoted developing independent, risk-taking problem-solvers. Teacher B determined that department heads and subject area teachers at his school supported SHSM-E but, contrary to his questionnaire response, they were not concerned at all about creativity.

Teacher B's discussion of Ontario Curriculum documents proved revealing. He explained that the school course calendar listed the Grade 12 University/College Preparation curriculum would be taught in the SHSM-E but he was most inclined toward the Grade 12 Workplace Preparation curriculum because it matched his outdoor focus and would not be overwhelming for his current students. Asked if the learning of creativity was effectively incorporated into the Workplace curriculum, Teacher B responded that he did not consider it "a high-end ingenuity course" but that he made some improvements by adding some instruction in creative thinking. Teacher B spoke of a SHSM-E colleague in another school district whose students' very strong academics allowed for debates, role plays, Problem Based Learning, or "whatever," implying the use of a variety of creative instructional strategies. Teacher B believed that utilizing creativity to that extent required "higher-end academic" students. Later in our discussion, Teacher B called into question his own partiality when recalling non-academic students in previous school years who had surprised him with their creativity. With the current class, though, he stated that "it looks more like it's a hands-on" course. He asserted that, if students could not learn in a more traditional way through rote and structure, then learning could be more fun and interesting, which was strongly connected to creativity. On a number of occasions, Teacher B stated that prime importance was placed on positive work skills and values, such as "punctuality, respect, work ethic" which could not be "undermined or sacrificed" by programming that was "very creative."

4.9 Bloom's Taxonomy

Bloom's Taxonomy is a model of classifying thinking according to multi-tiered levels of complexity. The six levels – Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation – are hierarchical, with each higher level built on proficiency in the previous levels. The model has been utilized pervasively pedagogically and is the "de facto standard" to classify thinking (Forehand, 2005, p. 3).

At both sites, student interviews indicated a high use of Knowledge and Comprehension in class and, when in the field, Application. My in-class observations confirmed a high use of Knowledge and Comprehension. Teacher questionnaire responses differed from the student experience. Teacher B indicated that he s*ometimes* used all levels except Application, which was used o*ften* (see Table 28). Teacher A indicated on his questionnaire that Comprehension, Application and Analysis were o*ften* used, with use of the other levels indicated as *sometimes* (see Table 13).

During interviews, both teachers exhibited casual mannerisms and vagueness about the Taxonomy. Neither teacher commented about Bloom's higher levels of abstraction; namely, Analysis, Synthesis and Evaluation, when directly questioned about the Taxonomy during formal interviews nor during informal conversations or instruction on my observation days in the classroom. Teacher A's indication on his questionnaire that Analysis was completed o*ften* was not supported by my observations or student responses.

Of all levels of Bloom's Taxonomy, Application appears to be the highest level for which the teachers expected their students to strive. Teacher A clearly stated that Application was valued most highly, and many of his students repeated that thought; whether it was mere repetition or belief is uncertain. Teacher A explained that knowledge and a deeper understanding were required in SHSM-E, too, but a strong correlation with the hands-on nature of the course made Application of prime importance. Teacher B acknowledged that Application was the most often used of Bloom's levels, as well as Knowledge and Comprehension. He commented that students demonstrated little use of the three higher levels of thinking, which he had concluded from two situations in which students had had difficulty or had lacked interest. In one situation, students were asked to connect their learning in the SHSM-E course to changes that they could make in their everyday lives and Teacher B was surprised by the simplicity of their common, well-accepted answers. In the other situation, after presenting an environmental issue of personal interest, individual students were unable to come up with unique answers to Teacher B's questions about how to apply their learning to increase the direct involvement of others and whether the knowledge that the student had acquired was going to make any difference. Teacher B explained that the answers he expected were more than students could give and that this was a missed opportunity for creative problem-solving.

4.10 Rural and Urban Comparison

The study by Dishke Hondzel et al. (2014) found differences between children's creativity scores in rural and urban elementary schools. Because the results were intriguing, the differences were explored qualitatively in this study through interviews, but not in questionnaires.

At the urban site, Teacher A noted that his personal experience supported the idea that greater opportunities for creativity existed in rural locations, although he had no professional teaching experience with rural students. Reflecting on his childhood visits every summer to a relative's farm led him to determine that his cousin had greater responsibilities and subsequent opportunity to respond creatively and independently. He recalled his uncle "ripping apart" an engine to determine and solve a problem with only the materials and tools at hand. His uncle did not take vehicles to a mechanic to make repairs. Additionally, he asked about the experiences of rural students at Site B and he agreed that hands-on activities could inspire creativity. Eventually, he speculated that maybe the formal learning environment did not sufficiently promote creativity, wondering whether outside of school experiences influenced "the mind set and approach" of students in solving problems.

Two rural students brought up the topic of solving problems creatively in their own rural settings. B05's declaration that she lived on a farm was clearly a statement of pride. She immediately began discussing how her rural location forced ingenuity, mimicking Teacher A's observation that "if something breaks, you have to come up with a solution to that, and you have to be creative," including the use of both materials and tools. She spoke proudly of her family's autonomy in not requiring an expert to service any machinery on the farm, primarily due to the efforts of her dad, described as "very do-it-yourself." She noted that he provided a setting in which she was left alone to try to fix things, supporting her ingenuity yet making himself available to assist, if needed. His attitude entailed developing independence to solve problems by consciously making "an effort not to do everything for me" (B05). She praised him as a good teacher, who did not "know exactly what we do at school" but believed that he would view it as "a great waste of time" if teaching ingenuity was not included.

B01's experience was very similar. As a dirt bike rider, "if there's a problem, you go and take it apart and put it back together. You just go and start trying stuff and eventually you get to it." He used this trial and error approach, for instance, to fix a cracked tailpipe by wrapping and welding a piece of metal of the right material, so that it would function properly once in use. Buying the manufacturer's replacement part or having a mechanic fix the tailpipe was not an option.

Chapter 5

5 Interpretation and Synthesis

5.1 Introduction

As outlined in Chapter 2, Constructivism is the basis of the theoretical framework of this study. It is operationalized through instructional practices in the teaching and learning of creative problem-solving in an environmental education context. The experiences of teachers and students, conveyed through field data, must be respected and mediated in order to answer the main research question: To what extent do educational programs (e.g., the Specialist High Skills Major – Environment (SHSM-E) program) address human ingenuity? More specifically:

a. What “school-based” pedagogies and instructional practices, such as problem-based learning, divergent thinking and inquiry, are being used as methods in formal education?
b. What field-based, experiential learning practices such as outdoor education, local field trips and co-ops are being used?
c. What limitations and curriculum supports/barriers, professional development, procedures and leadership do teachers encounter in trying to address human ingenuity?
d. Do students have opportunities to develop Bloom’s higher levels of learning (i.e., Analysis, Synthesis, Evaluation) for creative thinking (see Shaunessy, 2000)?
e. Are learning conditions, such as collaboration or independence to explore personal interests, encouraged for students?
f. Are human ingenuity-fostering attributes, such as the valuing of experience, ambition, independence, norm doubting, autonomy, non-conformity (see Weisberg, 2010, p. 244) being nurtured?
g. Is creative problem-solving or human ingenuity acknowledged in provincial and school district documents as an educational outcome?

Following from the data compilation and analysis in Chapter 4, this chapter presents themes extracted from qualitative, semi-structured interviews, questionnaires, on-site observations, and anecdotal records of student and teacher participants collected in a rural and an urban high school in the Specialist High Skills Major – Environment (SHSM-E) program. The purpose of the multi-sourced data collection was to gather firsthand accounts of participants' experience with creative problem-solving and its development as an outcome. Three broad themes emerged during the analysis: the comparative value of teaching methods that promote creative problem-solving, the importance of creativity, and the exploration/inspiration value of innovation and real events. Two of these themes have been divided into more specific sub-themes to provide richer descriptions of the creative problem-solving experience.

5.2 Theme 1: Teaching Methods That Promote Creativity

Creative instructional strategies and teaching methods have been labelled as "creative" in this thesis because of their potential to engage students in creative problem-solving, thinking or human ingenuity that constructs useful and original outcomes. Outcomes at this level of education are likely to be original to an individual student or relative to peers, and may be original to humanity. Creativity is more likely to occur during the construction of knowledge, the use of Bloom's higher-order thinking skills, the solving of ill-defined problems or greater student-centred control over the learning process. Theme 1 emerges from the data showing that these teaching methods are ineffectively used: The creative instructional strategies of Inquiry Based Learning and Problem Based Learning, and the high-order thinking skills of Bloom's Taxonomy are severely underused or completely absent from the SHSM-E programs while Class Discussion and Experiential Learning are underutilized, all falling below their optimal use.

5.2.1 Subtheme 1: Creative Instructional Strategies

Students clearly indicated that they preferred creative instructional strategies to the non-creative instructional strategies that were used in class. Students at both sites wanted creative instructional strategies more often and communicated an excitement to engage in them during interviews. In relation to my creative and non-creative instructional strategies dichotomy, Teacher A at the urban site was able to identify instructional strategies that effectively promote creative problem-solving while Teacher

B's identification was not. The following in-depth look at each creative instructional strategy helps expose the extent to which it was effectively taught.

Experiential Learning

Students and teachers at both sites stated that they had participated in Experiential Learning. However, the instructional strategy was only partially implemented, according to common Experiential Learning practices. The most prominent Experiential Learning Theory by Kolb (1984) is used here to benchmark the experience of this study's participants. SHSM-E students often engaged in out-of-the-classroom learning experiences (Concrete Experience - CE). Afterwards, they made observations based on how they felt about the experience (Reflective Observation - RO). Site A students engaged in this reflection regularly while Site B students struggled to make meaningful observations, even after Teacher B provided guiding questions. The next two steps of Experiential Learning Theory were omitted at both sites. Firstly, strong connections needed to be made between student observations (RO) and the curricular concepts being learned by using logic and ideas to understand the experience (Abstract Conceptualization - AC). Secondly, the theories generated through these connections needed to be tested "to make predictions about reality" and then acted upon (Active Experimentation - AE) (Akella, 2010, p. 102). As a cyclical process that can be started at any of the four steps, this instructional strategy has strong potential for developing creative problem-solving through knowledge construction, abstract thought and student engagement in real life, ill-structured situations. Realistically, the comprehensive completion of all four steps may be difficult. As it was used in SHSM-E, Experiential Learning did not engage students in all steps and fell short of optimizing learning. If Experiential Learning is indeed one of the primary instructional strategies as SHSM-E teachers and students alike stated repeatedly, and it commands substantial class time and resources, then the instructional strategy needs to be thoroughly comprehended and fully utilized. In its current usage, Experiential Learning has been devalued, perhaps to little more than fun, beyond-the-classroom activities, with a low probability of significant learning and creativity.

Contrast in Experiential Learning also occurred between Sites A and B. For instance, with Concrete Experience (CE), Teacher A provided off-site experiences requiring problem-solving which had some challenge and ill-structure, because “in the real world things aren’t always laid out for you.” Teacher B, on the other hand, assigned open-ended and obscure outdoor explorations, which required students to determine a topic of study before they were ready, resulting in disparate observation and off-task behaviour. Teacher B adjusted, by providing guiding questions and samples of observational logs but the difficulty centred on the open-endedness of the Concrete Experience: Some students could not narrow and choose a topic from vast possibilities, which Teacher B labelled as a lack of understanding or inability. To initiate students to the strategy, a well-defined, focussed topic could be provided by Teacher B with students then choosing the guiding questions for observations. This may have provided sufficient structure and still allowed student choice. As it was used, the activity was too difficult without additional teaching, and was eventually abandoned.

Inquiry Based Learning

This creative instructional strategy was not used at all, at either site. Teacher B stated that almost all of his students would not be able to do Inquiry Based Learning, an inference he made on the basis of their difficulties in completing other, simpler tasks. Teacher A understood the meaning of inquiry, but was unfamiliar with the particulars of Inquiry Based Learning as an instructional strategy. Once it was explained in more detail, he stated that, in the future, the time and opportunity existed for students to complete one of the steps of the process (such as the collection of data, choosing a topic or drawing conclusions), but not for them to “have total or sole control over, start to finish, what happens.” When queried, he acknowledged that this lack of use was his instructional choice.

Problem Based Learning

The creative instructional strategy of Problem Based Learning was utilized at both sites, but was not effectively implemented. Teacher B did attempt to use a Problem Based Learning scenario for a proposed subdivision but poor student response threatened to sabotage the activity. Students had been given a list of guiding questions to answer (such as how could the task be accomplished, what was their rationale, who was consulted, etc.) but they had not been taught how to approach and complete the task.

Students flatly refused to participate. To salvage the learning opportunity, Teacher B began to teach them how to accomplish the task by first calming them down through reassurance, then simplifying the task by focussing them on brainstorming as the most important activity. His re-direction slowly moved the students to greater involvement until one student became inspired and took over as the leader. The turning point occurred when Teacher B's teaching of the Problem Based Learning process led to student understanding, giving them the necessary skills, direction and confidence to take on the task. The students were later successful with a similar task at the Envirothon team competition. Teacher B did not realize that his teaching during the initial task had prepared the students to take on the next task. An explanation of the scenario, without instruction, had been insufficient: The process had to be taught, and when it was, the creative potential became more apparent.

Teacher A used a Problem Based Learning debate format for exploration of a highly conflictual hydro-electric dam scenario, with students taking on the roles of key stakeholders. In an ideal implementation of the instructional strategy, a solution would evolve from the debate experience using a two-step process to explore stakeholder positions (Step 1) followed by a group-based effort to find a solution for all or some of those stakeholders (Step 2). In this ill-structured problem, the process would include all six stages of Bloom's Taxonomy, where Step 1 would primarily address Knowledge and Comprehension and Step 2 would cover the remaining four higher levels of abstraction.

At the outset of the debate, students were required to research their roles and present their findings in character, as per Step 1. One student in particular, A18, began creative problem-solving during the debate, incorporating others' ideas with her own and modifying her suggestions to come up with solutions. Step 2 of the debate did not occur. Student groups could have moved into a creative problem-solving mode, to think divergently, come up with multiple, possible solutions and then converge the ideas to determine the best possible solution. Because Step 2 was not carried out, many students in post-debate interviews expressed disappointment at the incompleteness of the activity that availed information but without any use: They highly desired to continue to Step 2 once the confrontation of the debate had dissipated in order to collaborate for the purpose of creating a best solution. The confluence of brainstorming possible solutions, conducting further research, determining primary issues by minimizing secondary issues, negotiating, and eliminating undesirable ideas are all part of the problem-solving process. Constructing a mutually agreeable solution to an ill-structured problem is creating a useful and original outcome. The implementation of Step 2 is requisite for the development of creativity using a Problem Based Learning instructional strategy.

Class Discussion

At both sites, Class Discussion was used often, was highly preferred and desired by students, and perceived by both teachers as effective in promoting creative problem-solving. Class Discussion occurred with the entire class and break-away, smaller groups which would reconvene as a class to debrief. Students at both sites commented that the sharing of ideas during Class Discussion exposed them to additional ideas and other viewpoints, and allowed them to evaluate their existing ideas by comparing their ideas to others' ideas.

The apparent simplicity of Class Discussion implies that its use would be straightforward but some evidence suggests that the learning opportunity could be improved. My observations revealed that Class Discussion involved students taking turns in sharing individual ideas while little or no attention was paid to how a student could subsequently use the ideas. As used, Class Discussion primarily sought to elicit existing student ideas and rarely focused on generating new ideas or building on, or scaffolding, other group members' ideas. To compound ideas rather than to merely share them, students can be taught group work protocols (e.g., focus on ideas, not people; no judging of ideas; add on to ideas; etc.) and cooperative learning skills, such as assigning functional roles or self-monitoring, so that groups are collaborative, motivated and interdependent (see, for instance, Bennett, Rolheiser-Bennett, & Stevahn, 1991; Johnson, Johnson, & Holubec, 1990). Following Class Discussion, integrating ideas into an existing body of knowledge, synthesizing new theories or evaluating ideas for relevance and merit can be taught. More importantly, the creative problem-solving process can be made explicit. Ideas that are useful and original to students can be openly identified. At Sites A and B, opportunities for this cooperative group work and integration, synthesis or evaluation were either missed or underutilized. B04, for instance, wanted to learn how to combine others' ideas with his own. Other students, like A13 and B05, reported making personal judgements about the quality and uniqueness of their own ideas vis-a-vis others', but the group had not learned to scaffold ideas nor was the opportunity provided. Teacher B reported that students just wanted answers, not discussion. My observations confirmed his assertion: Students appeared to perceive little value in discussion, simply went through the motions to appease the teacher, and lacked inspiration and energy in the process. My discussion with them found that their behaviour was likely a result of an inability to engage in a meaningful process.

While Class Discussion exposed students to some ideas of others, the evaluation of these ideas as useful or original must also occur to determine their value and usefulness. My impression from talking with the teachers at Sites A and B is that their belief is that the act of sharing of ideas leads to creativity and, as a result, convergent thinking as a means to evaluate the usefulness and originality of the ideas was rare or was circumvented by giving students the "correct" answer as determined by the teacher. Like divergent thinking, narrowing or converging ideas into key points or a single new theory must be modelled and explicitly taught, without which the instructional strategy omits an important part of learning the creative problem-solving process.

Creative instructional strategies, my data suggest, are powerful tools, not only to teach creative problem-solving, but also to inspire students to take a more active role in their learning by giving them more independence, responsibility and decision-making. This active role demands far more student involvement than the more passive non-creative instructional strategies of direct instruction. Students require incremental, ongoing learning and teacher guidance during activities of creative instructional strategies to accomplish this gradual release of responsibility. In general, many students have had very little or no experience with student-centred, constructivist learning in earlier grades. Students need to be met where they are rather than, as Teacher B assumed, where they were expected to be. Proficiency can be time-consuming for students: Making learning personally meaningful to them and using the creative process may not occur by always using the most efficient instructional method (Beghetto & Plucker, 2006). Teachers may be impatient with student progress and wish to abandon creative instructional strategies altogether for non-creative, teacher-directed instructional strategies. Teacher A seriously questioned the time and effort to change his instruction to use creative instructional strategies. At Site B, students were asked to conduct Inquiry Based Learning outside but did not know how to proceed. Teacher B labelled this confusion as inability, withdrew their independence, and replaced it with more structured learning. Yet, student interview responses at both sites communicated clear interest and excitement in using creative instructional strategies. They recognized their current inabilities but wanted to learn, requesting that teacher guidance be available to help manage their risk-taking. I was struck by their willingness and motivation to try new methods of learning through creative instructional strategies.

5.2.2 Subtheme 2: Higher-Order Thinking

This subtheme contends that SHSM-E learning activities and instructional strategies included Bloom's first three levels of Knowledge, Comprehension and Application (lower-order thinking) and rarely included the three higher levels of Analysis, Synthesis and Evaluation (higher-order thinking). Bloom's Taxonomy classifies thinking according to complexity (Forehand, 2005). By focussing on only part of Bloom's Taxonomy, learning activities were not taken far enough to include higher-order thinking and students missed opportunities that could have led to creative problem-solving.

Almost all data collected confirm the predominance of lower-order thinking to the exclusion of higher-order thinking. Only two responses, both from Teacher A, contradict this evidence. Firstly, his questionnaire response indicated that the class had *often* engaged in Analysis (Level 4) and secondly, he reported teaching students a "toolbox" of critical thinking skills, such as considering bias, which students self-determined the appropriate situation to use. However, this use of Analysis was not supported by any other evidence and the lack of consistent, teacher direction to implement the toolbox skills casts uncertainty on the extent of student use. Nonetheless, the lower levels of Bloom's Taxonomy were well covered at both sites. The students' demonstrated considerable Knowledge and Comprehension of a significant amount of curriculum and the Application of this knowledge occurred throughout a plethora of field trips, certifications, work site placements and other beyond-the-classroom experiences.

Taking activities beyond the well covered lower levels of the Taxonomy was rarely witnessed. An example from each site will describe this omission and a method of including high-order thinking will be suggested.

At Site A, students debated the construction of a hydro-electric dam. The Problem Based Learning activity engaged students in the Taxonomy's lower-order thinking by conducting initial research and, during the debate, providing arguments for their own positions while comparing and understanding the positions of other stakeholders. The activity ended at this point. The next step forward to use Bloom's higher-order thinking could have been achieved by involving students in post-debate group work to find a mutually acceptable solution for all stakeholders through creative problem-solving. Students could engage higher, abstract levels of Bloom's taxonomy by identifying key components and recognizing patterns (Analysis); relating knowledge from several areas to predict and draw conclusions (Synthesis); and comparing and discriminating between ideas before assessing the value of solutions and making a best choice based on a reasoned argument (Evaluation). Together, these levels unite as the creative problem-solving process and students can ultimately construct new knowledge. Several students, A13 and A18, attempted to creative problem-solve during the debate and many students later discussed during personal interviews that they would have liked to have engaged in formalized problem-solving once the debate had ended. This logical progression that can utilize all levels of Bloom's taxonomy was never provided to them.

At Site B, the events and causes of the Gulf Oil Spill had been discussed in class with Teacher B, providing Knowledge and Comprehension. During interviews, students were questioned about Problem Based Learning and, without any actual experience with it, an activity was suggested in which students would assume roles of Gulf Oil Spill stakeholders; simulate the damaged rig using hoses, piping and water; assess the damage; and attempt to physically solve the problem, in real-time. The resulting activity would utilize all levels of Bloom's Taxonomy, in addition to providing an experience for students of all learning styles, including several highly tactile, hands-on learners who felt that their learning style had been ignored. The simulation would require lower-order thinking of research, discussion, scale drawing and model building which would act as a base upon which to build the higher, abstract levels of Bloom's Taxonomy. In order to come up with a solution and attempt to repair the leak, some students would use creative problem-solving or thinking: analyze through identifying key components and searching for patterns; synthesize by co-ordinating ideas of all stakeholders, predicting outcomes and drawing actionable conclusions; and comparing ideas, evaluating and rationalizing solutions and choosing a solution based on reasoning. Other students would use ingenuity to act, using the same cognitive processes while attempting hands-on solutions. Using either creative problem-solving or human ingenuity could lead to discovery or construction of useful and original knowledge.

These two examples show that activities in which students engaged could have been taken further to include all levels of Bloom's Taxonomy and ultimately led to an optimal learning experience and engagement in creative problem-solving. Responses by both teachers to my questions about Bloom's Taxonomy during interviews indicated that neither consciously planned its use in their instruction. Their casual mannerisms and vagueness about the Taxonomy lend support to this supposition. Undoubtedly, curricular, temporal, logistical and other challenges existed, of which I was unaware, that could complicate the implementation of Bloom's taxonomy into classroom learning activities. Ontario curriculum documents, though, incorporate Bloom's Taxonomy in several locations, including the preamble, curriculum expectations and categories of the curriculum achievement chart, which all teachers are fully aware of, use frequently and understand are required for student assessment (see Ontario Ministry of Education, 2005, p. 18). Particularly relevant to SHSM-E teachers, explicit statements about the teaching of higher-order thinking, creative thinking skills and creative instructional strategies are found in Ontario Ministry of Education curriculum documents *Canadian and World Studies* (2015) which is the geography curriculum from which SHSM-E draws and *Environmental Education Scope and Sequence of Expectations Grades 9-12* (2011). Other curriculum also regularly reference higher-order thinking. For instance, the Ontario Envirothon Teacher's Guide (n.d.), used in preparation for the training and competition in which students from both sites participated, enumerates learning goals for all of its core topics using Bloom's Taxonomy.

5.3 Theme 2: The Importance of Creative Problem-Solving

Both teachers made positive statements about creative problem-solving. However, deeper explanations during interviews and, in particular, their teaching practices revealed that creative problem-solving is minimally valued in the SHSM-E classrooms and is strongly incongruous with their earlier positive statements.

Teacher A indicated support for creative problem-solving on a number of occasions. He responded on his questionnaire that, in general, creative problem-solving was *Important*. Additionally, he stated that creativity needed to be taught at a young age so children were "not confined within certain parameters," if the goal of education was to have outside-the-box, creative leaders. His ranking of the effectiveness of instructional strategies that promote creativity generally matched my effectiveness rankings. Yet, the instructional strategies and activities that promote creative problem-solving were not used in class, nor was their use being planned or investigated for the future. Overall, Teacher A indicated that changing instruction to include creative strategies would take more time and effort, without any assurance of improved learning. He believed that using established, less creative instructional strategies might not be as "rich" for students but these direct instruction methods would cover essential curriculum, which he felt strongly pressured to do. He conveyed that the learning of creative problem-solving was desirable but did not provide enough value to become a high priority in mainstream teaching.

Teacher B also responded on his questionnaire that creative problem-solving was *Important*. His ranking of the effectiveness of instructional strategies to promote creativity differed significantly from those strategies that I identified as effective creative instructional strategies. When asked about influences that might encourage or discourage the use of creative problem-solving, Teacher B identified several encouraging influences, including a discussion with a colleague in another SHSM-E program who had implemented creative instructional strategies and creative activities, the success of which was attributed to highly academic students. Teacher B believed his current students to be more "hands-on" and not well suited to creative instructional strategies. Additionally, Teacher B stated that basic skills were not to be jeopardized by creativity: Prime importance was to be placed on positive work skills and values, which could not be "undermined or sacrificed" by creative programming. Teacher B's strong belief that learning occurred in "super-structured environments" clearly directed his pedagogical preferences towards non-creative, direct instruction strategies. When that type of learning could not be accomplished, "fun and interesting" learning activities, which he considered synonymous with "creativity and ingenuity," become his pedagogy.

Clearly, creative problem-solving was neither understood nor valued significantly in these SHSM-E classrooms. Beghetto and Kaufman (2010, p. 192) contend that creativity perceived as an "add-on" may leave teachers ambivalent about its instruction. Teachers hold the ultimate authority in determining content, instructional strategies and assessment in a classroom. The decisions that teachers make are influenced by what they regard as valuable for their students. Valuing creative problem-solving can be influenced by many variables: their understanding of creative problem-solving, its underlying theories, such as Bloom's Taxonomy, and their ability to effectively deliver creative instructional strategies. According to Ministry curriculum documents, teachers are required to teach and assess problem-solving and higher-order thinking as well as the lower-order thinking skills of Knowledge, Comprehension and Application. Indeed, the new economic reality where creative problem-solving is one of the most highly sought-after employee qualities (IBM, 2010) demands a SHSM-E response, particularly if one of the program's stated goals is to assist students in the transition from high school to university, college, workplace or apprenticeships (Ontario. Ministry of Education, 2010, p. iii).

5.4 Theme 3: Exploring Innovations and Real Events

5.4.1 Environmental Innovations and Technologies

Questions about exploring environmental innovations and technologies, and discussing improvements to existing innovations sought to inquire about exposure and excitement about new environmental advances. In personal interviews, students demonstrated very little exposure to, or understanding of, any current innovations. Discussion of unfamiliar examples of environmental innovations and technologies listed on the questionnaire were met with surprise, curiosity, disbelief, or claims that I had made them up. My expectation from students was not intimate knowledge of these particular examples, but I did expect them to show some interest, to ask for further information or share familiarity about other innovations, all of which I found little or none, leading me to believe that discussion of environmental innovations was novel to them. Teacher questionnaire responses indicated a high level of classroom exploration of innovations and technologies with some discussion of improvements but teacher interviews later revealed that this exposure was accomplished primarily through brief discussion of news events or non-participatory field trips aimed at providing information about innovations that were, in fact, no longer cutting-edge. Together, this data indicates that SHSM-E included some current environmental innovation, but without significant depth of learning or meaningful student engagement.

This line of questioning about environmental innovations and technologies also revealed unexpected student perceptions about creative problem-solving. Strong student confidence in creative problem-solving indicated in questionnaires did not translate into student confidence in trying creative problem-solving to solve real environmental issues. Students claimed that they could not generate useable or significantly valuable ideas or that someone else could invent a solution or had already done so. It seemed out of character for the highly creative problem-solving debater A18 to state that “I know we can’t do something like that.” Alternatively, A12’s comment that student solutions would be “too crazy” implies a lack of brainstorming practice, which typically encourages imaginative ideation. B01 was one of only a few students who felt that he could creative problem-solve any challenge, providing it was hands-on. B05 humbly expressed her confidence to invent something environmental, stating that “I’m not saying I could invent it, but I can usually come up with a couple different solutions and I’d build off those.”

Various data collected led me to expect that students would be willing to engage in creative problem-solving of current environmental issues. Firstly, students expressed personal self-confidence in interviews and questionnaires. They were highly confident in finding creative solutions in an area of personal strength, though less confident in generating extreme imaginative ideas in that same area, and most confident when considering working with an equally capable partner. When asked if they were the kind of person who was often able to come up with interesting and unique solutions to challenges or problems in other areas outside of the SHSM-E class, 63% of Site A and

100% of Site B students responded that they could *often* or *always*. Secondly, when asked about group creativity, most students at Site A, though far fewer at Site B, enjoyed coming up with interesting and unique solutions. The majority of students at both sites reported successfully finding many solutions to challenges in class. Thirdly, students perceived that they had often engaged in creative problem-solving in class, particularly at Site A, where they reported being asked regularly how to solve issues, think of alternatives and use their imaginations. Students did indicate on their questionnaires that they engaged in two creative activities, Becoming an Expert and Becoming an Inventor, but none made any comment, or even seemed to make the connection to creative problem-solving.

While the confluence of student confidence in personal problem-solving, group creativity, enjoyment and opportunity does not lead to a conclusive picture, it does call into question why students would express such a strong negativity to exploring solutions for real environmental issues. Combining this confluence with a presumed interest in the environment because they are in the SHSM-E program, students would be expected to aspire to finding solutions to existing environmental issues. The missing catalyst may be the perceived inability and lack of practice in the creative problem-solving process. When students understand the process and they are taken through the process with authentic examples, some of the mystery and uncertainty of creativity can be dispelled, and self-confidence may increase. At this time, they may be more capable of developing their creative potential in order to address environmental issues.

5.4.2 Contextualizing Learning With Real Environmental Events

Students and teachers reported that they had discussed real environmental events and issues. However, they had not brainstormed possible preventions, contingencies or, most importantly, solutions. They deflected the entire thrust of the question. Fortunately, the discussion resulted in the discovery of other unexpected benefits; that is, many students immediately expressed enjoyment and inspiration when discussing real events. These interview discussions of real events focussed on deeper discussions of events that they had discussed in class as well as unfamiliar real events that I suggested. All discussions focussed on how to use creative problem-solving. Students responded quite positively to learning activities in which creative instructional strategies could be used to address real environmental issues.

Students displayed several indicators of their enjoyment and inspiration. Students at both sites enthusiastically embraced the hypothetical Gulf Oil Spill simulation, which I proposed as a hands-on, realistic Problem Based Learning activity. They immediately reacted to the idea with descriptors like “cool,” “that would be fun,” “awesome,” and “I’d love to do that,” which demonstrated an attitude that encourages creative thinking Nickerson (2010). These comments were noteworthy considering the difficulty in getting some teenagers excited by learning, especially Site B students, from whom I observed very little emotion and Teacher B often “didn’t get much response.” After initial, positive reactions, students were energized that this activity could suit their learning style, particularly for hands-on learners.

Most surprising was the involvement of individual students in co-planning this learning activity. A07 ran with the idea on his own, seeing the opportunity to make the idea into a “big project” that required significant time and effort in order to break the class into small groups, determine one best solution, and then send it in a letter to authorities. B05 juxtaposed this active learning of Problem Based Learning to her more commonly occurring classroom activities of report writing or a teacher lecture; instead, she wanted to work outdoors to come up with three different ways to efficiently clean up the spill to learn “not just that it did work, but how and why.” B01 was so excited by the idea that he sat bolt upright, moved to the edge of his seat, and began talking feverishly about this scenario as an opportunity for learning. He was not merely listening to me explain how this lesson could be arranged but he actively contributed to its design. We were on the same wavelength, trading ideas, sometimes finishing each other’s sentences. He recognized the limitations of the scenario but also the creative purpose as well. In comparison to the uninvolved and seemingly disinterested student that I had observed earlier in class, this student became alive. It was an exciting, yet brief exchange which, I believe, was creative problem-solving. This student, with my assistance, was moving through the process of constructing an outcome which was useful and original to him. Class time to work on the activity would have allowed this student to continue the problem-solving process and, with other group members, may have led to a creative outcome.

I observed this enjoyment and inspiration in many other situations where real environmental events or issues were combined with creative instructional strategies. At Site A, the hydro-electric dam scenario, referred to by Teacher A as analogous to the Three Gorges Dam in China, became an intense debate in which fully costumed students argued in character and were eager to engage in post-debate problem-solving had it been offered. At Site B, students expressed excitement at the possibility of completing their final projects on environmental issues by using Inquiry Based Learning to make methodological choices rather than a teacher directed, cut-and-paste assignment. B03 stated that, if SHSM-E had been about issues, then it would have been a lot better. B01 enviously spoke of an Experiential Learning project completed at another school to convert a diesel engine to run on used restaurant cooking oil. And finally, all students at both sites endorsed, some passionately, Experiential Learning experiences which occasionally addressed real environmental issues, such as reforestation by assisting local conservationists with a field experiment or encouraging the return of bird populations by building species-specific birdhouses.

Real environmental events combined with creative instructional strategies have two unique characteristics that were attractive to these students. Firstly, these events brought a meaningful practicality to learning in that the problems were real problems and real solutions were being sought. Secondly, there was a sense of a call to take action, of *doing* something, working together with peers, to improve an immediate situation. Studying real events to stimulate "student interest and curiosity" flows directly from the curriculum document for the SHSM-E program, *Canadian and World Studies* (Ontario. Ministry of Education, 2005, p. 22).

Teachers A and B connected real events to the curriculum being studied. But, by all accounts, this examination of real environmental events was rarely undertaken with any depth. Clearly, a disparity existed between what students thought would be interesting, fun and inspiring, and what teachers thought. Of course, all learning cannot be interesting, fun and inspiring but if examining real events and potential solutions is desired more often by 75% of Site A students and 88% of Site B students, it only seems logical to expound on that enjoyment and inspiration brought about by these events when they are combined with creative instructional strategies.

5.5 Summary

In this chapter, three broad themes were presented. Each emerged from the questionnaire, interview, observational and anecdotal data collected.

Theme 1 consisted of two sub-themes. Sub-theme 1 indicated that creative instructional strategies were completely absent (i.e., Inquiry Based Learning), started but stopped before creative problem-solving could occur (i.e., Problem Based Learning), or key steps were omitted (i.e., Class Discussion and Experiential Learning). Most of the readily available opportunities to use creative instructional strategies were unrecognized, ignored or addressed minimally. When environmental activities using creative instructional strategies were proposed to students during interviews, they responded positively with excitement and interest, and recognized that learning skills could be improved. Sub-theme 2 focused on Bloom's Taxonomy, showing that lower-order thinking dominated instruction and classroom activities, to the exclusion of higher-order thinking and the potential to engage students in the process of creative problem-solving.

Theme 2 revealed that creative problem-solving was poorly understood and not valued significantly by the SHSM-E teachers, despite inclusion in ministry curriculum documents of creativity-inspiring instructional strategies, increasing demand as a job skill and pervasive attention to innovation in business and other organizations. Statements by both teachers, that creativity/human ingenuity was important, were not supported by their instructional practices.

Theme 3 indicated that contextualizing environmental learning with real events occurred in SHSM-E, but without thorough exploration of events, possible solutions, causes or contingencies. Current environmental innovations that were investigated were rarely cutting edge and did not elicit significant student engagement. Interview discussions with students about exploring events and innovations using creative instructional strategies, which would allow them to take a more active role in learning by giving them more independence, responsibility and decision-making, had students expressing excitement and motivation to participate.

Chapter 6

6 Reflections and Discussion

As described in chapter 1, the purpose of this study is to determine how Ontario schools are addressing the need for, and development of, children's creative problem-solving and thinking in a Specialist High Skills Major – Environment (SHSM-E) program. The findings of the study indicate that the learning of creative problem-solving is insufficiently addressed but can be improved through the explicit teaching of the creative problem-solving process and the increased use of instructional strategies that inspire creative problem-solving. Four areas were examined to determine how creative problem-solving is being addressed.

6.1 Understanding Creative Problem-Solving

The current use of creative instructional strategies in the SHSM-E programs was initially explored through a single question on the student questionnaire, observed and recorded as anecdotals during classroom activities over several observation days, and then fleshed out during interviews of teachers and students. The overall pattern that emerged showed that the use of creative instructional strategies was infrequent or ineffective. Inquiry Based Learning was rarely used and Problem Based Learning was severely underused. Class Discussion and Experiential Learning, though used extensively, were not implemented to their full potential. However, students' questionnaire data indicated that they preferred creative instructional strategies to non-creative instructional strategies and would like to use creative instructional strategies more often. During interviews, some students demonstrated great excitement and interest in engaging in creative instructional strategies when examples of possible environmental activities were described to them. Students communicated that independence, motivation, participation and self-efficacy would also increase. Teachers identified most of the strategies that inspired creativity and stated that the development of creativity was important.

The use of Bloom's Taxonomy of Abstraction was found to focus exclusively on lower-order thinking. Students often demonstrated effective learning through understanding, comprehension and application. During interviews, both students and teachers frequently voiced the importance and primacy of application to the SHSM-E program. Higher-order thinking, which is involved in creative problem-solving, could have been accomplished by simply extending classroom activities that had concentrated on lower-order thinking. Students communicated a desire to extend these activities and engage in the creative problem-solving process in order to try to find solutions. Students stated that working collaboratively with peers on these ill-structured problems to define the procedure, complete research, evaluate possibilities and determine a best solution would be beneficial and enjoyable.

The use of creative activities that redefined creative problem-solving in alternative terms was explored. These terms stated an explicit task that would be accomplished, such as becoming an expert or inventor, or engaging in divergent and convergent thinking. Many students exhibited significant interest in these processes and desired to use them more often in class.

The use of environmental innovations, which can excite hands-on problem-solving (ingenuity) and creative ideation, was not employed in SHSM-E. Examples of innovations provided in the student questionnaire and then discussed during interviews piqued the interest of some students. Many students believed that innovation was so far beyond their creative problem-solving abilities that they would not consider making any attempt.

In class, the exploration of real environmental events was given cursory attention. When asked what they knew of the Deepwater Horizon Spill, the largest oil spill in history and the most immediate environmental disaster of their lives, students were only aware of the most basic information. Student interest and curiosity increased substantially as they learned in our discussions how creative instructional strategies could be used to involve them in developing unique solutions through problem-solving. Research supporting this increase in interest and curiosity is found in the SHSM-E Geography Curriculum document (Ontario. Ministry of Education, 2005; Ontario. Ministry of Education, 2015).

6.2 Implications

The findings from this case study provide considerable information. The implications for instruction and curriculum are significant. The implications, outlined below, are for practice, policy and future research. They intend to provide insight into advancing the teaching and learning of creative problem-solving in environmental education.

6.2.1 Implications for Practice

While the teachers in this study agreed that creativity and creative problem-solving are important, there is a distinct separation between their belief and action. To enable action for the teachers in this study, one teacher needed more professional knowledge while the other teacher required convincing that changing his current practice would benefit students and be worth his effort. Both teachers require professional development in order better prepare their students for the contemporary demands of the working world, where creativity and innovation are highly sought after (for example, IBM, 2010). If the workplace is demanding more creative problem-solvers and the stated purpose of SHSM-E is to prepare students for apprenticeships, the workplace, college and university (Ontario. Ministry of Education, 2010), then teachers must answer the call. Creative instructional strategies are teacher tools to accomplish that goal. The creative instructional strategies examined in this study – Experiential Learning, Problem Based Learning, Inquiry Based Learning and Classroom Discussion – are easily recognized by educators yet the strategies are complex and poorly understood pedagogies that require further understanding prior to use in the classroom and ongoing collegial dialogue afterwards in order to reach mastery.

One suggestion would be to organize professional development specifically for SHSM teachers in all subject areas within a school district to replace or expand the regular administrative meetings of which Teacher A spoke. Dialogue needs to occur about why the focus has been on content at the expense of skills, such as inquiry or problem-solving. Using a professional learning community (PLC) format would model Inquiry Based Learning that begins from the teachers' experiences and needs in order to improve instruction, which the teachers could then use with their students. The first topic examined might be the full implementation of Experiential Learning Theory (Kolb, 1984) because of its importance to the SHSM experience. Additional topics for a PLC could include research on creative instructional strategies, designing ill-structured problems, asking questions using Bloom's Taxonomy, critical thinking, the integration of real events into lessons or cooperative learning to improve group work (see, for instance, Bennett et al., 1991).

6.2.2 Implications for Policy

Two implications for policy are evident. Firstly, the expansion of the secondary environmental education curriculum would permit creative problem-solving to be addressed in different subject areas, many of which already use creative instructional strategies. Secondly, introducing significant environmental education in the elementary grades would build a strong skill and content base for high school programs, like SHSM-E, to tackle more complex issues and ill-structured problems promptly and with more depth.

Implication 1: Expanded Environmental Education Curriculum Content

The current curriculum for the SHSM-E program is Senior Geography and Biology. Creative problem-solving can be taught in that context. However, in order to properly develop the skills and knowledge of students as citizens who are increasingly involved in environmental issues, using a multidisciplinary approach would provide a wider curricular scope. In its simplest form, other high school subject areas such as science, business studies, philosophy, political science, economics and technological studies have strong and significant connections with environmental issues and could provide ill-structured problems unique to those disciplines. Some creative instructional strategies are well established in these curriculum areas, such as Inquiry Based Learning in Science, Problem Based Learning in business studies and developing creative design solutions in Tech Studies.

Identifying the Environmental Foundation

From an environmental education perspective, curriculum needs to be broadened to include different environmental perspectives. Steffen (2009) identifies four types of environmentalists on “The New Environmental Spectrum”: Bright Greens seek ecological sustainability through systemic innovation; Light Greens make individual, lifestyle choices to enact small environmental changes that can lead to larger movements; Dark Greens embrace local, community action while questioning the perils of industrialization, such as over-consumption; and Grays deny the need for environmental action. Both SHSM-E teachers in this study – unknowingly, I believe – taught the course almost exclusively from a Light Green perspective, in which students were asked, for example, to determine eco-friendly changes they could make at home or to present an environmental issue important to them. Instead, student exploration of all perspectives, from the lifestyle changes of Light Green and the fast growing Bright Green movement, to the status quo-questioning perspective of the Dark Greens and the rejection by the Grays, develops understanding of the fundamentals of contemporary environmentalism. As a spectrum, these perspectives frame ecological sustainability and present diverse and alternative paradigms in which creative problem-solving can be conducted. For the environmentalist, overlapping Green perspectives can result in alliances, rather than division and strengthen the assault on the Grays’ position that has created widespread and well-established public scepticism of the seriousness of environmental issues (Dunlap, 2008).

The Development of Leadership Skills

The SHSM-E program at both schools was affectionately known as the Environmental Leadership Program. If environmental problems are to be solved, then leadership will be critical, as it is with all social movements (Morris & Staggenborg, 2004). As environmental leaders, students will have to engage a populace overwhelmed and bewildered by a plethora of green crises. They will have to lead through expertise developed by finding and presenting evidence, marketing, developing team building skills and motivating followers to action, among other skills.

Another approach to environmental leadership centers on the development of personal attributes that may foster creativity/human ingenuity, such as Openness to experience, Drive, Ambition, Independence, Norm doubting, Autonomy and Nonconformity (Weisberg, 2010). Additionally, exposing *status quo* bias and questioning hegemonic practices may appear radical for high school students but are common amongst environmental leaders (see, for instance, Weyler, 2009).

A tempered, more politically-correct approach might consider establishing a more creativity-enabling atmosphere in the classroom. The research of Dyer et al. (2011) implies that there is a need to create an educational atmosphere of innovation where students question, observe, network, and experiment; where innovating is safe and exciting; and where disruptive questions are asked that explore what currently is and what might be. Such an atmosphere was not often evident in this study. Some creative instructional strategies, such as Inquiry Based Learning, support the wonderings of students and their subsequent search for answers rather than the teacher controlling curriculum content and the learning process.

Implication 2: Starting Environmental Education Earlier

As an environmentalist with strong Dark Green tendencies that forecast the doom of inaction, I was bothered by a ubiquitous lack of urgency amongst participants of the study to learn how to solve pressing environmental issues. The idea of starting environmental education in the Elementary grades (JK-8) struck me repeatedly as I talked with students and teachers during interviews. Teacher A agreed that the early development of environmental knowledge and skills would ideally allow students entering high school to "go beyond and have more rich case studies or real-world type problems"; that is, Problem Based Learning and ill-structured problems. An elementary curriculum rich in creative problem-solving skills and well-practiced creative instructional strategies would prepare students to tackle complex, ill-structured problems and not be "confined within certain parameters" in high school (Teacher A).

The current state of elementary environmental education curriculum in Ontario is adequate to accomplish this goal, provided the curriculum is being taught. Environmental education has received increased importance in newer curriculum documents but without the implementation of environmental education as a dedicated subject area. Curriculum in science addresses environmental education through non-compulsory, opportunistic integration into existing, non-environmental science lessons. In social science, the curriculum frequently addresses environmental issues, but it is from a singularly human, or anthropocentric, perspective. The contention in the preamble that "the People and Environments strand focuses on contemporary environmental issues and the importance of sustainable living and development" implies that the concern with conservation of the environment is primarily for the exploitation by and for human purposes (Ontario. Ministry of Education, 2013, p. 43). On a positive note, the same Grade 7 and 8 Geography curriculum document specifically delves into various contemporary environmental education topics.

In terms of the teaching and learning of creative problem-solving through creative instructional strategies, the Social Studies, History and Geography, as well as Science curriculum documents explicitly outline the use and methodology of subject-specific inquiry based learning and problem-solving. Tips and suggestions are also provided to show teachers how the process may be non-linear or can be partially implemented prior to full implementation. The curriculum would benefit from the addition of a definition of creative problem-solving and ingenuity, separate from critical thinking, that identifies creative instructional strategies and other teaching practices to develop the creative potential, independence and self-efficacy of students.

6.2.3 Implications for Future Research

This thesis generated more questions than answers.

To extend the work started in this study, the examination of creative problem-solving in an SHSM-E program in which the teacher is already utilizing creative instructional strategies would more accurately determine the enjoyment, desirability and effectiveness of those strategies to explore creative solutions to environment issues. In the current study, participants were asked to recall instructional strategies that had been used, based on a description of the creative instructional strategies, often without any actual experience with the instructional strategies.

The SHSM-E program draws in students pursuing post-secondary pathways to the workplace, apprenticeships, college and university. Narrowing the student population would provide insight into how students on different pathways engage in creative problem-solving or human ingenuity. For instance, do students pursuing a workplace or apprenticeship path prefer hands-on, Experiential Learning or Trial and Error ingenuity? Do university-bound students prefer a more theoretical case study approach for creative problem-solving that uses Problem Based Learning? Or, perhaps learning style (visual, auditory or kinesthetic) is a more distinguishing factor to determine which creative instructional strategies are preferred.

Further research could focus on the teaching perspective. How does a teacher's placement on Steffen's Environmental Spectrum impinge on the teaching of creative problem-solving in SHSM-E? How might it affect a more academic program, or a science program, or a tech studies course?

Additionally, a research study could employ a pre- and post-test design to quantitatively measure changes in student creativity (dependent variable) using a Torrance Test of Creative Thinking when a creative instructional strategy (independent variable) is implemented. Very little quantitative research has been conducted on the link between creative problem-solving and instruction using creative instructional strategies, Bloom's Taxonomy, creative activities, hands-on learning or trial and error. Quantitative research might bolster teacher practitioner knowledge that intuitively supports these linkages.

6.3 Summary and Recommendations

The results of the findings from this study suggest teachers must devote significantly more instructional time and effort to creative instructional strategies in order to develop creative problem-solving among today's youth. Improving creative problem-solving skills of students will not happen without a change in teacher beliefs about the importance and priority of creative problem-solving/thinking and creative instructional strategies. Making a change may seem daunting to a teacher who largely uses non-creative, teacher-directed, didactic instructional strategies such as Lecture, Teacher Instructing or Laboratory. As a starting point, teachers can choose one of the simpler, more manageable creativity-inspiring methods: a creative instructional strategy like Inquiry Based Learning; questioning using Bloom's higher-order thinking for one unit of study using the word cues found in Appendix D; or a creative activity such as Divergent and Convergent Thinking on a single topic. Once a theoretical or atheoretical understanding of the strategy has been gained, an instructional change can be set in motion by implementing the method in class, evaluating progress and making improvements, at all points involving students in the teacher's process of learning the strategy. The students in this study were thrilled to try creative instructional strategies, and had excellent and insightful ideas about the process, and how to tailor the strategies to their learning style and educational needs. They wanted to be heard and respected as co-planners in the educational journey, a long-standing adult learning principle. I believe students everywhere want to be regarded in the same way.

The world beyond high school is increasingly dealing with ill-structured problems. Those problems identified as environmental may be the most critical in years to come, determining many aspects of human lifestyle and, perhaps, humanity's very existence, along with the future of millions of other species on Earth. Educators, policy makers and curriculum writers are charged with designing and providing the best learning experience for students to meet these challenges. Whether the issue is environmental or it can be found in another realm of human endeavour, a global demand has been clearly voiced for students to become creative problem-solvers, innovators and critical thinkers who can engage in a process that creates useful and original outcomes, that constructs new knowledge, that utilizes contemplation and action. Our futures depend on it.

References

Adams, J. (1980). *Conceptual blockbusting* (2nd ed.). New York: Norton.

Akella, D. (2010). Learning together: Kolb's experiential theory and its application, *Journal of Management & Organization*, *16*(1), 110-112.

Aljughaiman, A. & Mowrer-Reynolds, E. (2005). Teachers' conceptions of creativity and creative students. *Journal of Creative Behavior, 39*, 17-34.

Anderson, L. W. & Krathwohl, D. R. (2001). *A Taxonomy for learning, teaching and assessing: A revision of Bloom's Taxonomy*. New York. Longman.

Baer, J. & Garrett, T. (2010). Teaching for creativity in an era of content standards and accountability. In R. A. Beghetto & J. C. Kaufman (Eds.), *Creativity in the classroom* (pp. 6-23). New York: Cambridge University Press.

Baldwin, A. Y. (2010). A look outside the box in classrooms. In R. A. Beghetto & J. C. Kaufman (Eds.), *Creativity in the classroom* (pp. 73-87). New York: Cambridge University Press.

Barlow, M. (2008, February 8). Allan Gregg in conversation. (A. Gregg, Interviewer) *TVO*. Retrieved March 15, 2011 from http://www.tvo.org/TVOsites/WebObjects/TVO.woa?b?9076831202526033000

Barron, F. (1995). The disposition toward originality. *Journal of Abnormal and Social Psychology, 51*, 478-485.

Beghetto, R. A. & Kaufman, J. C. (2010). Broadening conceptions of creativity in the classroom. In R. A. Beghetto & J. C. Kaufman (Eds.), *Creativity in the classroom* (pp. 191-205). New York: Cambridge University Press.

Beghetto, R. A. & Plucker, J. A. (2006). The relationship among schooling, learning and creativity: "All roads lead to creativity" or "You can't get there from here". In J. C. Kaufman & J. Baer (Eds.), *Reason and creativity in development* (pp. 316-332). New York: Cambridge University Press.

Bennett, B., Rolheiser-Bennett, N. C., & Stevahn, L. (1991). *Cooperative learning: Where heart meets mind: An interactive resource book*. Toronto: Educational Connections.

Birley, G., & Moreland, N. (1998). *A practical guide to academic research*. Kogan Page.

Bloom, B. S., Engelhart, M. D., Furst, E.J., Hill, W. H., & Krathwohl, D. R. (1956). Taxonomy of educational objectives: The classification of educational goals. New York: Mckay.

Bronson, P., & Merryman, A. (2010, July 10). The creativity crisis. *Newsweek*. Retrieved from http://www.newsweek.com/2010/07/10/the-creativity-crisis.html

Bruner, J. S. (1961). The act of discovery. *Harvard Educational Review, 31* (pp. 21-32).

Chan, C. K. (2010). Classroom innovation for the Chinese learner: Transcending dichotomies and transforming pedagogy. In C. K. Chan & N. Rao (Eds.), *Revisiting the Chinese learner: Changing contexts, changing education* (Vol. 25) (pp. 169-210). Springer Netherlands.

Clapham, M. M. (2011). Testing/measurement/assessment. In M. A. Runco & S. R. Pritzker (Eds.), *Encyclopedia of creativity* (Vol 2, pp. 458-464). Two-Volume Set: Online Version. Academic Press. Retrieved July 17, 2015 from <http://www.myilibrary.com?ID=311870>

Clover, D. (1995). Theoretical foundations and practice of critical environmental adult education in Canada. *Convergence, 28*(4), 44. Retrieved July 2, 2007, from Professional Development Collection database.

Clover, D. E. (1999). *Learning patterns of landscape and life: Towards a learning framework for environmental adult education* (Ph.D. dissertation). Retrieved June 30, 2007, from ProQuest Digital Dissertations database.

Clover, D. E. (2002). Environmental adult education. *Adult Learning, 13*(2/3), 2-6.

Creswell, J. W., Plano Clark, V. L., Gutmann, M. L., & Hanson, W. E. (2003). Advanced mixed methods research designs. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research*, (pp. 209-240). Thousand Oaks, CA: Sage.

DCAL, DE, DETI, DHFETE. (2000). *Unlocking creativity: A strategy for development*. Retrieved August 10, 2011, from nidirect: Department of Culture, Arts and Leisure: http://www.dcalni.gov.uk/index/arts_and_creativity/unlocking_creativity_-_a_strategy_for_developement.pdf

DCAL, DE, DETI, DHFETE. (2004, April 7). *Unlocking creativity: A creative region*. Retrieved August 10, 2011, from nidirect: Department for Employment and Learning: http://www.delni.gov.uk/es/index/publications/pubs-misc/unlocking-creativity.htm

Dewey, J. (1938). *Education and experience*. New York: Simon and Schuster.

Dewey, J. (1961). *Democracy and education*. New York: Macmillan.

Dishke Hondzel, C., Hansen, R., Sørebø Guilliksen, M., & Lindfors, E. (2014, May). Creativity and the environment: Looking at differences between Canadian, Norwegian and Finnish Students on the TTCT. Paper presented at the *Canadian Society for the Study of Education Annual Conference,* St. Catharines ON.

Dunlap, R. (2008). The new environmental paradigm scale: From marginality to worldwide use. *The Journal of Environmental Education, 40*(1), 3-18.

Dyer, G. (2009, July 3). Climate wars: Allan Gregg in conversation. (A. Gregg, Interviewer). *TVO*. Retrieved from http://www.tvo.org/TVOsites/WebObjects/TVO.woa?b?9078351246672800000

Dyer, J. H., Gregersen, H. B., & Christensen, C. M. (2011). *The innovator's DNA: Mastering the five skills of disruptive innovators*. Boston: Harvard Business Press.

Forehand, M. (2005). Bloom's taxonomy: Original and revised. In M. Orey (Ed.), *Emerging perspectives on learning, teaching, and technology*. Retrieved October 16, 2014, from http://projects.coe.uga.edu/epltt/

Fullan, M. (2013). *Great to excellent: Launching the next stage of Ontario's education agenda*. Retrieved July 27, 2014 from http://www.michaelfullan.ca/media/13599974110.pdf

Good, T. L. & Brophy, J. E. (1991). *Looking in classrooms*. New York: HarperCollins.

Handwerk, B. (2003, March 25). Belize Reef die-off due to climate change? *National Geographic News*. Retrieved August 8, 2011, from http://news.nationalgeographic.com/news/2003/03/0325_030325_belizereefs.html

Hansen, R. (2008, Nov). *Human Ingenuity Research Project.* Paper read at the 5th Annual International Conference on Technology Education Research. Griffith Institute for Educational Research, Brisbane, Australia.

Healey, M., & Jenkins, A. (2000). Kolb's experiential learning theory and its application in geography in higher education. *Journal of Geography, 99*(5), 185-195. Retrieved April 6, 2015 from http://www.tandfonline.com/doi/pdf/10.1080/00221340008978967

Homer-Dixon, T. (1995). The ingenuity gap: Can poor countries adapt to resource scarcity? *Population and Development Review, 21*(3), 587-612.

Hong, N. S. (1998). *The relationship between well-structured and ill-structured problem-solving in multimedia simulation* (Doctoral dissertation). Retrieved from http://www.cet.edu/pdf/structure.pdf

Hung, W., Jonassen, D. H., & Liu, R. (2008). Problem-based learning. *Handbook of research on educational communications and technology, 3*, 485-506.

IBM. (2010). *Capitalizing on complexity: Insights from the global chief executive officer study*. Somers, NY: IBM Institute for Business Value. Retrieved June 15, 2011 from http://public.dhe.ibm.com/common/ssi/ecm/en/gbe03297usen/GBE03297USEN.PDF

Illeris, K. (2007). What do we actually mean by experiential learning? *Human Resource Development Review, 6*(1), 84-95. Retrieved from http://search.proquest.com/docview/221820562?accountid=15115

Jamieson, B. (2006). State of the Teaching Profession 2006: Back in the day…. *Professionally Speaking: A newsletter for Ontario teachers*. Retrieved Aug 3, 2014 from http://professionallyspeaking.oct.ca/september_2006/survey.asp

Johnson, D. W., Johnson, R. T., & Holubec, E. J. (1990). *Cooperation in the classroom* (rev. Ed.). Edina, MN: Interaction Book.

Jonassen, D. H. (1997). Instructional design models for well-structured and ill-structured problem-solving learning outcomes. *Educational Technology Research and Development*, *45*(1), 65-94. Retrieved from http://www.webkelley.com/HBS/ID%20Models%20for%20Well-Structured.pdf

Kim, K. H. (2011). The creativity crisis: The decrease in creative thinking scores on the Torrance Tests of Creative Thinking. *Creativity Research Journal, 23*(4), 285-295. Retrieved July 13, 2015 from http://journals1.scholarsportal.info.proxy1.lib.uwo.ca/pdf/10400419/v23i0004/285_tcctditttoct.xml

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist, 41*(2), 75-86.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice Hall.

Kolb, D. A., Boyatzis, R. E., & Mainemelis, C. (2001). Experiential learning theory: Previous research and new directions. In R. J. Sternberg & L. Zhang (Eds.), *Perspectives on thinking, learning, and cognitive styles* (pp. 227-249). New Jersey: Lawrence Erlbaum.

Kolm, J. (2013). Why are so many of Canada's young people out of work? *CBC News*. Posted: Jun 21, 2013. Retrieved July 31, 2014 from http://www.cbc.ca.proxy1.lib.uwo.ca/news/canada/why-are-so-many-of-canada-s-young-people-out-of-work-1.1370260

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview, *Theory Into Practice*, *41*(4), 212-218, DOI: 10.1207/s15430421tip4104_2

Krathwohl, D. R., & Anderson, L. W. (2010). Merlin C. Wittrock and the revision of Bloom's taxonomy, *Educational Psychologist*, *45*(1), 64-65, DOI: 10.1080/00461520903433562

Lin, Y. (2011). Fostering creativity through education – A conceptual framework of creative pedagogy. *Creative Education, 2*, 149-155. doi: 10.4236/ce.2011.23021.

Lovgren, S. (2004, April 26). Warming to cause catastrophic rise in sea level? *National Geographic News*. Retrieved August 8, 2011, from http://news.nationalgeographic.com/news/ 2004/04/0420_040420_earthday.html

Mackin, J. (1996). A creative approach to physics teaching. *Physics Education, 31*(4), 199-202.

Merriam, S. B. (1988). *Case study research in education: A qualitative approach*. San Francisco, CA: Jossey-Bass.

Merriam, S. B. (2002). *Qualitative research in practice: Examples for discussion and analysis*. San Francisco, CA: Jossey-Bass.

Morris, A., & Staggenborg, S. (2004). Leadership in social movements. In D.A. Snow, S. A. Soule & H. Kriesi (Eds.), *The Blackwell companion to social movements* (pp. 171-196). Malden, MA: John Wiley & Sons.

Mourshed, M., Chijioke, C., & Barber, M. (2010). How the world's most improved school systems keep getting better. *McKinsey & Company*. Retrieved July 28, 2014, from http://mckinseyonsociety.com/downloads/reports/Education/How-the-Worlds-Most-Improved-School-Systems-Keep-Getting-Better_Download-version_Final.pdf

National Advisory Committee on Creative and Cultural Education. (1999). *All our futures: Creativity, culture and education*. London: Department for Education and Employment (DFEE).

Nickerson, R. S. (2010). How to discourage creative thinking in the classroom. In R. A. Beghetto & J. C. Kaufman (Eds.), *Creativity in the classroom* (pp. 73-87). New York: Cambridge University Press.

Nijstad, B. A., & Paulus, P. B. (2003). *Group creativity: Innovation through collaboration*. New York: Oxford University Press.

Ontario College of Teachers. (2006). Teachers love their jobs despite high stress. Toronto, Ont.: Ontario College of Teachers. Retrieved Aug 3, 2014 from https://www.oct.ca/public/media/press-releases/2006/20060828

Ontario College of Teachers. (2013). *Transition to teaching 2013*. Toronto, Ont.: Ontario College of Teachers. Retrieved Aug 3, 2014 from http://www.oct.ca/-/media/PDF/Transition%20to%20Teaching%202013/EN/TransitionToTeaching2013.pdf

Ontario. Declining Enrolment Working Group. (2009). *Planning and possibilities*. Toronto, ON: Ontario. Retrieved from http://www.edu.gov.on.ca/eng/policyfunding/DEWG.pdf

Ontario Envirothon Teacher's Guide (n.d.). About the Envirothon. Retrieved April 27, 2015, from http://www.ontarioenvirothon.on.ca/index.php/teacherguide

Ontario Ministry of Education and Training [MET]. (2010). *The Ontario Curriculum, Grades 9 and 10: The Arts*. Retrieved Sept 20, 2011, from http://www.edu.gov.on.ca/eng/curriculum/secondary/arts910curr2010.pdf

Ontario Ministry of Education. (2005). *The Ontario Curriculum, Grades 9-12: Canadian and World Studies.* Retrieved March 28, 2015, from http://www.edu.gov.on.ca/eng/curriculum/secondary/canworld1112curr.pdf

Ontario Ministry of Education. (2008). *Specialist High Skills Major: Sector-Specific Guide: The Environment: Draft, 2007-2008*. Retrieved September 16, 2011, from http://www.edu.gov.on.ca/eng/studentsuccess/pathways/shsm/environment.pdf

Ontario Ministry of Education. (2010). *Specialist High Skills Major: Policy and Implementation*. Retrieved Sept 23, 2011, from http://www.edu.gov.on.ca/morestudentsuccess/SHSMBinder.pdf

Ontario Ministry of Education. (2011). *The Ontario Curriculum, Grades 9-12: Environmental Education Scope and Sequence of Expectations Resource Guide*. Retrieved March 28, 2015, from http://www.edu.gov.on.ca/eng/curriculum/secondary/environ9to12curr.pdf

Ontario Ministry of Education. (2013). *The Ontario Curriculum, Grades 1 to 6. Social Studies; Grades 7 and 8, History and Geography*. Toronto, ON: Queen's Printer.

Ontario Ministry of Education. (2015). *The Ontario Curriculum, Grades 11 and 12. Canada and World Studies*. Toronto, ON: Queen's Printer.

Paulus, P. B. (2000). Groups, teams, and creativity: The creative potential of idea-generating groups. *Applied Psychology, 49*(2), 237-262. doi:10.1111/1464-0597.00013

Pedaste, M., Mäeots, M., Siiman, L. A., de Jong, T., van Riesen, S. A., Kamp, E. T., Manoli, C. C., Zacharia, Z. C., Tsourlidaki, E., & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review, 14*, 47-61.

Phillips, D. C. (1995). The good, the bad, and the ugly: The many faces of constructivism. *Educational Researcher*, 5-12.

Piaget, J. (1967). The mental development of the child. *Six psychological studies*, 10-17.

Plucker, J. A., & Dow, G. T. (2010). Attitude change as the precursor to creativity enhancements. In R. A. Beghetto & J. C. Kaufman (Eds.), *Creativity in the classroom* (pp. 73-87). New York: Cambridge University Press.

Pollack, H. L. (1988). Questioning strategies to encourage critical thinking. *Insights into Open Education 21*, (1) (09): 11, Accessed July 24, 2015 from http://search.proquest.com/docview/63118900?accountid=15115 ().

Ramos, J. L. S., Dolipas, B. B., & Villamor, B. B. (2013). Higher order thinking skills and academic performance in physics college students: A regression analysis. *International Journal of Innovative Interdisciplinary Research, 4*, 48-60.

Runco, M. A. (1999). Tactics and strategies for creativity. In M. A. Runco & S. Pritzker (Eds.), *Encyclopedia of creativity* (Vol 2, pp. 611-615). San Diego, CA: Academic Press.

Runco, M. A. (2003). Education for creative potential. *Scandinavian Journal of Educational Research, 47*(3), 317-324.

Runco, M. A. (2007). *Creativity. Theories and themes: Research, development and practice.* Burlington, MA: Elsevier Academic Press.

Runco, M. A. (2008). Creativity and education. *New Horizons in Education*, *56*(1). Retrieved October 19, 2014 from http://files.eric.ed.gov/fulltext/EJ832901.pdf

Runco, M. A. (2011). Personal creativity. In M. A. Runco & S. R. Pritzker (Eds.), *Encyclopedia of creativity* (Vol 2, pp. 220-223). Two-Volume Set: Online Version. Academic Press. Retrieved July 17, 2015 from http://www.myilibrary.com? ID=311870

Runco, M. A., & Kim, D. (2011). The four Ps of creativity: Person, product, process, and press. In M. A. Runco & S. R. Pritzker (Eds.), *Encyclopedia of creativity* (Vol 1, pp. 534-537). Two-Volume Set: Online Version. Academic Press. Retrieved July 17, 2015 from <http://www.myilibrary.com?ID=311870>

Russell, C. L., & Bell, A. C. (1996). A politicized ethic of care: Environmental education from an ecofeminist perspective. In K. Warren (Ed.), *Women's voices in experiential education* (pp. 172-181). Dubuque, Iowa: Kendall/Hunt.

Sallam, S. S., & Krockover, G. H. (1982). The effect of inquiry in geosciences instruction on the attitudes and creativity of junior high/middle school science teachers. *School Science & Mathematics, 82*(4), 279-283.

Schamel, D., & Ayres, M. P. (1992). The minds-on approach: Student creativity and personal involvement in the undergraduate student laboratory. *Journal of College Science Teacher*, *21*(4), 226-229.

Schwartz, B., & Millar, G. (1996). You are what you ask—the power of teaching students' questioning skills for enabling thinking. Presented at the Annual SAGE conference proceedings: *Faces of Excellence*. Calgary, Alberta: Centre for Gifted Education.

Scott, C. L. (1999). Teachers' biases toward creative children. *Creativity Research Journal*, *12*, 321-337.

Shaunessy, E. (2000). Questioning techniques in the gifted classroom. *Gifted Child Today, 23*(5), 14-21.

Shymansky, J. A., & Penick, J. E. (1981). Teacher behaviour does make a difference in hands-on science classrooms. *School Science and Mathematics, 81*(5), 412-422.

Simonton, D. K. (2004). *Creativity in science: Chance, logic, genius, and zeitgeist*. Cambridge, UK: Cambridge University Press.

Song, G., Kwan, C. Y., Bian, Z., Tai, B., & Wu, Q. (2005). Perspectives: Exploratory thoughts concerning educational reform with problem-based learning in China. *Teaching and Learning in Medicine, 17*(4), 382-384.

Stake, R. E. (1978). The case study method in social inquiry. *Educational Researcher*, 5-8.

Statistics Canada. (n.d.). *Data and definitions: Box 1 geography definitions*. Last updated June 29, 2009. Accessed July 14, 2015 from http://www.statcan.gc.ca/pub/21-006-x/2008002/def-eng.htm

Steffen, A. (2009, Feb 27). Bright green, light green, dark green, gray: The new environmental spectrum. *World Changing*. Retrieved 08 May 2015 from http://www.worldchanging.com/archives/009499.html

Stokes, P. D. (2010). Using constraints to develop creativity in the classroom. In R. A. Beghetto & J. C. Kaufman (Eds.), *Creativity in the classroom* (pp. 88-112). NY: Cambridge University Press.

Treffinger, D. J., Renzulli, J. S., & Feldhusen, J. F. (1971). Problems in the assessment of creative thinking. *The Journal of Creative Behavior, 5*, 104-111.

U.S. Dept. of Homeland Security/U.S. Coast Guard. (2011). *On scene coordinator report on Deepwater Horizon Oil Spill* (Report). September 2011. Retrieved Sept 6, 2014 from http://www.uscg.mil/foia/docs/DWH/FOSC_DWH_Report.pdf

Weisberg, R. (2010). The study of creativity: From genius to cognitive science. *International Journal of Cultural Policy, 16*(3), 235-253.

Weyler, R. (2009, July 7). *Deep green: Overshoot and tech dreams*. Greenpeace International. Retrieved May 13, 2015 from http://www.greenpeace.org/international/en/about/deep-green/deep-green-june-09/

Wideen, M. F., O'Shea, T., Pye, I., & Ivany, G. (1997). High-stakes testing and the teaching of science. *Canadian Journal of Education / Revue canadienne de l'éducation, 22*(4), 428-444.

Wilhelm, J. D. (2014). Learning to love the questions: How essential questions promote creativity and deep learning. *Knowledge Quest 42*, (5): 36-41, Accessed July 24, 2015 from http://search.proquest.com/docview/1651836788?accountid=15115.

Yin, R. K. (2003). *Case study research: Design and methods*. Thousand Oaks, CA: Sage.

Yin, R. K. (2011). *Qualitative research from start to finish*. New York: Guilford Press.

Zabarenko, D. (2007, March 4). Global warming is human rights issue: Nobel nominee. Retrieved August 8, 2011, from *Reuters* http://www.reuters.com/article/2007/03/06/dcbrights-globalwarming-rights-dc-idUSN0227026920070306

Zalasiewicz, J., Williams, M., Steffen, W., & Crutzen, P. (2010). The new world of the anthropocene. *Environmental Science & Technology, 44*(7), 2228-2231.

Appendices

Appendix A: Comprehensive Questionnaire Data

Table 2: Attitudes about Creativity (Students at School A)

Activity	*Current Frequency of Use*				
	Student (n=19)				
	never (%)	*rarely (%)*	*sometimes (%)*	*often (%)*	*always (%)*
1. What one activity, hobby or school subject do you have strong abilities, have done a lot of, and leads to confidence in yourself?	Responses were not quantified				
2. If you were given a challenge or problem around that one activity, hobby or school subject, would you be able to come up with several interesting and unique solutions?	0	5	11	47	37
3. Could you use your imagination and come up with some wild and crazy solutions?	0	11	26	37	26
4. If you could work with someone else who had as strong abilities, experience and confidence as you do, would you be able to come up with even more interesting and unique solutions?	0	0	21	32	47
5. Are you the kind of person who is often able to come up with interesting and unique solutions to challenges or problems in other areas outside of this class?	0	5	32	37	26
6. Do you think that you get opportunities in this class to come up with interesting and unique solutions to challenges or problems?	0	5	37	37	21
7. Do you think that all your classes in the SHSM-E program help you develop your problem solving ability to come up with interesting and unique solutions to challenges and problems?	0	5	26	53	16

Table 3: Instructional Strategies, Current Usage (Students at School A)

Creative Strategies			*Non-Creative Strategies*		
Strategy	*Often (%)*	*Always (%)*	*Strategy*	*Often (%)*	*Always (%)*
Problem Based Learning	63	0	Teacher Instructing	53	11
Inquiry Based Learning	16	5	Lecture	32	5
Experiential Learning	37	37	Teacher Demonstration	53	11
Class Discussion	47	11	Checking Work	58	5
			Assessment	11	0
			Seatwork	53	0
			Laboratory	5	0

Table 4: Instructional Strategies, Preference (Students at School A)

Creative Strategies			*Non-Creative Strategies*		
Strategy	*Like (%)*	*Strongly Like (%)*	*Strategy*	*Like (%)*	*Strongly Like (%)*
Problem Based Learning	53	42	Teacher Instructing	53	6
Inquiry Based Learning	58	16	Lecture	53	0
Experiential Learning	22	78	Teacher Demonstration	74	21
Class Discussion	58	42	Checking Work	79	11
			Assessment	26	5
			Laboratory	53	11
			Seatwork	28	0

Table 5: Instructional Strategies, Desired Future Usage (Students at School A)

Creative Strategies			*Non-Creative Strategies*		
Strategy	*Same Amount (%)*	*More Often (%)*	*Strategy*	*Same Amount (%)*	*More Often (%)*
Problem Based Learning	47	37	Teacher Instructing	79	0
Inquiry Based Learning	42	42	Lecture	63	0
Experiential Learning	53	47	Teacher Demonstration	68	26
Class Discussion	37	63	Checking Work	84	11
			Assessment	63	5
			Laboratory	53	16
			Seatwork	53	0

Table 6: Creative Activities, Frequency of Use (Students at School A)

Activity	*Current Frequency of Use*				
	Student (n=19)				
	never (%)	*rarely (%)*	*sometimes (%)*	*often (%)*	*always (%)*
Divergent Thinking	0	5	42	42	11
Convergent Thinking	0	11	53	37	0
Become an Expert	0	11	53	32	5
Explore topics of personal interest	0	16	32	37	16
Trial and Error	0	16	32	32	16
Work together with partner or group on solving a challenge	0	5	5	47	42
Be an inventor	0	21	37	26	16

Table 7: Using Creativity in Solving Challenges in Class (Students at School A)

Activity	*Current Frequency of Use*				
	Student (n=19)				
	never (%)	*rarely (%)*	*sometimes (%)*	*often (%)*	*always (%)*
a) enjoy it?	0	0	26	47	26
b) successfully find many solutions?	0	0	32	58	11
c) have difficulty?	5	16	63	11	5
d) prefer to learn facts and ideas rather than coming up with interesting and unique solutions?	0	37	42	16	5
e) depend on the ideas of experts, from your textbook or teacher, rather than developing your own personal ideas?	5	37	47	11	0

Table 8: Questioning the Status Quo (Students at School A)

Activity	*Current Frequency of Use*				
	Student (n=19)				
	never (%)	*rarely (%)*	*sometimes (%)*	*often (%)*	*always (%)*
12a) In this class, do you ever question why things are done the way they are and whether they could be done in a more environmentally friendly way?	0	5	11	47	37
	Less Often (%)		*More Often (%)*		
12b) Would you like to question "why" more or less often in this class?	11		89		

Table 9: Innovation and Current Environmental Events (Students at School A)

Activity	*Current Frequency of Use*				
	Student (n=19)				
	never (%)	*rarely (%)*	*sometimes (%)*	*often (%)*	*always (%)*
13a) Examine actual environmental events, such as the Gulf Oil Spill, discuss what happened and suggest possible solutions or ways to prevent it?	0	0	32	47	21
13b) Explore new environmental ideas and solutions. For example, giant mirrors in space to block the sun, collecting drinking water from fog, or using chicken feathers to store fuel in nitrogen fuel cars.	0	16	42	37	5
13c) Discuss improvements to existing technology to make it more environmentally friendly. For example, can we make cars more fuel efficient by reducing their weight or can water used in the shower be re-used in flushing the toilet?	0	11	21	58	11

Table 10: Attitude and Perception of Human Ingenuity/Creative Problem-Solving (Teacher A)

How Important is Developing Student Human Ingenuity/Creative Problem Solving?	
	Important

Perceived Support for the Development of Human Ingenuity/Creative Problem-Solving in SHSM-E	
i) School Administration	*Neither Discourage/Encourage*
ii) Department Heads Or Divisional/Subject Area Teachers	*Encourage*
iii) School District Consultants, Superintendents, Director	*Discourage*
iv) Ontario Ministry of Education	*Neither Discourage/Encourage*
v) Other Educational Organizations You Deal With	*Encourage*
vi) Parents	*Neither Discourage/Encourage*
vii) Ontario Curriculum Documents (Ministry of Education Curriculum)	*Discourage*
viii) Other Curriculum You Use Or Are Familiar With	*Neither Discourage/Encourage*
ix) School District Professional Development	*Encourage*
x) School-Based Professional Development (e.g., Professional Learning Communities Or Action Research)	*Neither Discourage/Encourage*

Table 11: Instructional Strategies, Effectiveness (Teacher A)

Creative Strategies		*Non-Creative Strategies*	
Strategy	*Effectiveness*	*Strategy*	*Effectiveness*
Problem Based Learning	Very Effective	Teacher Instructing	Effective
Inquiry Based Learning	Very Effective	Laboratory	Effective
Experiential Learning	Very Effective	Lecture	Moderate
Class Discussion	Effective	Teacher Demonstration	Moderate
		Assessment	Moderate
		Seatwork	Little
		Checking Work	Little

Table 12: Creative Activities, Frequency of Use (Teacher A)

Activity	*Frequency of Use*
Divergent Thinking	Sometimes
Convergent Thinking	Often
Personal Meaning Making - Without Expert Opinion From Text, Teachers Or Other Authorities	Sometimes
Personally Exploring Topics That Interest Them	Often
Trial and Error	Often
Peer Collaboration - Partnerships Or Groups	Often
Development Of Original Ideas	Sometimes

Table 13: Bloom's Taxonomy, Frequency of Use (Teacher A)

Level	*Frequency of Use*	*Level*	*Frequency of Use*
Knowledge	Sometimes	Analysis	Often
Comprehension	Often	Synthesis	Sometimes
Application	Often	Evaluation	Sometimes

Table 14: How Students Deal With Challenges Involving Creativity (Teacher A)

i) They enjoy it	Often
ii) They achieve the desired learning outcome	Often
iii) They have difficulty	Often
iv) They prefer more traditional fact-based learning	Sometimes
v) They refer to expert (text, teacher, authority) opinion rather than personal opinion	Often

Table 15: Level of Achievement/Opportunity in Learning Activities (Teacher A)

Learning Activity	*Low=1 to High =5*
i) Questioning the status quo of	
(1) Products	5
(2) Processes	4
(3) Power relationships	4
ii) They achieve the desired learning outcome examining the impact of actual environmental events, speculating on what occurred and suggesting possible preventions, contingencies and solutions	4
iii) They have difficulty exploring new environmental innovations and technologies	4
iv) They prefer more traditional fact-based learning discussing improvements on existing innovations	3

Table 16: Effectiveness of SHSM-E Program Requirements in Developing Creative Problem-Solving (Teacher A)

SHSM-E Program Requirements	*Effectiveness*
i) Experiential learning activities	Very Effective
ii) Certifications and training programs	Moderately Effective
iii) Co-ops	Effective
iv) Reach ahead experiences	Effective
v) Career exploration activities	Moderately Effective

Table 17: Attitudes about Creativity (Students at School B)

Activity	*Current Frequency of Use*				
	Student (n=8)				
	never (%)	*rarely (%)*	*sometimes (%)*	*often (%)*	*always (%)*
1. What one activity, hobby or school subject do you have strong abilities, have done a lot of, and leads to confidence in yourself?	Responses were not quantified				
2. If you were given a challenge or problem around that one activity, hobby or school subject, would you be able to come up with several interesting and unique solutions?	0	0	13	63	25
3. Could you use your imagination and come up with some wild and crazy solutions?	0	13	13	25	50
4. If you could work with someone else who had as strong abilities, experience and confidence as you do, would you be able to come up with even more interesting and unique solutions?	0	0	25	0	75
5. Are you the kind of person who is often able to come up with interesting and unique solutions to challenges or problems in other areas outside of this class?	0	0	0	88	13
6. Do you think that you get opportunities in this class to come up with interesting and unique solutions to challenges or problems?	0	13	63	25	0
7. Do you think that all your classes in the SHSM-E program help you develop your problem solving ability to come up with interesting and unique solutions to challenges and problems?	13	25	50	13	0

Table 18: Instructional Strategies, Current Usage (Students at School B)

Creative Strategies			*Non-Creative Strategies*		
Strategy	*Often (%)*	*Always (%)*	*Strategy*	*Often (%)*	*Always (%)*
Problem Based Learning	38	0	Teacher Instructing	25	13
Inquiry Based Learning	38	0	Lecture	25	38
Experiential Learning	38	13	Teacher Demonstration	25	13
Class Discussion	75	0	Checking Work	38	0
			Assessment	0	0
			Laboratory	25	13
			Seatwork	53	0

Table 19: Instructional Strategies, Preference (Students at School B)

Creative Strategies			*Non-Creative Strategies*		
Strategy	*Like (%)*	*Strongly Like (%)*	*Strategy*	*Like (%)*	*Strongly Like (%)*
Problem Based Learning	50	38	Teacher Instructing	50	0
Inquiry Based Learning	50	25	Lecture	25	13
Experiential Learning	38	63	Teacher Demonstration	75	13
Class Discussion	50	25	Checking Work	38	13
			Assessment	25	0
			Laboratory	50	25
			Seatwork	25	0

Table 20: Instructional Strategies, Desired Future Usage (Students at School B)

Creative Strategies			*Non-Creative Strategies*		
Strategy	*Same Amount (%)*	*More Often (%)*	*Strategy*	*Same Amount (%)*	*More Often (%)*
Problem Based Learning	38	63	Teacher Instructing	50	13
Inquiry Based Learning	25	50	Lecture	58	13
Experiential Learning	38	63	Teacher Demonstration	50	50
Class Discussion	25	50	Checking Work	50	25
			Assessment	38	13
			Laboratory	50	38
			Seatwork	63	0

Table 21: Creative Activities, Frequency of Use (Students at School B)

Activity	*Current Frequency of Use*				
	Student (n=8)				
	never (%)	*rarely (%)*	*sometimes (%)*	*often (%)*	*always (%)*
Divergent Thinking	0	0	63	38	0
Convergent Thinking	0	25	13	63	0
Become an Expert	0	25	38	0	38
Explore topics of personal interest	0	25	25	50	0
Trial and Error	0	13	75	13	0
Work together with partner or group on solving a challenge	0	0	25	38	38
Be an inventor	0	38	38	25	0

Table 22: Using Creativity in Solving Challenges in Class (Students at School B)

Activity	*Current Frequency of Use*				
	Student (n=8)				
	never (%)	*rarely (%)*	*sometimes (%)*	*often (%)*	*always (%)*
a) enjoy it?	0	0	63	13	25
b) successfully find many solutions?	0	0	38	38	25
c) have difficulty?	0	38	38	25	0
d) prefer to learn facts and ideas rather than coming up with interesting and unique solutions?	0	13	38	50	0
e) depend on the ideas of experts, from your textbook or teacher, rather than developing your own personal ideas?	13	50	13	25	0

Table 23: Questioning the Status Quo (Students at School B)

Activity	*Current Frequency of Use*				
	Student (n=8)				
	never (%)	*rarely (%)*	*sometimes (%)*	*often (%)*	*always (%)*
12a) In this class, do you ever question why things are done the way they are and whether they could be done in a more environmentally friendly way?	13	0	38	38	13
	Less Often (%)	*More Often (%)*			
12b) Would you like to question "why" more or less often in this class?	13	88			

Table 24: Innovation and Current Environmental Events (Students at School B)

Activity	*Current Frequency of Use*				
	Student (n=8)				
	never (%)	*rarely (%)*	*sometimes (%)*	*often (%)*	*always (%)*
13a) Examine actual environmental events, such as the Gulf Oil Spill, discuss what happened and suggest possible solutions or ways to prevent it?	0	38	38	25	0
13b) Explore new environmental ideas and solutions. For example, giant mirrors in space to block the sun, collecting drinking water from fog, or using chicken feathers to store fuel in nitrogen fuel cars.	13	13	13	63	0
13c) Discuss improvements to existing technology to make it more environmentally friendly. For example, can we make cars more fuel efficient by reducing their weight or can water used in the shower be re-used in flushing the toilet?	0	25	25	25	25

Table 25: Attitude and Perception of Human Ingenuity/Creative Problem-Solving (Teacher B)

How Important is Developing Student Human Ingenuity/Creative Problem Solving?	
	Important

Perceived Support for the Development of Human Ingenuity/Creative Problem-Solving in SHSM-E	
i) School Administration	*Neither Discourage/Encourage*
ii) Department Heads Or Divisional/Subject Area Teachers	*Encourage*
iii) School District Consultants, Superintendents, Director	*Neither Discourage/Encourage*
iv) Ontario Ministry of Education	*Highly Encourage*
v) Other Educational Organizations You Deal With	*Highly Encourage*
vi) Parents	*Neither Discourage/Encourage*
vii) Ontario Curriculum Documents (Ministry of Education Curriculum)	*Encourage*
viii) Other Curriculum You Use Or Are Familiar With	*Encourage*
ix) School District Professional Development	*Neither Discourage/Encourage*
x) School-Based Professional Development (e.g., Professional Learning Communities Or Action Research)	*Neither Discourage/Encourage*

Table 26: Instructional Strategies, Effectiveness (Teacher B)

Creative Strategies		*Non-Creative Strategies*	
Strategy	*Effectiveness*	*Strategy*	*Effectiveness*
Problem Based Learning	Effective	Teacher Instructing	Effective
Inquiry Based Learning	Moderate	Lecture	Ineffective
Experiential Learning	Very Effective	Teacher Demonstration	Effective
Class Discussion	Effective	Checking Work	Effective
		Assessment	Little
		Seatwork	Little
		Laboratory	Very Effective

Table 27: Creative Activities, Frequency of Use (Teacher B)

Activity	*Frequency of Use*
Divergent Thinking	Rarely
Convergent Thinking	Sometimes
Personal Meaning Making - Without Expert Opinion From Text, Teachers Or Other Authorities	Rarely
Personally Exploring Topics That Interest Them	Sometimes/Often
Trial and Error	Often
Peer Collaboration - Partnerships Or Groups	Often
Development Of Original Ideas	Rarely

Table 28: Bloom's Taxonomy, Frequency of Use (Teacher B)

Level	*Frequency of Use*	*Level*	*Frequency of Use*
Knowledge	Sometimes	Analysis	Sometimes
Comprehension	Sometimes	Synthesis	Sometimes
Application	Often	Evaluation	Sometimes

Table 29: How Students Deal With Challenges Involving Creativity (Teacher B)

i) They enjoy it	Rarely
ii) They achieve the desired learning outcome	Sometimes
iii) They have difficulty	Often
iv) They prefer more traditional fact-based learning	Often
v) They refer to expert (text, teacher, authority) opinion rather than personal opinion	Always

Table 30: Level of Achievement/Opportunity in Learning Activities (Teacher B)

Learning Activity	*Low=1 to High =5*
i) Questioning the status quo of	
(1) Products	2
(2) Processes	2
(3) Power relationships	1
ii) They achieve the desired learning outcome examining the impact of actual environmental events, speculating on what occurred and suggesting possible preventions, contingencies and solutions	3
iii) They have difficulty exploring new environmental innovations and technologies	4
iv) They prefer more traditional fact-based learning discussing improvements on existing innovations	2

Table 31: Effectiveness of SHSM-E Program Requirements in Developing Creative Problem-Solving (Teacher B)

SHSM-E Program Requirements	*Effectiveness*
i) Experiential learning activities	Very Effective
ii) Certifications and training programs	Effective
iii) Co-ops	Very Effective
iv) Reach ahead experiences	Very Effective
v) Career exploration activities	Moderately Effective

Appendix B: Letters of Information and Consent; UWO Ethics Approval

The UNIVERSITY of WESTERN ONTARIO

LETTER OF INFORMATION/CONSENT TO PARTICIPATE IN RESEARCH

Dear Student;

INTRODUCTION

I am a Masters Student from the Faculty of Education at the University of Western Ontario and the information I am collecting will be used in my thesis and is being conducted under the supervision of Dr. Ronald Hansen and Dr. Immaculate Namukasa.

PURPOSE OF THIS STUDY

You are being invited to participate in a research study looking at creative problem solving, also known as human ingenuity, in the Specialist High Skills Major – Environment program. The title of my research is: "The learning of human ingenuity in a formal environmental education program: A case study."

The purpose of this letter is to provide you with the information you require to make an informed decision on participating in this research.

HOW MANY PEOPLE WILL BE ENROLLED AND HOW LONG THIS STUDY WILL LAST

You will be one of approximately 30 students in this school and 30 students in another Ontario school who will be asked to participate in this study. All the students in your class and your teacher will be invited to participate in the study.

This study will be completed in your classroom during your regular class time. Overall, the study will take place every day over approximately 2 weeks.

RESEARCH PROCEDURES FOR THIS STUDY

1. If you take part in this study, you will be asked to complete a questionnaire about your learning in the Specialist High Skills Major – Environment class. The questionnaire will take approximately 30 minutes to complete.
2. You may also be asked to participate in one or two interviews with the researcher to expand on some of your questionnaire responses. These interviews will take about 10-15 minutes each. The interviews will be audio-recorded and transcribed into written form.
3. You will also be observed and may be asked to clarify and explain interesting answers or solutions that you give in class.
4. I may also ask you if I may copy documents, such as written notes or assignments, in order to provide more detailed information for the period of the school year for which I was not present in the classroom.

RISKS AND DISCOMFORTS TO YOU IF YOU PARTICIPATE IN THIS STUDY

There are no known risks to your participation in this study.

THE BENEFITS TO YOU IF YOU TAKE PART IN THIS STUDY

You will not get a personal benefit from participation in this research, but your participation may help us get new knowledge that may benefit future students in this program.

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect on your academic status.

Additionally, this study is an opportunity to give university students experience in doing research. It is a training and teaching exercise. Please note that it will not affect my grade if you decide that you do not want to participate, or decide to withdraw part way through the study.

CONFIDENTIALITY

Your confidentiality will be respected. The information collected will be used for research purposes only and neither your name, nor information which could identify you or your school will be used in any publication or presentation of the study results.

When collecting information, your name will be paired with a code number, which will appear on all your written materials. The list pairing your name to the code number assigned to you will be kept private and separate from the other research materials.

Students who choose not to participate will be given an opportunity to work on an alternative project associated with environmental awareness, in order to protect their confidentiality.

IF ADDITIONAL INFORMATION IS REQUIRED

If you have any questions about this study, please contact:

Brian Smith, [redacted], [redacted]
Dr. Ronald Hansen, [redacted], [redacted]
Dr. Immaculate Namukasa [redacted], [redacted]

If you have any questions about your rights as a research subject, you may contact:

Office of Research Ethics
The University of Western Ontario
[redacted]

This letter is yours to keep for future reference.

Brian Smith

The Learning of Human Ingenuity in a Formal Environmental Education Program: A Case Study

Brian Smith (Master's Candidate, Faculty of Education, UWO)
Dr. Ronald Hansen (Professor Emeritus, Faculty of Education, UWO)
Dr. Immaculate Namukasa (Assistant Professor, Faculty of Education, UWO)

CONSENT FORM

I have read the Letter of Information, have had the nature of the study explained to me and I agree that my child may participate in the study. All questions have been answered to my satisfaction.

Name of Student (please print): ____

Signature of Student: ____

Name of Parent/Guardian (please print): ____

Signature: ____

Date: ________________________________

The UNIVERSITY of WESTERN ONTARIO

LETTER OF INFORMATION/CONSENT TO PARTICIPATE IN RESEARCH

Dear Teacher;

INTRODUCTION

I am a Masters Student from the Faculty of Education at the University of Western Ontario and the information I am collecting will be used in my thesis and is being conducted under the supervision of Dr. Ronald Hansen and Dr. Immaculate Namukasa.

PURPOSE OF THIS STUDY

You are being invited to participate in a research study looking at creative problem solving, also known as human ingenuity, in the Specialist High Skills Major – Environment program. The title of my research is: "The learning of human ingenuity in a formal environmental education program: A case study."

The purpose of this letter is to provide you with the information you require to make an informed decision on participating in this research.

HOW MANY PEOPLE WILL BE ENROLLED AND HOW LONG THIS STUDY WILL LAST

You will be one of two teachers who will be asked to participate in this multi-site, multi-school district study. All the students in each of these classes (approximately 30) will also be asked to participate in the study. Overall, the study will take place every day over approximately 2 weeks.

RESEARCH PROCEDURES FOR THIS STUDY

This study employs a case study methodology and, consequently, seeks to gather data from multiple sources.

1. If you take part in this study, you will be asked to complete a questionnaire about your teaching and student learning in your Specialist High Skills Major – Environment class. The questionnaire will take approximately 30 minutes to complete.
2. You will be asked to participate in two interviews with the researcher to expand on some of your questionnaire responses and to answer additional questions. The first interview after the completion of the questionnaire will take about 1 hour while the second interview, close to the completion of the study, will take about 30 minutes. The interviews will be audio-recorded and transcribed into written form.
3. You and the students in this class will be observed to contextualize the teaching/learning and to become familiar with key actors, procedures and the educational environment.
4. I would like to engage in some participant observation, in which I will take an overt, unobtrusive role in the classroom to deepen my understanding of the teaching/learning that are occurring.
5. You will also be asked to kindly share documentation, such as lesson and unit plans, in order to provide more detailed information and longitudinal data for the period of the school year for which I was not present in the classroom.

This study will be completed in your classroom during your regular class time and in other location(s) outside of class time, if more privacy is required.

RISKS AND DISCOMFORTS TO YOU IF YOU PARTICIPATE IN THIS STUDY

There are no known risks to your participation in this study.

THE BENEFITS TO YOU IF YOU TAKE PART IN THIS STUDY

You will not get a personal benefit from participation in this research, but your participation may help us get new knowledge that may benefit future students and teachers. There are possible benefits to Environmental Science, the Specialist High Skills Major – Environment program and society at large.

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect to you.

Additionally, this study is an opportunity to give university students experience in doing research. It is a training and teaching exercise. Please note that it will not affect my grade if you decide that you do not want to participate, or decide to withdraw part way through the study.

CONFIDENTIALITY

Your confidentiality will be respected. The information collected will be used for research purposes only and neither your name, nor information which could identify you or your school will be used in any publication or presentation of the study results.

When collecting information, your name will be paired with a code number, which will appear on all your written materials. The list pairing your name to the code number assigned to you will be kept private and separate from the other research materials.

IF ADDITIONAL INFORMATION IS REQUIRED

If you have any questions about this study, please contact:

Brian Smith, [redacted], [redacted]
Dr. Ronald Hansen, [redacted], [redacted]
Dr. Immaculate Namukasa, [redacted], [redacted]

If you have any questions about your rights as a research subject, you may contact:

Office of Research Ethics
The University of Western Ontario
[redacted]

This letter is yours to keep for future reference.

Brian Smith

The Learning of Human Ingenuity in a Formal Environmental Education Program: A Case Study

Brian Smith (Master's Candidate, Faculty of Education, UWO)
Dr. Ronald Hansen (Professor Emeritus, Faculty of Education, UWO)
Dr. Immaculate Namukasa (Assistant Professor, Faculty of Education, UWO)

CONSENT FORM

I have read the Letter of Information/Consent to Participate in Research, have had the nature of the study explained to me and I agree to participate. All questions have been answered to my satisfaction.

Name (please print): ____

Signature: ____

Date: _________________________________

Name of Person Obtaining Informed Consent:____

Signature of Person Obtaining Informed Consent:____

Date: __________________________________

THE UNIVERSITY OF WESTERN ONTARIO
FACULTY OF EDUCATION

Western
Education

USE OF HUMAN SUBJECTS - ETHICS APPROVAL NOTICE

Review Number:	1111-9
Principal Investigator:	Immaculate Namukasa
Student Name:	Brian Smith
Title:	*The Learning of Human Ingenuity in a Formal Environmental Education Program: A Case Study*
Expiry Date:	August 31, 2012
Type:	M.Ed. Thesis
Ethics Approval Date:	January 3, 2012
Revision #:	
Documents Reviewed & Approved:	UWO Protocol, Letters of Information & Consent

This is to notify you that the Faculty of Education Sub-Research Ethics Board (REB), which operates under the authority of The University of Western Ontario Research Ethics Board for Non-Medical Research Involving Human Subjects, according to the Tri-Council Policy Statement and the applicable laws and regulations of Ontario has granted approval to the above named research study on the date noted above. The approval shall remain valid until the expiry date noted above assuming timely and acceptable responses to the REB's periodic requests for surveillance and monitoring information.

During the course of the research, no deviations from, or changes to, the study or information/consent documents may be initiated without prior written approval from the REB, except for minor administrative aspects. Participants must receive a copy of the signed information/consent documentation. Investigators must promptly report to the Chair of the Faculty Sub-REB any adverse or unexpected experiences or events that are both serious and unexpected, and any new information which may adversely affect the safety of the subjects or the conduct of the study. In the event that any changes require a change in the information/consent documentation and/or recruitment advertisement, newly revised documents must be submitted to the Sub-REB for approval.

[redacted]

Dr. Alan Edmunds (Chair)

2011-2012 Faculty of Education Sub-Research Ethics Board

Dr. Alan Edmunds	**Faculty of Education (Chair)**
Dr. John Barnett	**Faculty of Education**
Dr. Farahnaz Faez	**Faculty of Education**
Dr. Wayne Martino	**Faculty of Education**
Dr. George Gadanidis	**Faculty of Education**
Dr. Elizabeth Nowicki	**Faculty of Education**
Dr. Immaculate Namukasa	**Faculty of Education**
Dr. Kari Veblen	**Faculty of Music**
Dr. Ruth Wright	**Faculty of Music**
Dr. Kevin Watson	**Faculty of Music**
Dr. Jason Brown	**Faculty of Education, Associate Dean, Research *(ex officio)***
Dr. Goli Rezai-Rashti	**Faculty of Education, Associate Dean, Graduate Programs *(ex officio)***
Dr. Susan Rodger	**Faculty of Education, UWO Non-Medical Research Ethics Board *(ex officio)***

The Faculty of Education [redacted] Karen Kueneman, Research Officer [redacted]

Copy: Office of Research Ethics

Appendix C: Student Questionnaire

Participant Code: # __________

Directions

This survey asks you about your learning in the Specialist High Skills Major - Environment program.

I am interested in how much creative problem solving is accomplished in your classroom. Creative problem solving is your ability to come up with interesting and unique solutions if you were given a challenge or problem.

The survey uses two types of questions. Question 1 is short answer. The remaining questions require you to circle the number that best describes your experience. Questions 9 and 10 ask you to circle one number from column 1 and another number from column 2.

1. What one activity, hobby or school subject do you have strong abilities, have done a lot of, and leads to confidence in yourself?

____

____

	Never	Rarely	Sometimes	Often	Always
2. If you were given a challenge or problem around that one activity, hobby or school subject, would you be able to come up with several interesting and unique solutions?	1	2	3	4	5
3. Could you use your imagination and come up with some wild and crazy solutions?	1	2	3	4	5
4. If you could work with someone else who had as strong abilities, experience and confidence as you do, would you be able to come up with even more interesting and unique solutions?	1	2	3	4	5
5. Are you the kind of person who is often able to come up with interesting and unique solutions to challenges or problems in other areas outside of this class?	1	2	3	4	5
6. Do you think that you get opportunities in this class to come up with interesting and unique solutions to challenges or problems?	1	2	3	4	5
7. Do you think that all your classes in the Specialist High Skills Major – Environment program helps you develop your problem solving ability to come up with interesting and unique solutions to challenges and problems?	1	2	3	4	5

Participant Code: # __________

8. **How often are the following ways of learning used in this class?**[i]

	Never	Rarely	Sometimes	Often	Always
a) Teacher instructing - The teacher usually calls on individual students to answer questions	1	2	3	4	5
b) Lecture - The teacher talks most of the time to teach information, ideas or skills	1	2	3	4	5
c) Class Discussion - The teacher leads a discussion to get students' opinions and ideas rather than "right" answers	1	2	3	4	5
d) Teacher demonstration - The teacher demonstrates how to do things (for example, how to use a microscope)	1	2	3	4	5
e) Checking work - The teacher leads a discussion to get the correct answers	1	2	3	4	5
f) Laboratory - An experiment or activity students do in which the <u>teacher</u> decides on the topic, hypotheses, procedures, what data to collect and how to analyze it, and conclusions	1	2	3	4	5
g) Assessment - In-class tests, quizzes and exams	1	2	3	4	5
h) Inquiry learning - An experiment or activity students do in which the <u>students</u> decide on the topic, hypotheses, procedures, what data to collect and how to analyze it, and conclusions	1	2	3	4	5
i) Experiential learning - Students are put into a real situation, even outside the classroom, in which students have to solve a challenge to meet a learning goal most often determined by the teacher	1	2	3	4	5
j) Problem Based Learning - The teacher presents a problem in class that might happen beyond the classroom. Students take on a role to become someone who had to actually solve the problem. Students work together to decide how to tackle the problem, come up with a plan, gather important information and come up with their best possible solution	1	2	3	4	5
k) Seatwork - Completion of textbook or teacher assigned questions/handouts	1	2	3	4	5

Participant Code: # __________

9. Indicate how much you like each of the following ways of learning and if you would like to do them more or less often in this class. Circle the number, in the first column and the second column, which best matches your feelings.

	How much do you like or dislike?				Would like to do…		
a) Teacher instructing - The teacher usually calls on individual students to answer questions.	Strongly Dislike 1	Dislike 2	Like 3	Strongly Like 4	Less Often 1	Same Amount 2	More Often 3
b) Lecture - The teacher talks most of the time to teach information, ideas or skills.	Strongly Dislike 1	Dislike 2	Like 3	Strongly Like 4	Less Often 1	Same Amount 2	More Often 3
c) Class Discussion - The teacher leads a discussion to get students' opinions and ideas rather than "right" answers	Strongly Dislike 1	Dislike 2	Like 3	Strongly Like 4	Less Often 1	Same Amount 2	More Often 3
d) Teacher demonstration - The teacher demonstrates how to do things (for example, how to use a microscope).	Strongly Dislike 1	Dislike 2	Like 3	Strongly Like 4	Less Often 1	Same Amount 2	More Often 3
e) Checking work - The teacher leads a discussion to get the correct answers.	Strongly Dislike 1	Dislike 2	Like 3	Strongly Like 4	Less Often 1	Same Amount 2	More Often 3
f) Laboratory - An experiment or activity students do in which the teacher decides on the topic, hypotheses, procedures, what data to collect and how to analyze it, and conclusions.	Strongly Dislike 1	Dislike 2	Like 3	Strongly Like 4	Less Often 1	Same Amount 2	More Often 3
g) Assessment - In-class tests, quizzes and exams.	Strongly Dislike 1	Dislike 2	Like 3	Strongly Like 4	Less Often 1	Same Amount 2	More Often 3
h) Inquiry learning - An experiment or activity students do in which the students decide on the topic, hypotheses, procedures, what data to collect and how to analyze it, and conclusions.	Strongly Dislike 1	Dislike 2	Like 3	Strongly Like 4	Less Often 1	Same Amount 2	More Often 3
i) Experiential learning - Students are put into a real situation, even outside the classroom, in which students have to solve a challenge to meet a goal most often determined by the teacher.	Strongly Dislike 1	Dislike 2	Like 3	Strongly Like 4	Less Often 1	Same Amount 2	More Often 3
j) Problem Based Learning - The teacher presents a problem in class that might happen beyond the classroom. Students take on a role to become someone who had to actually solve the problem. Students work together to decide how to tackle the problem, come up with a plan, gather important information and come up with their best possible solution.	Strongly Dislike 1	Dislike 2	Like 3	Strongly Like 4	Less Often 1	Same Amount 2	More Often 3
k) Seatwork - The completion of textbook or teacher assigned questions/handouts.	Strongly Dislike 1	Dislike 2	Like 3	Strongly Like 4	Less Often 1	Same Amount 2	More Often 3

Participant Code: # __________

10. Indicate whether you do each of the following activities in this class and if you would like to do them more or less often. Circle the number, in the first column and the second column, which best matches your experience and feelings.

	How often do you do the activity?					Would like to do...		
a) Come up with unique and different ideas; brainstorming.	Never 1	Rarely 2	Sometimes 3	Often 4	Always 5	Less Often 1	Same Amount 2	More Often 3
b) Narrow a group of ideas and decide which one is the best.	Never 1	Rarely 2	Sometimes 3	Often 4	Always 5	Less Often 1	Same Amount 2	More Often 3
c) Become an expert by determining your own understanding and definitions rather than depending on opinions from textbooks and teachers.	Never 1	Rarely 2	Sometimes 3	Often 4	Always 5	Less Often 1	Same Amount 2	More Often 3
d) Personally explore topics that interest you through discussion, books, the Internet or your own thoughts.	Never 1	Rarely 2	Sometimes 3	Often 4	Always 5	Less Often 1	Same Amount 2	More Often 3
e) Learn by trial and error. That is, try a solution to a problem, find an error and try to fix it with another solution. Keep going until the problem is solved.	Never 1	Rarely 2	Sometimes 3	Often 4	Always 5	Less Often 1	Same Amount 2	More Often 3
f) Work together with a partner or group on solving a challenge.	Never 1	Rarely 2	Sometimes 3	Often 4	Always 5	Less Often 1	Same Amount 2	More Often 3
g) Be an inventor: Come up with a new and unique idea to solve a challenge or a problem.	Never 1	Rarely 2	Sometimes 3	Often 4	Always 5	Less Often 1	Same Amount 2	More Often 3

11. When you and/or your group are given a challenge or problem in this class and have to come up with interesting and unique solutions, do you...

a) enjoy it?	Never 1	Rarely 2	Sometimes 3	Often 4	Always 5
b) successfully find many solutions?	Never 1	Rarely 2	Sometimes 3	Often 4	Always 5
c) have difficulty?	Never 1	Rarely 2	Sometimes 3	Often 4	Always 5
d) prefer to learn facts and ideas rather than coming up with interesting and unique solutions?	Never 1	Rarely 2	Sometimes 3	Often 4	Always 5
e) depend on the ideas of experts, from your textbook or teacher, rather than developing your own personal ideas?	Never 1	Rarely 2	Sometimes 3	Often 4	Always 5
f) Other: ____________________________________	Never 1	Rarely 2	Sometimes 3	Often 4	Always 5

Participant Code: # ________

12. **Some environmental advocates question why things are done the way they are and whether they could be done in a more environmentally friendly way. For example: Most products we buy are covered by plastic for 3-6 months, starting from their date of manufacture to when we use them. The plastic packaging takes over 500 years to decompose. Why do we use something for 6 months when this plastic garbage will last for over 500 years?**

	Never	Rarely	Sometimes	Often	Always
a) In this class, do you ever question why things are done the way they are and whether they could be done in a more environmentally friendly way?	1	2	3	4	5

	Question "Why" Less Often	Question "Why" More Often
b) Would you like to question "why" more or less often in this class?	1	2

13. **Indicate whether you do each of the following activities in this class.**

	Never	Rarely	Sometimes	Often	Always
a) Examine actual environmental events, such as the Gulf Oil Spill, discuss what happened and suggest possible solutions or ways to prevent it?	1	2	3	4	5
b) Explore new environmental ideas and solutions. For example, giant mirrors in space to block the sun, collecting drinking water from fog, or using chicken feathers to store fuel in nitrogen fuel cars.	1	2	3	4	5
c) Discuss improvements to existing technology to make it more environmentally friendly. For example, can we make cars more fuel efficient by reducing their weight or can water used in the shower be re-used in flushing the toilet?	1	2	3	4	5

14. **Indicate whether you would like to do the following activities in this class more or less often?**

	Do Less Often	Do More Often
a) Examine actual environmental events, such as the Gulf Oil Spill, discuss what happened and suggest possible solutions or ways to prevent it?	1	2
b) Explore new environmental ideas and solutions. For example, giant mirrors in space to block the sun, collecting drinking water from fog, or using chicken feathers to store fuel in nitrogen fuel cars.	1	2
c) Discuss improvements to existing technology to make it more environmentally friendly. For example, can we make cars more fuel efficient by reducing their weight or can water used in the shower be re-used in flushing the toilet?	1	2

---

[i] Adapted from Wideen, M. F., O'Shea, T., Pye, I., & Ivany, G. (1997). High-Stakes Testing and the Teaching of Science. *Canadian Journal of Education/Revue canadienne de l'éducation, 22* (4), 428-444.

Appendix D: Teacher Questionnaire

Participant Code: # ________

Directions

This survey asks you about teaching and learning in the Specialist High Skills Major – Environment (SHSM-E) program only. It is not asking you about teaching and learning in other classes or your teaching and learning experiences in general.

I am interested in how much creative problem solving (macro- and micro-level) is accomplished in your SHSM-E classroom. Creative problem solving, or human ingenuity, is defined as "the aptitude and ability to solve problems through experience with originality and imagination."

	Unimportant	Of Little Importance	Moderately Important	Important	Very Important
1. How important to you is developing the human ingenuity/creative problem solving of students?	1	2	3	4	5

2. How much does each of the following either encourage or discourage the development of human ingenuity/creative problem solving in your teaching in the SHSM-E program?

	Highly Discourage	Discourage	Neither Discourage nor Encourage	Encourage	Highly Encourage
a) School administration	1	2	3	4	5
b) Department heads or divisional/subject area teachers	1	2	3	4	5
c) School district consultants, superintendents, director	1	2	3	4	5
d) Ontario Ministry of Education	1	2	3	4	5
e) Other educational organizations you deal with	1	2	3	4	5
f) Parents	1	2	3	4	5
g) Ontario Curriculum documents (Ministry of Education curriculum)	1	2	3	4	5
h) Other curriculum you use or are familiar with	1	2	3	4	5
i) School district professional development	1	2	3	4	5
j) School-based professional development (for example, professional learning communities or action research)	1	2	3	4	5

Participant Code: # ________

3. **How would you rate the following instructional strategies/instructional formats used for fostering the creative problem solving skills of adolescents in the SHSM-E program?**[1]

Instructional strategy/format	Ineffective	Of Little Effect	Moderately Effective	Effective	Very Effective
a) Teacher instructing - Relatively short exchanges between the teacher and students, in which the teacher usually calls on individual students to answer questions	1	2	3	4	5
b) Lecture - The teacher talks most of the time to impart information, ideas or skills	1	2	3	4	5
c) Class Discussion - Teacher led discussion to elicit opinions and ideas rather than "right" answers from students	1	2	3	4	5
d) Teacher demonstration - The teacher demonstrates skills, methods and procedures	1	2	3	4	5
e) Checking work - Teacher led discussion to elicit correct answers to teacher assigned work	1	2	3	4	5
f) Laboratory - Experimentation and hands-on Investigations in which the majority of components (topic, hypotheses, procedures, data collection, data analysis, conclusions) are determined by the teacher	1	2	3	4	5
g) Assessment - Individual, in-class tests, quizzes and exams	1	2	3	4	5
h) Inquiry learning - Experimentation and hands-on Investigations in which the majority of components (topic, hypotheses, procedures, data collection, data analysis, conclusions) are determined by students	1	2	3	4	5
i) Experiential learning - Students are immersed in a real situation in which they actively engage in skill and knowledge development and problem-solving to achieve a learning outcome	1	2	3	4	5

Participant Code: # ________

3. **How would you rate the following instructional strategies/instructional formats used for fostering the creative problem solving skills of adolescents in the SHSM-E program? (continued)**

	Ineffective	Of Little Effect	Moderately Effective	Effective	Very Effective
j) Problem Based Learning - The teacher presents a rich, concrete problem with basic background information to students, who assume roles as real stakeholders with ownership. They decide how to tackle the problem by extracting key information and searching for connections, generate and evaluate hypotheses, engage in research to determine missing information and determine their best possible solution	1	2	3	4	5
k) Seatwork - Completion of textbook or teacher assigned questions or handouts	1	2	3	4	5

4. **What other instructional strategies, instructional formats or pedagogies do you use which, in your view, support ingenuity/creative problem solving?**

____

____

____

____

____

5. **How often do students in the SHSM-E program engage in the following activities?**

	Never	Rarely	Sometimes	Often	Always
a) Divergent thinking - coming up with unique or different ideas; brainstorming	1	2	3	4	5
b) Convergent thinking - narrowing and combining ideas for a best end result	1	2	3	4	5
c) Personal meaning making - determining their own definitions or understanding without expert opinion from text, teachers or other authorities	1	2	3	4	5
d) Personally exploring topics that interest them through discussion, print and electronic media, or self reflection	1	2	3	4	5
e) Trial and error	1	2	3	4	5
f) Peer collaboration - partnerships or groups	1	2	3	4	5
g) Development of original ideas	1	2	3	4	5

Participant Code: # ________

6. **What levels of Bloom's Taxonomy[ii] are achieved in the SHSM-E program in your opinion?**

	Never	Rarely	Sometimes	Often	Always
a) Knowledge - observation and recall of information; knowledge of dates, events, places; knowledge of major ideas; mastery of subject matter *Question Cues: define, describe, identify, label, list, name, quote, show, tabulate*	1	2	3	4	5
b) Comprehension - understanding information; grasp meaning; translate knowledge into new context; interpret facts, compare, contrast; order, group, infer causes; predict consequences *Question Cues: associate, contrast, describe, differentiate, discuss, distinguish, estimate, extend, interpret, predict*	1	2	3	4	5
c) Application - use information; use methods, concepts, theories in new situations; solve problems using required skills or knowledge *Questions Cues: apply, calculate, change, complete, classify, demonstrate, discover, examine, experiment, illustrate, modify, relate, show, solve*	1	2	3	4	5
d) Analysis - seeing patterns; organization of parts; recognition of hidden meanings; identification of components *Question Cues: analyze, arrange, classify, compare, connect, divide, explain, infer, order, select, separate*	1	2	3	4	5
e) Synthesis - use old ideas to create new ones; generalize from given facts; relate knowledge from several areas; predict, draw conclusions *Question Cues: combine, compose, create, formulate, generalize, integrate, invent, modify, plan, design, prepare, rearrange, rewrite, substitute, what if?*	1	2	3	4	5
f) Evaluation - compare and discriminate between ideas; assess value of theories, presentations; make choices based on reasoned argument; verify value of evidence; recognize subjectivity *Question Cues: assess, compare, conclude, convince, decide, discriminate, explain, grade, judge, measure, rank, recommend, select, summarize, support, test*	1	2	3	4	5

7. **When students have the opportunity to use creative problem solving/human ingenuity (that is, come up with several interesting and unique solutions to challenges or problems), do they...**

	Never	Rarely	Sometimes	Often	Always
a) enjoy it?	1	2	3	4	5
b) achieve the desired learning outcome?	1	2	3	4	5
c) have difficulty?	1	2	3	4	5
d) prefer more traditional fact-based learning?	1	2	3	4	5
e) refer to expert (text, teacher, authority) opinion rather than personal opinion?	1	2	3	4	5
f) Other: ______________________________	1	2	3	4	5

Participant Code: # ________

8. **What level of achievement/opportunity in the SHSM-E program is reached in the following?**

a) questioning the status quo of					
i. products (for example, why is non-biodegrade plastic packaging for consumer products used for such temporary purposes?)	Low 1	2	3	4	High 5
ii. processes (for example, are municipal programs diverting all possible recyclables from landfill?)	Low 1	2	3	4	High 5
iii. power relationships (for example, why do governments not take a stronger stand against commercial polluters?)	Low 1	2	3	4	High 5
b) examining the impact of actual environmental events (for example, Gulf Oil Spill), speculating on what occurred and suggesting possible preventions, contingencies and solutions	Low 1	2	3	4	High 5
c) exploring new environmental innovations and technologies	Low 1	2	3	4	High 5
d) discussing improvements on existing innovations	Low 1	2	3	4	High 5

9. **How would you rate the following learning approaches in terms of effectiveness in developing human ingenuity/creative problem solving in the SHSM-E program?**

a) Experiential learning activities	Ineffective 1	Of Little Effect 2	Moderately Effective 3	Effective 4	Very Effective 5
b) Certifications and training programs	Ineffective 1	Of Little Effect 2	Moderately Effective 3	Effective 4	Very Effective 5
c) Co-ops	Ineffective 1	Of Little Effect 2	Moderately Effective 3	Effective 4	Very Effective 5
d) Reach ahead experiences	Ineffective 1	Of Little Effect 2	Moderately Effective 3	Effective 4	Very Effective 5
e) Career exploration activities	Ineffective 1	Of Little Effect 2	Moderately Effective 3	Effective 4	Very Effective 5

[i] Adapted from Wideen, M. F., O'Shea, T., Pye, I., & Ivany, G. (1997). High-Stakes Testing and the Teaching of Science. *Canadian Journal of Education/Revue canadienne de l'éducation, 22* (4), 428-444.

[ii] Retrieved from http://coun.uvic.ca/learning/exams/blooms-taxonomy.html

Curriculum Vitae

Name:	Brian Douglas Smith
Post-secondary Education and Degrees:	The University of Western Ontario London, Ontario, Canada **1982-1986**
	University of Waterloo Waterloo, Ontario, Canada **1986-1988,** B.A.
	The University of Western Ontario London, Ontario, Canada **1989-1990**, B.Ed.
	The University of Western Ontario London, Ontario, Canada **2005-2015,** M. Ed.
Related Work Experience	Elementary School Teacher London District Catholic School Board **2004-present**
	Family Literacy Conference Committee London DCSB, Curriculum Services (English and Literacy) **May 2005 - May 2006**
	Inquiry Based Learning Implementation Committee London DCSB, Curriculum Services (Science and Technology) **Jan 2004 - June 2006**
	Elementary School Teacher York Catholic District School Board **1992-1998**
	EQAO Math Assessment Pre-Marking Team **Nov - Dec 1996**
	Elementary School Supply Teacher Various Boards of Education **Sept 1990 - June 1991**