COMPUTATIONAL THINKING AND VISUAL PROGRAMMING: CODING FOR GRADERS 6-7 IN BC’S NEW CURRICULUM

by

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We accept the Process Paper as conforming to the required standard.

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Abstract

The 2015 BC Education Plan discussed the important role technology would play in our students' lives. Computational Thinking was one change made to BC's New Curriculum to reflect the demands our students now face in a digital world. However, I believe, simply acknowledging the importance of computational thinking in the Education Plan and making it a curricular choice for educators to implement does not provide the majority of educators in BC the resources or background with which to effectively teach coding. Thus, the purpose of this project was to create a coding website resource to enable intermediate students and educators to help meet the strong curricular expectations of the BC Curriculum. To help do this, the Critical Challenge Question was posed, ‘How can intermediate students be engaged to deepen their learning through collaborative game design and coding?’ I believe the project website will provide a strong unit of study, however, each professional should always seek out additional skills and knowledge which they find additionally important. Therefore, professional development and personal learning is highly recommended for any teacher considering introducing coding to their students.

The project can be found at the following web address: [http://bckidscode.weebly.com/](http://bckidscode.weebly.com/).

A companion teacher resource site is available at [http://codingquest.weebly.com](http://codingquest.weebly.com).

*Keywords: BC Education Plan, BC’s New Curriculum, Computational Thinking, Coding*
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A final thank-you to Dominique Sullivan, Educational Technology Advisory Group (ETAG) member, for keeping me advised of current school district FIPPA practices and for her support with current coding practices.
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Chapter 1 – Introduction

Context for the Major Project

The internet and technology have vastly changed how we go about our daily lives. We can now digitally track packages, including our pizza orders, freely access a plethora of information on the internet and even create our own internet channels to earn a living. These ongoing changes have provided educational institutions the essential task of preparing people with the knowledge, skills and attitudes to be successful in an ever changing technologically driven world. The BC Education Plan (2015) reflected such changes in the following quote. “To ensure students are able to thrive in an increasingly digital world, BC’s Education Plan must continue to support quality learning empowered by technology.” For me, after thirteen years teaching in the public school system, I felt like it was time to modernize my own education in an attempt to better meet the needs of my future students.

Thus, my learning journey to attempt to remain current with these prevalent changes in our educational system and a technologically driven world began. In September of 2015, I entered the Online Learning and Teaching graduate Diploma (OLTD) program at Vancouver Island University which culminated in the Fall of 2017 with enrollment in the Masters in Education Leadership (MEdL) program. Upon entering the OLTD program, I was very excited about gaining the knowledge that would allow me to appropriately use technology to enhance my teaching. I was immediately impacted during the first course, OLTD 501: Introduction to Online Learning, as I learned about educationally sound practices in terms of online education. As I worked my way through the program, I continued to adjust my educational pedagogy and teaching based on current research which in turn positively impacted my classroom instructional
practices. It was near the end of my first year in the OLTD program when BC’s New Curriculum (2016) was released and included new content such as Computational Thinking and Digital Literacy. It was at this point I decided to learn more about the role of coding in this new curriculum. It was a second quote from the BC Education Plan (2015) which peaked my interest in the use of coding at the intermediate school level.

The economies of industrialized countries are also in the midst of dramatic change. More than ever, the economic imperative is to ensure young people entering the workforce have the lifelong skills and competencies that employers are increasingly looking for: creative thinking, problem solving, initiative, curiosity, and the ability to lead and work well in groups.

Furthermore, “Seven million job openings in 2015 were in occupations that required coding skills, and programming jobs overall are growing 12% faster than the market average.” (Dishman, 2016). The types of skills being promoted by the quote were very similar to the skills which could potentially be learned during visual programming and game design. As An (2016) stated, “Recent studies show that game design has the potential to help students develop a range of skills, including creative thinking, critical reasoning, storytelling, visual design, problem solving, and audience awareness skills.” There was such a strong overlap in skill sets that I felt the necessity to learn about visual programming, and game design through coding to support my intermediate students with this important 21st Century skill.

It was during my second year of the OLTD program when I decided to further enhance my learning journey by applying for a Special Education Technology - British Columbia (SET BC) Classroom Based Projects 2016-2017 - Coding Grant. This afforded me the opportunity to work with several other educators from around the province. We would communicate our
learning twice a month through online teleconferencing and via blogging. This was a great way to share our ideas, plans, and results as we all progressed through our ten-month coding journey with our own students.

During my implementation of the SET BC Coding Grant (2016/2017 school year) I realized there was not a lot of structured or organized learning in terms of the new visual programming (Coding) curriculum. As I navigated my way through the SET BC Coding Grant I discovered what worked and what didn’t work through the implementation of the visual programming curriculum with students. I discovered some excellent online resources such as Hour of Code and Scratch. These sites were student friendly, provided some scaffolding, and allowed students to personalize and share their projects. However, as students developed their projects more autonomously there were few additional scaffolds to support their learning. There was no student self-reflection included to allow for student metacognition, and some students became overwhelmed with the amount of freedom they had when designing their projects. In their paper, Lye & Koh (2014), discussed how many students are expected to learn through “trial and error” when placed into the visual programming environment. “There seems to be an implicit assumption that learners can exhibit such computational practices and perspectives through pure self-discovery” (2014). It was this laissez faire approach to coding which made me recognize the need for a more structured educational approach.

The completion of my BC Coding Grant occurred simultaneously with OLTD 508: Mobile Learning and Gaming, where my learning involved current and emerging research around educational gaming theory. I was especially impacted by Jim Paul Gee’s Principles on Gaming and how many of his principles could be used to help create a thorough and educationally structured coding curriculum for intermediate students in BC.
The creation of this interactive online unit of study was meant to answer the Critical Challenge Question: ‘How can intermediate students be engaged to deepen their learning through collaborative game design and coding?’

Computational Thinking

“In recent years, the availability of free and user-friendly programming languages has fueled the interest of researchers and educators to explore how computational thinking can be introduced in K-12 contexts” (Lye & Koh, 2014). As of September 2015, the BC Ministry of Education began to implement changes to the provincial curriculum. A new subject heading, Applied Design, Skills, and Technologies (ADST), emerged and included the new content heading of Computational Thinking (CT). Under the CT umbrella of learning is Visual Programming which includes programs such as Scratch and Kudo (B.C.’s New Curriculum - Province of British Columbia, 2017). These curricular adjustments mark changes in a technologically-driven world where there is an inherent need for students to understand and gain the CT skills necessary to compete for jobs in the global marketplace. For instance, in the United States, “seven million job openings in 2015 were in occupations that required coding skills, and programming jobs overall are growing 12% faster than the market average” (Dishman, 2016). However, “teaching programming can be a very difficult task. Therefore, suitable educational tools and strategies must support programming courses, so that any individual may become proficient in programming and may further develop their thinking abilities in a reasonable time” (Buitrago Flórez et al., 2017).

The BC ADST curriculum for grades 6-8 allows teachers a wide range of topics to choose from and many teachers have most likely focused their teaching on personally familiar content under the ADST umbrella. The purpose of this Major Project was to create a course to
introduce Computational Thinking through coding at the intermediate school level, Grades 6-8, which provided those teachers with minimal to no CT teaching experience with a functional tool to help implement visual programming curriculum.

“Over the last decade, computer science and programming have grown remarkably and have permeated several fields, such as Biology, Chemistry, Physics, Medicine, Engineering, Art, Music, and Social Sciences” (Buitrago Flórez et al., 2017). This growing need for programming experience, and today’s increasingly technology-driven society, have created the demand for increased knowledge and expertise with programming. For BC educators, implementing visual programming curricula for intermediate students has become the first step in preparing students for many of the aforementioned 21st Century occupations.

**Major Project Overview**

This unit of study was designed for intermediate students, Grades 6-7, to successfully learn how to code using programs such as Scratch. The intention was to provide a more structured approach for students to gain coding skills. This project was hosted on the Weebly website platform due to my previous experience using this web authoring tool.

The next step in the development of this project was to compile a number of reflective practices for each of the coding lessons. These lessons were further developed integrating Gee’s Game Design Principles to allow for proper scaffolding. Strategies for skill repetition were provided and scaffolds for achievable learning goals were applied.

Most of the lessons of this unit were directly accessed from the Scratch website and modified or adopted to suit the expectations of this Major Project.
Key Deliverables

The overall purpose of this Project was to provide intermediate school teachers and students an interactive website which meets the requirements of BC’s New Curriculum (2016) and at the same time provides those educators with little to no coding experience a very useable tool for teaching coding. It is important to note that this was primarily a qualitative study with no formal Ethical Review required as direct qualitative research on human subjects was not employed.

Definition of Terms

Table 1. Definition of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algorithm</td>
<td>A series of instructions on how to accomplish a task. An algorithm is a sequence of instructions written to perform a specified task.</td>
<td>“Code.org Glossary” and Vocabulary list.</td>
</tr>
<tr>
<td>Algorithmic thinking</td>
<td>Design simple steps or rules to solve each of the smaller</td>
<td>“Teachers’ Guide to Computational Thinking”</td>
</tr>
<tr>
<td>----------</td>
<td>----------------------------------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Conditions</td>
<td>Conditions are if, then, statements that modify how code is executed. They tell the computers what to do and when to do it. For example, if the password is correct, then allow access to the program.</td>
<td>“Code.org Glossary” and Vocabulary list.</td>
</tr>
<tr>
<td>Debugging</td>
<td>The act of finding and fixing a problem within the code to allow the computer program to work properly.</td>
<td>“Code.org Glossary” and Vocabulary list.</td>
</tr>
<tr>
<td>---</td>
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</tr>
<tr>
<td>Function</td>
<td>A piece of code that can be called over and over.</td>
<td>“Code.org Glossary” and Vocabulary list.</td>
</tr>
<tr>
<td>Loops</td>
<td>Repeat a portion of code a set number of times until a process is complete. Loops help save time and minimize errors.</td>
<td>“Code.org Glossary” and Vocabulary list.</td>
</tr>
<tr>
<td>Parameters</td>
<td>Extra bits of information that you can pass into a function to customize it.</td>
<td>“Code.org Glossary” and Vocabulary list.</td>
</tr>
<tr>
<td>Sequences</td>
<td>The order that commands are executed by the computer</td>
<td>Kodable Elementary Programming Curriculum</td>
</tr>
</tbody>
</table>
which allows us to carry out tasks that have multiple steps.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Store information in a program. Variables control the output of the program or what the user sees. The three types of variables include strings, integers and arrays.</th>
</tr>
</thead>
</table>

**Project Timeline**

Table 2. Project Timeline

<table>
<thead>
<tr>
<th>June-December 2017</th>
<th>Website build underway. Ch 1 and Ch 2 developed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 10-January 30, 2018</td>
<td>Chapter 1 completed (Supervisor review.) Ch. 2 additions and revisions as required. Website build continues.</td>
</tr>
<tr>
<td>February 1-March 1</td>
<td>Chapter 3 completed (Supervisor review.) Ch. 2 additions and revisions as required. Website build continues.</td>
</tr>
<tr>
<td>March 1-March 15</td>
<td>Website build completed. (v.1)</td>
</tr>
<tr>
<td>March 15-March 22</td>
<td>Call for Reviewer Feedback. Feedback results collated.</td>
</tr>
<tr>
<td>March 22-April 7</td>
<td>Ch. 4 completed (Supervisor review.) Website build completed. (v.2)</td>
</tr>
</tbody>
</table>
April 7- May 7  |  Ch. 5 completed. Supervisor final review of completed Process Paper.

May 15         |  Process Paper submitted for APA review and final signoff.

This project was informed by a comprehensive Literature Review presented as Chapter 2 of this Process Paper.
Chapter 2 – Literature Review

Introduction

The British Columbia Ministry of Education began a three-year curriculum redesign process in the 2015/2016 school year. One purpose of this redesign was to “provide students with an education that is flexible and innovative” (B.C.’s New Curriculum - Province of British Columbia, 2017). Almost any electronic device requires code (computer programs) to make it operate. Code is a set of instructions a computer uses to perform intended functions. Introducing Scratch, a user-friendly programming tool, at the intermediate level is part of the Ministry’s plan to provide students with the means to be successful in today’s technology driven world. The notion of game design being an important aspect to student’s learning is also gaining momentum. For instance, Akcaoglu (2014) states, “today’s complex and fast-evolving world necessitates young students to possess design and problem-solving skills more than ever.” Further supporting Akcaoglu is An (2016) stating that there are many higher-level thinking skills which are learned through the process of game design. Moreover, as (Prensky, 2008) suggests, game design is a “process of creation that includes modelling, designing, testing and a lot of meta-learning in between and within phases. As a result, game creation by students will make schools a truly engaging learning environment.” In an era of readily available technology, research is beginning to show that collaborative game design, through student coding, is an important element of the redesigned B.C. curriculum. With the curricular implementation of coding the question then becomes: ‘How can intermediate students be engaged to deepen their learning through collaborative game design and coding?’
Problem Solving and 21st Century Learning

The 2015 BCEdPlan Focus on Learning lists critical thinking and problem solving as an essential competency which must be developed by today’s students (Ministry of Education, 2015). Jonassen poses an important notion, “problem solving is generally regarded as the most important cognitive activity in everyday and professional contexts” (2000). However, historically problem solving learned at schools has involved generalized thinking skills and knowledge which are applied to structured problems that do not resemble real life problems (Akcaoglu, 2014). In addition, “this misalignment between what is emphasized in schools and what students face outside does not adequately prepare them for the challenges of the everyday and professional contexts” (Jonassen, 2000). Gershenfeld describes possible challenges and professional contexts mentioned by Jonassen in the following.

Making a good game requires not only a deep understanding of technology, art, interactive design, project management, and marketing, but also the ability to work with diverse teams and skill sets, continually solve problems, iterate based on quantitative and qualitative feedback, and work within constrained budgets and schedules (2011).

Therefore, the skills acquired through collaborative game design in terms of coding have an inherently important role in the future of education.

Game Design

 Scratch, by the MIT Media Lab is a free of charge, drag and drop, block programming environment. According to Ke, “Scratch is user-friendly for school children who can learn mathematical and computational ideas by creating and sharing Scratch projects” (2014). Brennan, & Resnick describe Scratch as a programming environment “that enables young people to create their own interactive stories, games, and simulations, and then share those
creations in an online community with other young programmers from around the world” (2012).

As An states, “when designing computer games, students become active learners, creators, and producers rather than consumers of computer games” (2016). In addition, when game design is based on coding, the learning “includes developing sequences, understanding triggers and events, parallel processes, and working with conditionals, operators and variables” (Falloon, 2016). Importantly, what the research demonstrates is increased learning in both content knowledge and skill development. Supporting this is Learning by Design (LBD), a middle school science program used to study design-based learning showed “that LBD students consistently learned earth and physical science content as well, or better than, comparison students and performed significantly better in scientific experiment design, analysis, collaboration, and metacognitive skills” (Ke, 2014).

Brennan & Resnick, (2012), created a framework to study and assess three aspects of Computational Thinking (CT) to study Scratch. The three areas of study included computational concepts, computational practices and computational perspectives. Computational concepts are based on the student’s understanding of programming as they set the coding blocks and create; “sequences, loops, events, parallelism, conditionals, operators and data storage/retrieval.” Computational practices investigated the strategies used to build code. Practices reflect the “how you are learning and include: being incremental and iterative, testing and debugging, reusing and remixing, and abstracting and modularizing.” Lastly, computational perspectives based on “expressing, connecting and questioning” gave the author's insight into the students’ self-expression, social interactions/collaboration, and critique of
technologies. Brennan and Resnick’s framework is useful for teachers because it describes how to effectively implement computational thinking skills within game design (coding) curriculum.

Akcaoglu, (2014), conducted a nine-session experimental study on game design using Microsoft Kodu software. The sessions involved four different activities which included: game design (3 sessions), problem solving (3 sessions), troubleshooting (1 session) and free design (1 session). During the game design sessions students learned how to use, or program, the Kudo software. Complex problems were then presented to the students followed by the “explicit teaching of thinking skills” (Akcaoglu, 2014) to help solve the problems. The troubleshooting phase involved students searching for missing code, or debugging code, to make the program work more effectively. Lastly, the free design session allowed students to explore and create their own game. The purpose of the study was to provide data on the cognitive benefits of problem solving in terms of the following three types of problems: “system analysis and design, decision making, and troubleshooting” (Akcaoglu, 2014). Although no notable gains were shown in troubleshooting, “students showed significant improvements in their system analysis and design, and decision-making skills” (Akcaoglu, 2014). The author notes three important aspects to this study. The first suggests that the design process was inherently engaging which may have led to the improvements in decision making skills seen throughout the study. Secondly, the study may have been limited due to the students being “self-selected from upper-middle class families” (Akcaoglu, 2014). Lastly, the different methods of instruction may have been another limiting factor as teachers have different levels of expertise teaching problem-solving skills.

**Student Engagement.** Hsieh, Lin, & Hou, (2015), conducted a study, using coding, based on student engagement which was measured in a qualitative manner by monitoring
student’s verbal and nonverbal behaviors. Smiling and screen focus are two examples of nonverbal behaviors which were measured. Private speech or verbal behaviors included things like self-questioning and murmuring. The study by Hsieh, et al, (2015), also noted that there was no gender inequity when it comes to engagement and achievement. “By connecting obvious nonverbal and verbal behaviors, this study visualized the learning process and provided evidence that the game can consistently increase students’ engagement in the game-based learning environment” (Hsieh et al., 2015). The author acknowledged that this was not an in-depth field of study and there is much more to be investigated to supply further results.

**Collaboration and Agency.** During a study of fifth grade students using Scratch to generate game designs based on science content, Baytak & Land, (2011), observed unstructured interactions which occurred during the design process of their study. They witnessed student to student and student to teacher collaboration taking place. “The teachers were also able to encourage informal sharing of strategies by referring some students’ questions to others who were knowledgeable in that area” (Baytak & Land, 2011). Students learned to improve their designs through “optimization strategies from each other” (Baytak & Land, 2011). Interestingly, students taking part in this study “did not appear to see anyone as the only expert, creating a social climate that encouraged a sense of agency (Barron et al. 1998) as cited by Baytak & Land. Additionally, An, describes how “students continually examined what they needed to know to further improve their designs, and their science and programming knowledge advanced through the cycle of design, testing, and redesign.”

**Knowledge Acquisition.** Similar to Scratch, GameSalad, a programming software, was used in a study to measure student growth in game design programming. GameSalad was used by eighth grade students to design two types of computer games. Pre-assessment surveys were
used to measure students’ prior knowledge of technology. During the sessions “Field notes, student responses to questions and surveys, and the student-constructed artifacts, were recorded and analyzed for changes in content knowledge” (Stiklickas, 2013). Stiklickas notes that although his study had some issues such as: the short duration of the study, a small student sample size, and student tardiness and absenteeism which may have affected the overall results, he was still able to determine that learning and growth took place. His results further demonstrated how students who created games using the GameSalad software and congruently learned about “technology/math/science content via the design process” showed significant learning in both math and technology content. Additionally, there was notable growth in the learning of science concepts. Overall, student game design was used successfully to deepen or increase student learning.

**Times of Change**

Gershenfeld, (2011), author and game designer for Activision, points to “…an era when video games were routinely vilified by politicians and dismissed by a great many parents and teachers as a frivolous waste of time.” Gershenfeld further states, “the process of creating a good video game requires a complex set of skills that maps closely to key competencies that students will need for productive lives and careers in the twenty-first century” (2011). This argument goes back several decades to Papert, (1993), who talked about “visionary” teachers implementing computers in their classrooms for regular use. These computers would be used in place of pencils and books, and allow for much more diversified student learning. More recently, Prensky, recognized that past educational software referred to as “edutainment” was nothing more than landfill due to it being styled after textbooks and lacking student input. He continues by arguing that for educational games to work there must be a paradigm shift in
teaching from ‘sage on the stage’ to facilitator or activator (‘guide on the side’) (2008). Kafai, (2006), takes this old teaching paradigm and frames it in terms of educational technology and learning. Kafai suggests that instructionists make games for learning while constructionists play games for learning. Instructionists follow traditional teaching pedagogy and can be seen as the holders of knowledge, or the ‘sage of the stage’, while, constructionists create opportunities for students to create, build, or extend their own knowledge.

“Vygotsky’s Sociocultural Theory suggests that development depends on interaction with people and the tools that the culture provides to help form their own view of the world” (Gros & Lopez, 2016). Building on Vygotsky’s theory, Gros and Lopez recognize that there is also “a dynamic process of instigating and maintaining learning interactions in technology-rich environments.” The researchers completed a study composed of three phases. Results from the research showed an ongoing need for discussion between student and teachers to negotiate design responsibilities.

We now face a situation in which the teachers know more than the learners about the content of the course but may well not know as much as learners about the technologies that could act as learning tools. For this reason, we consider that there is now an important opportunity for reciprocal teaching and learning (Gros & Lopez, 2016). The point is made that students know more about certain aspects of learning, such as technology use. Furthermore, they suggest that “traditional teaching roles need to change to allow for student views and identity to be authentic, in context and meaningfulness” (Gros & Lopez, 2016).

Educational pedagogy for student game design is commonly based on the construction of an artifact. “Learning-By-Design is rooted in the constructionist perspective which encourages
knowledge-in-use through developing physical or digital objects” (Papert, 1993). Further, Papert explains, “designing artifacts and sharing them with others make students’ ideas concrete and allows them to establish a personal connection with new knowledge.” Pedagogically, game design arguably finds its roots in experiential learning, constructivism and most recently constructionism. “Experiential learning focuses on developing concrete experience and reflective observation, abstract, conceptualization, and active experimentation.” (Kolb, 1984). While Jean Piaget’s Constructivist theory states that “knowledge is actively constructed (in one’s mind) by students rather than transmitted by a teacher” (An, 2016). Thus, Constructionism is said to “build on” Constructivism because the resulted artifact is concrete in nature (An, 2016). Although there is a history of closely related pedagogy surrounding game design, educational pedagogy continues to evolve in this relatively new area of learning. For instance, constructionism may describe the building of an ‘artifact’ in terms of a game. However, it is Vygotsky’s Sociocultural Theory which truly describes the collaborative nature of ‘how’ the game was created. Therefore, curriculum design should reflect both the collaborative problem-solving nature of game design in association with the learning of design elements necessary to construct a game.

The intrinsic link between collaboration and game design can be noted through the work of Harel and Papert, (1990), who used LOGO programming (the precursor to Scratch) in a study which showed “ongoing personal engagement and gradual evolution of different kinds of knowledge; at the same time, it also facilitated the sharing of that knowledge with other members of the community.” In addition, Gershenfeld (2011) acknowledges that these communities of practice are important for the success of student game designers as they offer a forum to share
ideas, develop games and to play others’ games. Essentially, the result of “creating a computer game is a highly enjoyable and engaging task that enhances student motivation” (An, 2016).

**Future Areas of Study**

In general, game design is a relatively new field of study and therefore lacks much in the way of research and experimental investigation. “In spite of its promise, research on learning through computer game making, especially for math, is still sparse” (Ke, 2014). There are a “lack of empirical studies exploring possible transfer of problem solving skills from computational tasks, to general problem solving in other domains” (Falloon, 2016). An (2016) describes the need for increased “research to explore the impact of game design on content learning in a variety of subject areas.” Also, Baytak & Land identify the need for more discussion and study of educational pedagogy in relation to game based learning due to a “lack of empirically grounded frameworks for integrating computer games into classrooms” (2011).

**Conclusions**

Research has shown that there is a place in current curriculum for game coding. Falloon (2016) states that, “sufficient evidence exists that well-designed coding tasks embedded in collaborative, problem-based and/or thematic curriculum designs, can support a wide array of student thinking capabilities.” He demonstrates that there is a necessity for every student to have the opportunity to engage with game design tasks as part of their schooling. Further, “while research on computer game design is relatively new, but expanding, most researchers agree that game design can have a positive effect on learning and the learning process” (Stiklickas, 2013).

The high levels of engagement and learning associated with coding may also help those students who lose interest in school. Gershenfeld (2011) suggests that, “many kids who have
disengaged from school are spending a great deal of time playing video games and creating/mashing-up digital media.” He goes on to describe the importance of engagement and motivation created by game play and game design as a method to keep these disengaged students in school.

He suggests that “if we can connect this passion to meaningful learning, help youth find an interest-driven pathway, and foster a community of practice and culture of mentorship, perhaps we can help make school and critical 21st Century and STEM skills more relevant and engaging to a greater percentage of students.”

The findings of this Literature Review have informed the Major Project design in answering the Critical Challenge Question: ‘How can intermediate students be engaged to deepen their learning through collaborative game design and coding?’ I combined what I had learned through the completion of a SET BC Coding Grant and the OLTD program with the literature review to identify key aspects needed in my Major Project. The procedures and specific methodologies as applied to the Major Project development are presented in Chapter 3.
Chapter 3 – Procedures and Methods

Major Project Design

The intent of the Major Project was to create an online, interactive unit of study to support the implementation of the new ADST curricular competency of Computational Thinking (CT) through coding. Although there are many online coding sites, most offer little in the way of authentic assessment opportunities, making it apparent that learning resources needed to be further developed. This unit is meant to serve as an Introduction to Coding which should allow other educators to build upon as student’s progress with their education and reflect on their learning. It was decided that two different websites would be developed to better suit the need of both students and teachers. The Student website (Appendix A) can be found at http://bckidscode.weebly.com/ and the Teacher website (Appendix B) can be found at http://codingquest.weebly.com.

Furthermore, this Major Project was designed to meet the new B.C Ministry of Education Curricular Competencies through both pedagogical and technological outcomes. Lessons were scaffolded to ensure progressive and sustained learning as content was aligned with reflective practices within the context of a comprehensive unit of study. Three specific design frameworks were applied to the project design.

Design Frameworks

Understanding by Design (UbD.) The Understanding by Design (UbD) framework originally developed by educators Grant Wiggins and Jay McTighe (Authentic Education, 2015), and frequently referred to as the “backward design” framework, was used in the planning of this unit. Essentially, UbD provides educators with an opportunity to reverse build a unit with the focus on authentic student learning by initially focusing the lesson design around curricular
learning goals and assessments. The lessons were then built to meet these learning goals and simultaneously focused on student engagement. Authentic Education (2015) describes UbD as a framework to enhance student performance based on the following key ideas:

- A primary goal of education should be the development and deepening of student understanding.

- Students reveal their understanding most effectively when they are provided with complex, authentic opportunities to explain, interpret, apply, shift perspective, empathize, and self-assess. When applied to complex tasks, these "six facets" provide a conceptual lens through which teachers can better assess student understanding.

- Effective curriculum development reflects a three-stage design process called "backward design" that delays the planning of classroom activities until goals have been clarified and assessments designed. This process helps to avoid the twin problems of "textbook coverage" and "activity-oriented" teaching, in which no clear priorities and purposes are apparent.

- Student and school performance gains are achieved through regular reviews of results (achievement data and student work) followed by targeted adjustments to curriculum and instruction. Teachers become most effective when they seek feedback from students and their peers and use that feedback to adjust approaches to design and teaching.

- Teachers, schools, and districts benefit by "working smarter" through the collaborative design, sharing, and peer review of units of study.

By adding a reflective assessment activity to each coding lesson with an accompanied lesson goal I have deepened the learning for the students and provided both teachers and students the ability to assess levels of learning. Therefore, I feel my resource development has closely
followed the UbD framework throughout the design process. My use of the Creative Commons license, Attribution-NonCommercial-ShareAlike 4.0 International, has provided avenues for other educators to remix or enhance my resource. The Provide Feedback page on the Teacher website (Appendix A) has enabled other educators to provide feedback which in turn would allow me to improve upon my Major Project.

**Universal Design for Learning (UDL).** The Universal Design for Learning (UDL) model was also incorporated with the design of this unit. Kortering, McClannon, & Braziel, (2008) report that "Three-Block Model" of UDL is based upon inclusive education, where educators frequently employed the use of technology to promote ingress of diverse learners. For inclusion to effectively occur, a community of learning has to be developed to ensure the healthy development of each student’s social and emotional well-being. Secondly, the use of an instructional framework such as UbD is employed and works in congress with differentiated instruction, differentiated assessment, and collaborative learning opportunities. Lastly, students need adequate and substantive accessibility to resources, both human and technological. My resource has enabled students to act autonomously, and collaboratively where there are multiple ways to express and assess their understandings. Students were able to employ “optimization strategies from each other” (Baytak & Land, 2011) which helped develop a diverse and inclusive social climate. My resource has also provided teachers with the ability to use Assessment for Learning strategies and thereby measure individual student’s progress throughout the unit. The application of an inquiry question is also an element of UDL. For example, my inquiry or challenge question on the Welcome page of the student site asks students if coding is their superpower and how they will change the world using coding.
The WebQuest Construct. The conceptual design for my student website was adapted from Dr. Bernie Dodge’s website construct. The format of his WebQuest website design is student friendly and age appropriate for the targeted grade levels. I used his format of presenting an initial challenge question or inquiry question on my Welcome page to get the students thinking about the upcoming learning journey. The second reason for using the WebQuest model was because it closely resembles the UbD framework. Dr. Bernie Dodge describes a WebQuest as “an inquiry-oriented lesson format in which most or all the information that learners work with comes from the web” (2017).

Gee’s Learning Principles. Gee’s Learning Principles were also considered in the build of this Major Project. Students will feel increased Agency as the activities allow for personal design choices and to develop personal identity with their projects. Next, the activities have sequenced problems to help solve future problems. Further, students can access “information on demand” by viewing the tutorial videos to help them solve challenges. I was introduced to the Screencast-o-matic video editor during OLTD 505 by instructor Alec Couros. Since then I have used the screen recording software to create several educational videos for my Google Classroom, thereby allowing my students, and their parents, to review these lessons synchronously and asynchronously. This same review strategy can be accessed by any student working through the unit. Lastly, the activities provide “situated meaning” because the vocabulary and skills being learned take place within the context of an authentic learning environment (Gee, 2013). The somewhat gamified nature of this project has therefore provided students the opportunities for Personal Agency, to develop problem solving skills and deep understanding. Ultimately, the Major Project was created to address these aspects as the Critical
Challenge Question: ‘How can intermediate students be engaged to deepen their learning through collaborative game design and coding?‘

Curricular Considerations

The Major Project was developed in response to BC’s New Curriculum and the addition of the Applied Design, Skills, and Technology (ADST) subject area which includes the learning of coding under the subtopic of Computational Thinking (CT). In September of 2015, the New BC curriculum was expected to be implemented by public schools throughout BC. At that time the ADST curriculum included Computational Thinking and Introductory Coding for grades 5 through 8. The following year the curriculum changed to only include grades 6 through 8 and again, in late 2017, the curriculum was revised again to only include grades 6 and 7. Hence, the Ministry of Education in BC has added another curriculum implementation day in 2018 to allow teachers time to review these types of ongoing curricular changes. I have built the project to reflect the curricular outcomes based on the grades 6 and 7 ADST subject area. However, due to the technological aspects of my project, I believe my project is suitable for students at, or above, the grade 5 level because it provides a strong starting point for anyone that has little to no coding experience.

Assessment Opportunities

To compliment the curricular goals and to meet the educational needs of the students a variety of assessment opportunities were planned throughout the Major Project. Each lesson contains two ‘stop and check-in with your teacher’ checkpoints, which provide timely opportunities for formative assessment. In addition, the presence of ‘Super Facts!!!’ on selected lessons provided students moments for reflective practice. Further, the collaborative nature of coding can also provide students ample formative assessment opportunities. This may happen
between students because, as mentioned by Gros & Lopez, coding offers an “opportunity for reciprocal teaching and learning” (2016). Peer interactions are enhanced by what Gershenfeld mentioned as “Communities of Practice” which offer students a forum to collaboratively share ideas.

Lessons seven and nine provide summative assessment opportunities. In lesson seven, students take a coding vocabulary quiz using an online Google form. Then in lesson 9, students sum up their learning by building a descriptive artifact by means of the Google slides application.

Finally, to meet the Ministry of Education’s goal of using self-assessment to report core competencies, students will complete the ‘Coding Self-Assessment’ Google doc at the end of lesson ten (2017). This Assessment as Learning piece is meant to support student meta-cognition and reflection, an inherent aspect of life-long learning.

**Visual Appeal and Legibility**

I used kid-friendly penguin graphics throughout to increase engagement for the students. These graphics were found on various internet websites by using advanced search features which indicated the use of the Creative Commons license - share-alike, attribution, non-commercial and no derivative categories. I also used large font sizes and an easy to read font style to enhance the legibility of the website. Further, I intentionally used white space to assist in age-appropriate readability and legibility.

**Website Navigation and Accessibility**

The use of the WebQuest design construct is also more suitable for accessing the site on mobile devices due to the left-hand side navigation menu as opposed to the horizontal menu which is more user friendly on a larger device such as a laptop or tablet. Similar to Dodge’s
WebQuest format (2017), I wanted students to access specific information directly from the internet through hyperlinks instead of having them personally search out, read over and extract essential meanings which is overly time consuming and does not serve the learning goals of the Major Project. To move forward with the Major Project, a Weebly themed template was applied to the site design.

**Development of the Major Project**

During OLTD 501, under the tutelage of instructor Mary O’Neill, I signed up for an education.weebly.com website builder account to help complete the OLTD program requirements. It should be noted that I used the free version of education.weebly.com for this design project which offered more educational features than the weebly.com version. During the two year OLTD program, I gained valuable experience and familiarity with education.weebly.com as a reliable and easy to use website builder which is why I immediately chose it to build my project deliverables.

**Content Organization**

The lesson content was organized into two separate steps where Step One was the coding and Step Two was the technologically-interactive reflective practice. Ten lessons in all were created to meet the foundational and curricular needs of an Introductory Coding unit.

I began to organize my unit based upon the essential skills and understandings which should be acquired through an Introductory Coding unit. I developed a set of ten sequential learning goals by beginning with the foundational learnings and worked up to the most complex. Skills and content were overlapped from lesson to lesson which provided review, more practice or rehearsal, and a gradual increase in complexity thereby allowing for a well scaffolded learning experience. The unit inquiry question or challenge question: “Is coding your superpower? How
“Will coding help you change the world?” provided a strong, over-arching, focal point for student self-reflection, self-assessment, and meta-cognition.

**Learning Activities.** Activities were then chosen to support each specific learning goal. The first two lesson activities came from professional development sessions at the 2017 Super Conference in Vancouver, by Computer-Using Educators of BC (CUEBC) representative Cari Wilson, [https://www.psasuperconference.ca/index.php?area=Workshop&workshop=WEN5737#start](https://www.psasuperconference.ca/index.php?area=Workshop&workshop=WEN5737#start).

The third coding lesson activity is Hour of Code, by Code.org. Lessons four through ten were all adapted from Scratch.com. I had previous experiences using both Hour of Code and Scratch as I used both coding sites with my 2016/2017 grade five class as I worked through the Set BC Grant. Both Scratch and Code.org are free to use websites which target school-aged kids and are meant to improve Computer Science and thinking skills.

To accompany each coding activity, I sought out technologically interactive tools to aid students in the reflective practice portion of each lesson. The first five interactive tools came from Michael Moynihan’s Online Safety 101 website, at [http://cedarelementary.weebly.com](http://cedarelementary.weebly.com) using the Creative Commons license attribution and share-alike. I have used the Online Safety 101 website with my students for several years and have found these online tools to be very engaging and user friendly. The remaining interactive tools were either Google applications or extensions because of my familiarity and experience with Google Classroom and Google Apps for Education (GAFE). As an employee of the Nanaimo-Ladysmith School District, I have been able to enjoy the District’s decision to use GAFE. Another important factor in choosing the interactive tools was the ability of students to use them and comply with FIPPA by not having to inadvertently share personal information.
Teacher Website Resource

A second, stand-alone, website was created strictly for teacher use because of the unrelated content such as the set-up of student accounts, and the direct instruction required for some lessons which is not relative to students. Several hyperlinks to educational resources and curriculum were placed on this website to allow educators easy access to pertinent information. Also, many video tutorials specifically for teachers were included to assist them with the implementation of the unit. The opportunity for teachers to provide feedback was also presented via the Provide Feedback page.

Evaluation of the Major Project

Upon completion of version 1 of the project, and in accordance with my proposed timeline, I sent out a reviewer’s questionnaire to attain feedback to further inform version 2 of the project design. The results from the beta/field testing have greatly improved many aspects of the project and are detailed in Chapter 4.
Overall Intention of Project

My goal for this project was to create an interactive online unit of study for intermediate teachers and students meant to answer the Critical Challenge Question: ‘How can intermediate students be engaged to deepen their learning through collaborative game design and coding?’ Essentially, two separate websites were developed in concurrence with this Process Paper in an attempt to answer the Critical Challenge Question presented.

Field/Beta Testing – Methods and Processes

A Google Form with primarily qualitative feedback questions was sent out by email with a request for participation to a select group of teachers and professors on Friday March 30th, 2018. This group included OLTD and MEDL students/educators and several colleagues working in the Nanaimo-Ladysmith School District. Anonymous participant feedback via the form (see Appendix C) was requested to be returned by April 3rd, 2018. The questionnaire was designed as a concise way for reviewers to provide critical feedback on many aspects of the website builds. Therefore, questions were presented as a combination of short answers, long answers, and low to high rating scales.

The Google Form had four distinct headings: Content of Website, Navigation and Accessibility of Website, Visual Appeal and Fun!, and Final Thoughts. The Google Form was distributed in an attempt to determine if the learning objectives of this project were achieved and to identify areas for possible improvement, as suggested by the reviewers. The essential outcome of this Major Project was to provide myself and fellow intermediate teachers with a useful, interactive online unit of study to help teach the relatively new curricular subject of Computational Thinking through Coding.
Feedback Questions

The preface to the Google Form asked reviewers for feedback based on “An instructional unit designed to introduce elementary students to the basics of coding.” To that end, sixteen questions were presented with the intent to gain valuable feedback from fellow educators to inform possible improvements to the Major Project. The sixteen questions asked on the Google Form included:

1. In your opinion, rate how engaging you found the content of this unit?
2. Where did the content delivery succeed in conveying the basics of the specified topics, and where did it not succeed?
3. In your classroom, what might you exclude from the materials presented in order to save time, or what might you include to add clarity to this unit?
4. Considering the purpose of the unit, can you think of a topic that was not covered?
5. Describe the ease of navigation for teachers with the Teacher Site.
6. Report any issues with the Teacher Site here.
7. Describe the ease of navigation from student's perspective with the Student Site.
8. Describe the ease of accessibility via mobile devices and a variety of browsers with the Student Site.
9. Report any issues with navigation of the Student Site here.
10. State additional comments and suggestions about navigation.
11. The website was designed for intermediate students. In your opinion, do you think the comics were suitable for this age group?
12. In your opinion, do you think the penguin graphics are suitable for this age group?
13. From a student perspective, how would you rate the overall use of graphics and media on
the student site?

14. Would you use (or recommend) this online coding unit to teach introductory coding? If you answered No to the above question what would make you more likely to use (or recommend) this online unit with your students?

15. Please add any final thoughts and suggestions regarding this online coding unit.

Findings of Field/Beta Testing

Fourteen professionals provided feedback from the Best Testing. The results of the feedback were very positive as all fourteen reviewers stated they would either use this interactive online unit of study and/or recommend it to their colleagues. The reviewers provided other constructive feedback which was applied to improve various aspects of both the companion Teacher Site and the Student Site.

Content of Website. A one to ten rating scale was used by participants to respond to the question “In your opinion, rate how engaging you found the content of this unit?” The majority of participants responded positively with a score of eight out of ten. The remaining participants rated it as nine and ten out of ten. There were several factors identified by participants which attributed to the overall engagement of the Major Project. Several responses to the second question demonstrate what participants felt made the website so engaging.

The second question asked, “Where did the content delivery succeed in conveying the basics of the specified topics, and where did it not succeed?” As one participant stated, “I loved the video instructions, the lesson goals and super facts!” Several other participants also identified these aspects as positively contributing to the engagement aspect of the website. A second participant said, “The videos and graphics were what caught my attention immediately.”, and a third participant said, “I liked that you added a goal to each lesson and the super facts were
great!” There were several comments on the design of both sites. For instance, “It was well laid out and covered content to introduce coding,” “I liked how each lesson had a specific focus relating to coding principles,” and “I loved that you added assessment.” Equally as important as the design aspect, one reviewer stated that I used “excellent examples and [examples for] real life usefulness.”

Some concerns were brought forward by reviewers using platforms other than Google and Google Apps for Education, (GAFE). As one reviewer stated, “for districts and schools that don't use Google some adjustments will need to be made to the lessons.” Since I work in a school district which promotes the use of GAFE and Chromebooks, I purposefully used applications which would be best suited for these platforms. This reviewer is correct and some alternatives will need to be considered. A second reviewer asked “can kids do (assignment one) with a Chromebook?” Unfortunately, they cannot use the Wordle application with a Chromebook because it does not support the required Flash Player application. Therefore, I will need to choose an alternate word cloud generator application (such as abcya.com’s Word Clouds) which works on Chromebooks.

Another reviewer mentioned that there should be an “Extensions” tab. “For example, some coding sites or coding game sites that students go to when they finish their assignments.” I think this is a great idea that will be addressed as a useful addition to the Student Site.

The third question under the Content section was, “In your classroom, what might you exclude from the materials presented in order to save time, or what might you include to add clarity to this unit?” Most reviewers positively responded by saying they would not exclude anything. As one reviewer said, “All topics and activities seem relevant and teach discrete concepts.” A second reviewer’s comment stated that “The unit was clear” and a third reviewer
expressed excitement [to use the instructional unit.] “I find it to be comprehensive, intelligently put together and very easy to navigate. This is such a gift! I hope I get a grade 5 or a high school class next year....I know you mentioned this is for grades 6 and up but I think with guidance, grades 5 would have a blast! In fact, I am going to take the course myself as a refresher!”

However, one reviewer did state that “I would have to let a class complete the full activity first to see if any material could be excluded or added for their full understanding.” While another said, “I might include [the] other YouTube coding videos, but only as reinforcement to concepts kids show trouble understanding.” I do agree with both comments. The old adage that “you don’t buy a car before test driving it” comes to mind as I won’t really know what should be adjusted until I have actually used the Major Project with my own students and received potential feedback from others using this digital resource.

The last question asked under the “Content of Website” heading was, “Considering the purpose of the unit, can you think of a topic that was not covered?” Thirteen of the fourteen reviewers replied “No”. Some did provide short comments as well, for example: “You were very thorough!” “It looks like you covered the topic well”; “all materials were included and covered and I believe the site does a very good job at introducing basics around coding.”; and “I think you have touched on all aspects of the BC Curriculum and the Core Competencies!”

One reviewer did mention that “binary numbers” should be included. I do agree with this comment and will have to continually watch the ongoing changes to the ADST curriculum as the History of Coding was added to the curriculum after I began my Major Project build. The figure below illustrates the feedback obtained from question #1.
Navigation and Accessibility. A rating scale from one to five was used to gain a quick indication of the ease of navigation for the Teacher’s Site. Three reviewers chose four out of five and eleven chose five out of five. The following question asked reviewers to report any issues with the navigation of the Teacher’s Site. Those who replied to this question all stated there were no issues with the navigation of the Teacher’s Site.

The next question asked reviewers to gauge the ease of navigation for the Student’s Site from a student’s perspective. Once again, a scale from one to five was used. Three reviewers chose three out of five, six chose four out of five and five chose five out of five.

Reviewers were then asked to provide feedback, using a one to five scale, on the “ease of accessibility via mobile devices and a variety of browsers.” Three reviewers chose three out of five, seven chose four out of five and four chose five out of five. When asked to report any
issues, two responses were given regarding the use of Apple products. One reviewer commented “It’s not so user friendly for iPhone users.”, and a second said “the menu for the individual lessons (when viewed on an iPad) isn't easily found.” It is important to note that this unit was never intended for mobile devices, instead, as mentioned earlier, it was specifically designed-to be used with GAFE and Chromebooks.

The last question in this section asked reviewers for “Additional comments and suggestions about navigation.” Overall, reviewers gave lots of positive feedback regarding the navigation. Some examples being: “For the students: I thought you did an excellent job of visual consistency in each lesson using Step 1, 2 and Stop.” “Each activity had a clear set of instructions with examples and/or video instructions [that were] easy to find. The task bar at the side was well organized and simple to follow.” “Teachers Site: the unit rationale and lessons were fantastic. You made this usable for a teacher that is brand new to this. I appreciated that everything was so clearly organized and I did not have to go hunting for anything.” “Love the layout and all the white space! The "tabs" location on the left side are very visible and give the site a fresh feel.” “Everything was laid out clearly and it was easy to navigate both the Student and the Teacher's websites.”

One reviewer suggested adjusting the placement of informational links on the Parent’s Page. “The links at the bottom at the bottom of the "Parent and Guardians" page would be better for parents if they were at the top of the page... as there are some good links there, parents would be able to find them easier.”

**Visual Appeal and Fun!** The first question under this heading read: “The website was designed for intermediate students. In your opinion, do you think the comics were suitable for this age group?” On the scale from one to five, six reviewers chose four out of five, while eight
chose five out of five. One of the final comments made by a reviewer stated that “The videos and graphics were what caught my attention immediately.”

The following question also used a five-point scale and asked, “In your opinion, do you think the penguin graphics are suitable for this age group?” One reviewer chose three out of five, six chose four out of five and seven chose five out of five.

The last question under this heading asked, “From a student perspective, how would you rate the overall use of graphics and media on the student site?” On the five-point scale seven chose four out of five and seven chose five out of five.

**Final Thoughts.** The question posed was, “Would you use (or recommend) this online coding unit to teach Introductory Coding?” To me, this was the most important question as it provided me with an overall assessment of the Major Project with regards to its overall ability to serve its intended purpose. I was thrilled to see that all reviewers answered Yes to this question.

The figure below illustrates the feedback obtained from question #14.

![Figure 2. Google Survey Form Question #14](image)
Reviewers were then given a chance to anecdotally add their final thoughts and suggestions. There were several positive comments. Some of those included: “Wow! This work represents an incredible investment of time. Well done!” “This is superb. I plan on showing this site to our teachers at Staff Training and, hopefully, some will adopt using it. Great job!” “Thank you for sharing your timely and contemporary learning with your colleagues and their students” and “Again, thank you for creating, and sharing such a timely and user-friendly site that meets most, if not all, of our BC Curriculum areas.” One of the most significant comments I had read, “I think teachers will really appreciate this Mike. You should do a district Pro D workshop.” After working through some of the suggested improvements and/or adjustments to my Major Project, I do plan on presenting it as a local Professional Development workshop.

Significance of Findings

The reviewers have also provided very specific and constructive feedback that I have since implemented in order to improve the usability and value of this instructional unit as detailed in Chapter 5. The feedback review process has also brought me to some useful conclusions regarding the overall successes, and possible issues, with implementing this project, which are also presented in the final chapter.
Chapter 5 – Conclusions and Recommendations

Conclusions in Relation to Project Intent

The purpose of the Major Project was to provide both students and teachers with an interactive online unit of study based on the new ADST curricular subject of Coding. The Major Project was developed in response to the Critical Challenge Question: ‘How can intermediate students be engaged to deepen their learning through collaborative game design and coding?’ It was decided that two different websites would be developed as key Project deliverables. The combination of the Student Site, Teacher Site and the Process Paper were all generated in an attempt to respond to the aforementioned Critical Challenge Question.

To address the topics of coding and technology use, two separate websites were created in an attempt to accomplish the following:

- Develop an interactive, online resource to help intermediate students acquire the skills and knowledge associated with the ADST curriculum in terms of coding and associated technological outcomes.
- Develop an interactive, online resource to support intermediate teachers, especially those new to coding, with the delivery of a well-structured coding unit.
- Provide students a user friendly and engaging resource to enter the realm of coding.
- Develop an online unit of study that aligns with the new BC ADST curricular outcomes associated with coding and technology.

The online unit was split into ten scaffolded lessons. Each lesson was designed to build off of the knowledge and skills acquired from the previous lesson. An assessment piece and lesson goal were applied to each lesson to monitor learning and to ensure the curricular outcomes
were met. The following list of lessons includes student learning goals, assessments, and project conclusions.

Lesson one activities included grid coding with a partner, reading about programming languages on a pre-selected website, and creating a word cloud specifying a variety of programming languages.

- **Goal:** To help gain an understanding of how coding works by changing actions into symbolic language and to recognize that there are many types of programming languages.
- **Assessment:** A saved screen capture of ten to fifteen coding languages presented as a word cloud visual.

Survey feedback indicated that the project goal was met through the applied activities and assessment. As one reviewer reported, “[the] partner activities at the beginning were engaging and I like how the kids needed to work together.”

Lesson two activities included writing sequences of code to have a partner move to a desired location and/or perform a specific task such as placing a ball in a bin. The second activity required students to demonstrate their learning through the creation of a poster using an online poster maker application.

- **Goal:** To sequence instructions into simple algorithms and to gain a basic understanding of what defines an algorithm.
- **Assessment:** A screen capture of a ‘Softprint’ poster which presented both the definition of an algorithm and one coding sequence developed by the student in part one of the lesson.
Once again, survey feedback indicated that the learning goal and assessment contributed to the success of the project. As one reviewer stated, “I liked that the beginning lessons were offline and involved partner work making them interactive and cooperative.”

Lesson three activities included learning to code using a block programming language via code.org – ‘Hour of Code’ and creating a word search puzzle with twenty coding-related occupations determined from a pre-selected video.

- **Goal:** Begin to learn how to code using block programming and learn about real life applications of coding.

- **Assessment:** Students were asked to create a word search puzzle (using an online tool) with twenty different coding related occupations taken from a selected video. Teachers could also view student progress on the code.org – ‘Hour of Code’ site.

Survey feedback indicated that some reviewers had previous experience using code.org – ‘Hour of Code’ and expressed how they thought this was a good place to start to learn block coding. However, one reviewer did state that they would skip this section due to the lengthy duration of the lesson and move directly into lesson four. Overall, the feedback showed that this lesson helped meet the goals of the project.

It is important to note that survey feedback for the next six lessons was somewhat generalized. Therefore, project conclusions based on the feedback will be presented following lesson ten.

Lesson four activities included working through an initial Scratch programming tutorial and then using an online audio recording program to record and share learning.

- **Goal:** Set up your Scratch account and get familiar with the Scratch programming feature "loops" or "looping".
• Assessment: The completed initial Scratch lesson which can be viewed by the teacher and the student voice recording explaining coding with loops.

Lesson five activities involved the use of a second Scratch tutorial in combination with the Google Voice typing application which was used to describe the differences between coding variables.

• Goal: To learn about variables and how they are used when coding.

• Assessment: The student Scratch coding work and the Google voice recording.

Lesson six activities saw students complete another Scratch tutorial lesson and then use an online drawing application to draw and label a Cartesian plane.

• Goal: To become familiar with the use of the Cartesian coordinate system in Scratch coding.

• Assessment: The student Scratch coding work along with the illustrated and labeled Cartesian plane.

Lesson seven activities included another Scratch tutorial lesson and a coding vocabulary quiz completed using Google Form.

• Goal: To learn about "if, then" statements which are known as conditionals or conditions. To review the Cartesian coordinate system, loops and variables.

• Assessment: The completed Scratch tutorial work and the Vocabulary Coding Quiz.

Lesson eight activities involved the completion of a Scratch tutorial lesson and the use of an online screen capturing software, ‘Screencastify’, to record and share a short video about the use of the audio features within Scratch.

• Goal: To learn about the three main sound functions associated with Scratch coding.

• Assessment: The completed Scratch lesson and the screen capture video.
Lesson nine activities included the completion of a Scratch tutorial lesson and the use of Google Slides to summatively demonstrate learning from all the prior lessons.

- **Goal:** To review the use of variables in Scratch coding.
- **Assessment:** A Google Slide show demonstrating all prior learning from this unit.

Lesson ten activities had students complete the Scratch tutorial lesson and a self-assessment form created to address the core competencies.

- **Goal:** To review the use of conditionals and the Cartesian plane in Scratch coding.
- **Assessment:** A core competency self-assessment form.

Survey feedback for lessons four through eight did indicate that the project goals were met. As one reviewer stated, “The Scratch lessons were well laid out and covered content to introduce coding. It was user-friendly for someone that does not know how to do or teach coding!” A second reviewer said, “I loved that you added assessment.” And, a third reviewer mentioned, “I think you did a superb job of adding a variety of technology to your activities. There was direct positive feedback about the inclusion of the core competency feedback and the lesson nine slide show, which one reviewer felt was an excellent method of having students representing their overall learning.

**Outcome Evaluation**

The abundance of positive feedback indicated that the Major Project successfully met its intended purpose. With coding being such a recent addition to the BC Curriculum, teachers found the Major Project very timely and functional as almost all of the curricular expectations for this content/topic were met.

All reviewers indicated they would either implement this unit of study or recommend it to their colleagues. The creation of a Teacher Site, was highly valued by those reviewers new to
coding. There were many comments about the value of the instructional videos which reviewers acknowledged would allow students to work at their own pace. The use of kid-friendly graphics and comics were also well received. The design of both websites made them easy to navigate. Several positive comments were made about the use of the ‘Step 1’. Step 2’, ‘Stop’, and ‘Super Facts!!!’ signs with each lesson which assisted students in understanding the lesson expectations. Some teachers also felt this unit was a good place to start learning about coding themselves.

**Results of Findings in Relation to Literature Review**

“Technology plays an important role in the classroom and in our rapidly changing digital world” (BC Ministry of Education). It is now not only the students who must keep up with a continuously advancing technological world, but teachers and other school staff as well. The BC Ministry of Education has acknowledged “students, teachers and school staff will have improved access to digital tools and resources that support both face-to-face and online learning”. Thus, the inclusion of technological outcomes throughout the Major Project, and its alignment with the most recent provincial curriculum has made it a useful resource for both students and teachers. BC’s New Curriculum also includes core competencies which are [in part]” ...at the centre of the redesign of curriculum and assessment.” The purposeful inclusion of the core competencies, along with formative, peer, self, and summative assessment opportunities helped the Major Project achieve its intended purpose.

Falloon (2016) stated, “Well-designed coding tasks embedded in collaborative, problem-based and/or thematic curriculum designs, can support a wide array of student thinking capabilities.” To a large extent the Major Project has achieved what Falloon has referred to as a “well designed coding task”.
Feedback deemed the Major Project was, to a large extent: fun, engaging, easy to navigate, and well planned in terms of content and assessment. The ‘Super Hero’ and penguin themes, accompanied with ‘Super Facts!!!’ were age appropriate and engaging. Engagement and motivation are essential to learning. “In education, the reasons for drop-outs or low performance include boredom or lack of engagement” (Hsin et al., 2013; Connell, 2012).

“The human mind is built in such a way that you need to sequence problem solving so that the problems people see early lead to generative solutions that work later on for harder problems” (Gee, 2013). The coding tasks were systematically delivered with additional skills added and previous skills repeated as per James Paul Gee’s Game Design Principles. The use of Scratch for the majority of the coding activities was purposeful because it “enables young people to create their own interactive stories, games, and simulations, and then share those creations in an online community with other young programmers from around the world” (Brennan, & Resnick, 2012).

Overall, feedback findings were positive with constructive feedback being applied to further improve aspects of the Major Project. It was rewarding to find that that every participant planned on either using the Major Project and/or sharing it with their colleagues.

**Major Project Recommendations**

Feedback from fourteen professionals was collected and considered. The feedback received was generally positive as most reviewers expressed their interests in using and/or sharing this project with their colleagues. At the same time, several reviewers did constructively identify certain aspects where improvements could be made.

Possibly the most important recommendation was to integrate the use of online applications which are Chromebook friendly. This meant using applications which do not
require the online Flash Player software to function. Some examples of these applications include: Google Chrome Voice Recorder, Word it Out, Make Word Mosaic, Tagul and Word Cloud Generator. After considering this constructive comment I revised lesson one’s use of the Wordle software and replaced it with abcyacom’s word cloud generator. This word cloud generator performs the same essential task, doesn’t require Flash Player, and can directly download the student’s work to their Google coding folder. I also changed the ‘Wordle’ instructional video for this lesson to accommodate the software changes.

The second recommendation that I took into consideration was the fact that this unit was meant to be completed specifically using a Chromebook. Many of the applications used to attain the unit’s the technological outcomes would be more difficult to achieve if the user was not using a Chromebook and/or the Google web browser. I have since posted a notification on both the Student and Teacher sites stating that the unit was meant to be completed using the Google Web browser and/or a Chromebook device.

The third recommendation that I addressed was in regards to the Super Hero voices on the main page of the Student Site. One reviewer stated, “Don’t speak so slowly, but be more upbeat and excited.” I had to agree that my voice was very slow and controlled which could be interpreted as somewhat mundane and un-engaged.

Other Suggestions

One suggestion was to make a change to the Student site to let users know what grade levels this project was targeting. I hesitated to apply this change to the Welcome Page of the Student Site for two reasons. The Teacher Site clearly identifies Grades six and seven as the intended audiences. Plus, this project could truly be used by anyone new to coding, as was identified by three other reviewers in the feedback call.
Another suggestion was to move links on the Parent page to the top of the navigation interface where they would be more accessible. This was a valued suggestion which I have since applied.

One request was made to add an “Extensions” tab where students who finish early could be provided with additional resources and extension activities. I initially thought this would be a great addition to the site. However, with further consideration, I believe the students could best use this time to further explore other coding tutorials on either code.org or Scratch, provided within the current content.

A question arose as to why there was not a lesson on the Introduction to the History of Coding and aspects like binary numbers. When the Major Project was being constructed, the History of Coding and binary numbers were not featured in the curriculum. However, these topics are now included within in the most recent curriculum revisions and I feel there should be a lesson or mini-unit created in the future to attend to this recent update.

One last comment suggested adding a “Next Page” link at the bottom of each page to aid in navigation. As the side navigation menu stays in place as the main content area scrolls downward, the menu remains static to facilitate ease of access. I feel that further navigation links would be redundant.

**Project Limitations**

The nature of the internet may inherently mean that web-based resources such as “Welcome to Your Coding Quest” may, intermittently, become unavailable. Even with current advances in internet speed and availability, connecting to the internet can still be an issue, especially in rural areas. External sites and links may be inaccessible due to a variety of unforeseen circumstances. Another limiting factor could be a lack of computers available for
student use. All of these potential limiting factors would essentially limit the use of this Major Project as a digital learning resource.

Other limitations could potentially arise as this online unit of study is implemented by teachers in the near future. I expect to receive, and act upon, additional feedback other teachers as they conduct this unit with their own students.

Next Steps

At some point, I would like to search out alternative software applications that do not require the proprietal Google browser and, using these tools, make a list of alternative learning activities. This may specifically assist Apple users and, in the event that a certain application is unavailable, there would be accessible alternatives to support a variety of platforms and devices.

As mentioned early in ‘Chapter 4 – Field/Beta Testing and Findings,’ the most relevant changes will occur after students and their teachers work through the resource and share their user experiences. I look forward to making further changes to make this an even stronger foundational tool to introduce kids to coding.

Final Conclusions

In today’s world, technology and its educational applications are becoming more prevalent. I myself use computers and technology every day in my teaching. One program I have used for several years is ‘Mathletics’, and another I use for online spelling, is ‘Flippity’. These applications provide students with immediate feedback, instant and ongoing assessment, and allow students to work at their own pace. The use of these types of digital resources are on the rise and it is my hope that my Major Project reaches its potential and becomes another useful resource in the arsenal that is “educational technology.”
The reviewer feedback process offered me valuable insight into what was working and what needed attention regarding the Project design and implementation. The overall result was an engaging unit of study based on collaborative work and game design through coding. I look forward to receiving continuing feedback and expect that there will be the necessity for ongoing Project maintenance to meet future changes in curriculum and technology.

The Critical Challenge Question has been answered by the development of this Major Project - ‘How can intermediate students be engaged to deepen their learning through collaborative game design and coding?’
References


Appendix A

Screen Capture of Student’s Site, http://bckidscode.weebly.com/

Welcome to Your Coding Quest!

Is coding your superpower?
How will coding help you change the world???
Appendix B

Screen Capture of Teacher’s Site, http://codingquest.weebly.com/

*Welcome to the Teacher Site*

The Applied Design, Skills, and Technologies curriculum builds on students’ natural curiosity, inventiveness, and desire to create and work in practical ways. It harnesses the power of learning by doing, and provides the challenging fun that inspires students to dig deeper, work with big ideas, and adapt to a changing world. It provides learning opportunities through which students can discover their interests in practical and purposeful ways.

Applied Design, Skills, and Technologies includes skills and concepts from the disciplines of Business Education, Home Economics, Information Technology, and Technology Education, as well as rich opportunities for cross-curricular work and space for new and emerging areas, such as Media Arts.

Information Technology encompasses evolving processes, systems, and tools for creating, storing, retrieving, and modifying information. As students design, share, and adapt knowledge in critical, ethical, purposeful, and innovative ways, they gain perspective on the long-term implications of this in a digital, connected world and
Appendix C

Screen Capture of Google Feedback Form

Introductory Coding Unit Feedback

Dear Colleague,

I am hoping you might take a few minutes to participate in this short survey, providing feedback for my final Master's project, BC KIDS CODE, An instructional unit designed to introduce elementary students to the basics of coding.


Thank you so much for taking the time to review the websites; your valued feedback will be used to modify and improve the website as well as become a part of my final academic paper. I am hoping to begin collecting the results by April 3, 2018.

Your feedback is greatly appreciated!
Mike Eyres,
MEdL 690 graduate candidate

* Required

Content of Website

In your opinion, rate how engaging you found the content of this unit. *

1  2  3  4  5  6  7  8  9  10

Not very engaging  ○  ○  ○  ○  ○  ○  ○  ○  ○  Very engaging

Where did the content delivery succeed in conveying the basics of the specified topics, and where did it not succeed? *

Your answer
In your classroom, what might you exclude from the materials presented in order to save time, or what might you include to add clarity to this unit? *

Your answer

Considering the purpose of the unit, can you think of a topic that was not covered? *

Your answer

**Navigation and Accessibility of Website**

This section describes how easy it was for you to get around the different areas of the sites, and how easy it was to find different areas such as Resources, Parent's page and Congratulations page.

**Ease of Navigation for Teachers - Teacher Site** *

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<td>Difficult</td>
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Report any issues here:

Your answer
### Ease of Navigation from Student's Perspective - Student Site *

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### Ease of accessibility via mobile devices and a variety of browsers - Student Site. *

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<tr>
<td>Difficult</td>
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</table>

**Report any issues here:**

Your answer

**Additional comments and suggestions about Navigation:**

Your answer

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#### Visual Appeal and Fun!

Please provide your comments and suggestions regarding the layouts, headings, font size and other design aspects of the website.

The website was designed for intermediate students. In your opinion, do you think the comics were suitable for this age group? *

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<th>3</th>
<th>4</th>
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<tbody>
<tr>
<td>Not at all</td>
<td></td>
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</table>
In your opinion, do you think the penguin graphics are suitable for this age group?

1 2 3 4 5

Not at all  O  O  O  O  O  Yes, they’re great!

From a student perspective, how would you rate the overall use of graphics and media on the student site?

1 2 3 4 5

Not very engaging or useful  O  O  O  O  O  Useful and engaging

**Final Thoughts**

Would you use (or recommend) this online coding unit to teach introductory coding?

☐ Yes

☐ No

If you answered no to the above question. What would make you more likely to use (or recommend) this online unit with your students?
If you answered no to the above question. What would make you more likely to use (or recommend) this online unit with your students?

Your answer

Please add any final thoughts and suggestions regarding this online coding unit.*

Your answer

Thank you for your participation!!!

SUBMIT

Never submit passwords through Google Forms.