Changing Curriculum:
A Critical Inquiry into the Revision of the
British Columbia Science Curriculum For Grades K-9

by

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Abstract

In 2010 British Columbia’s Ministry of Education started the process of redesigning the provincial school curriculum, Kindergarten to Grade 12. Mandatory implementation of the new curriculum was set for the 2016/17 school year for Grades K-9, and 2017/18 for Grades 10-12. With a concerted emphasis on personalized learning and through the frame of a Know-Do-Understand curriculum model, the new curriculum aims to meet the needs of today’s learners, described as living in a technology-rich, fast-paced and ever-changing world, through a concept-based and competency-driven emphasis. This thesis is a critical analysis of the BC K-9 Science curriculum as written and published, looking specifically at how science is treated as a form of knowledge, its claimed presentation as a story, and on whether the intentions claimed by the designers are matched in the curriculum’s final form.
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Chapter One: Setting the Stage

“The unexamined curriculum is not worth offering” (Schubert, 1986, p. 128).

Curriculum theorist and philosopher John Dewey wrote that that without effective transmission of societal norms and rules from one generation to the next, “the most civilized group will relapse into barbarism and then into savagery” (2009, p. 5). Curriculum theorist, William Schubert reinforced the significance of the task of curriculum development by asking, “What can be more serious or more important than the experiences through which we choose to induct the young into the human race?” (1986, p. 5). Schools are an important vehicle for this knowledge transmission, and curriculum provides a map to guide the process. Science is one key method in which people make sense of the world around them, with most children typically experiencing it formally as a school subject. Relying on unbiased observation, evidence, and peer review, science attempts to provide a systematic explanation of natural phenomena. The ability to think scientifically and to recognise science’s strengths and limitations cannot be overestimated as curricular objectives.

It is important that students know what science is, as well as what it is not. Much emphasis has been placed on students becoming more science and math-literate, however science is but one of several forms of knowledge. Robin Barrow, a professor of curriculum theory, references Hirst’s list of distinct forms of knowledge: mathematics, scientific, moral, interpersonal, philosophical, religious, and literature and the fine arts (Barrow, 1984). Each form of knowledge requires its own set of rules in which to operate – science must operate with a distinct logic as compared with the others, such as religion or morality (Barrow, 1984). Classical
education sought to teach these distinct forms of knowledge and to aid students in learning there are multiple ways to know and understand their world. Being fully aware that science is but one form of knowledge is important, particularly in a contemporary society that often defaults to scientism (“the belief that everything that exists can be understood through the same methods, that there is only one legitimate way to verify knowledge of the world, and that unless something can be quantified it cannot be truly understood or known”) (Eisner, 1985, p. 27). The manner in which the young are introduced to science, and how their understanding is developed, is particularly important in this day and age where, according to the Oxford Dictionary, 2016’s 'word of the year' is “post-truth”, “relating to or denoting circumstances in which objective facts are less influential in shaping public opinion than appeals to emotion and personal belief” (Post-truth, n.d.).

This thesis examines the Canadian province of British Columbia’s new K-9 science curriculum. The review considers both how the new curriculum proposes to develop students’ understandings of science as a form of knowledge, and how it treats the various key concepts and disciplines that are often included in a school-based general science program.

A Context for Change—the BC Education Plan

British Columbia’s Ministry of Education started a sweeping curriculum revision in 2010. October 2011 saw the publication online of BC’s Education Plan (the Plan), a document that has been used as the philosophical and theoretical basis for the curriculum rewrite (BC Ministry of Education, 2015a). Parents, educators, and community members at large have been given numerous opportunities to offer feedback on the Plan through the Ministry’s website (https://curriculum.gov.bc.ca/) and through Ministry-convened public consultations. The Ministry also established Curriculum Revision Committees for core subjects. Since its original
publication, the Plan has been through a number of revisions although the core elements have remained intact.

The Plan opens with a message from Peter Fassbender, then the Minister of Education, that states: “British Columbia has one of the best education systems in the world. But it’s a world that is changing rapidly and we owe it to our students to keep pace” (BC Ministry of Education, 2015a, p. 1). The message continues to describe what kind of provincial curriculum will help meet the needs of the students: “It seeks to create a more flexible and dynamic education system where students are more engaged and better prepared for their life’s journey” (BC Ministry of Education, 2015a, p. 1). The Minister’s message then explains the focus of the new curriculum.

The key focus is personalized learning – where students have more opportunity to pursue their passions and interests – while maintaining B.C.’s high standards on foundational skills like reading, writing and numeracy (BC Ministry of Education, 2015a, p. 1).

Curriculum theorist, Elliot Eisner (1985) states, “The quality of school curriculum and quality of teaching are the two most important features of any educational enterprise” (p. 1). Apparently, “BC’s education system is widely seen as a global leader… [with] “great teachers at the heart of this success” (BC Ministry of Education, 2015a, p. 4). Therefore, to “build on our strengths”, it is the quality of the school curriculum that is now under consideration (BC Ministry of Education, 2015a, p. 4).

The Plan, “is based on a simple vision: Capable young people thriving in a rapidly changing world” (BC Ministry of Education, 2015a, p. 4). This vision is then extended by a description of the requirements needed to attain it.
To achieve this, we need an education system that better engages students in their own learning and that fosters the skills and competencies they will need to succeed. The focus for this transformation is the movement to increasingly personalized learning, which is enabled and supported by quality teaching and learning, flexibility and choice, and high standards (BC Ministry of Education, 2015a, p. 4).

The Plan clearly states that the curriculum proposals do not represent a “top down” detailed blueprint; nevertheless, they do represent a deliberate design establishing how the new curriculum should be framed. That said, regardless of how well-intentioned or permissive and enabling proposals such as BC’s Education Plan may appear to be, school curriculum, especially for government-sponsored public schools, is affected by the stated goals of education as well as a number of other factors. These include, but are not limited to, school organizational structures already in place such as schedules or timetables (both daily and long-term), how students are grouped in same-age cohorts, how personnel at the school are organized and deployed, and the use of space (both physical and virtual) (Jacobs, 2010; Schubert, 1986). Other factors relate to the teachers who deliver and activate the curriculum in schools and classrooms. Teacher job satisfaction, their autonomy, workload, class size and composition, and relationships with administration all contribute to how a curriculum is implemented. Jacobs (2010) claims that proposed changes in curriculum often must involve concurrent changes in these key program structures. BC’s Education Plan makes little mention of these.

A Focus on the BC K-9 Science Curriculum

Today curriculum revisions are happening throughout North America, in various educational jurisdictions including many Canadian provinces, US states, and through some US
federal Department of Education initiatives. Science and science-related subjects, sometimes referred to under the acronym, STEM (Science, Technology, Engineering and Mathematics) (Honey, Pearson, & Schweingruber, 2014) are often key foci of these revisions. Science is a required course for public schools in British Columbia, and science will be a part of the core curriculum for most students up to Grade 10. In Grades 11 and 12 the elective science curriculum will split into options including biology, chemistry, Earth sciences, environmental science, and physics. There is a commonly-held belief that through studying the subjects included under the STEM umbrella, students will gain the knowledge and skills to make sense of information, gather and assess information, and solve difficult problems—knowledge and skills some see as critical for personal and vocational success in the 21st century (Kober, 2015). In the United States, the STEM Education Coalition’s central mission is to “inform federal and state policymakers on the critical role that science, technology, engineering, and mathematics (STEM) education plays in U.S. competitiveness and future economic prosperity” (2012, para. 1). In BC the revision of the science curriculum for Grades 10-12 is currently still underway.

**Research Questions and Methods**

The focus of this thesis was to conduct a critical review of the BC Science Curriculum for Grades K-9. My research question was:

Using the lens of critical curriculum inquiry and with a systems orientation, how does BC’s new, intended K-9 Science curriculum measure up to the stated intentions and goals of the curriculum designers?

My analysis was based on the written and published K-9 Science curriculum as it appears on the BC Ministry of Education’s website (https://curriculum.gov.bc.ca/). In addition, I used relevant historical and recent documents, reports, and plans available through the BC Ministry of
Education. It is important to note that I have looked solely at the intended curriculum, what Eisner describes as, “what is planned in the way of aims, content, activities, and sequence” (1985, p. 46). The scope of this thesis does not cover the operational curriculum, as it is being implemented in classrooms by teachers and how it is being received by students (including any review of formal evaluations of student learning outcomes). Consideration of these latter approaches and attributes would fall more into the domain of the evaluation of a program in operation rather than a review of the program as proposed and presented in written, published and publicly accessible form.

Since the curriculum as written (designed) is intended to have value as a grounding or foundation for practice, consideration of the qualities and theoretical bases of the published curriculum is a valid and useful activity and one that can inform the development of the curriculum during its implementation and utilization in the future. While the proof of the pudding is in the actual eating, knowing if the recipe is any good before assembling ingredients is time well spent. Eisner has written that a review of intended, not operational curricula, is justified, and involves examining, “what is planned in the way of aims, content, activities and sequence” (Eisner, 1985, p. 46). I accepted Eisner’s position and have applied it to elements of my review of the BC K-9 Science curriculum. I have also used frames and constructs proposed by curriculum theorists such as Dewey (2009), Tyler (1949), Barrow (1984), Schubert (1986), Egan (1996), Joyce, Weil and Calhoun (2004), and Jacobs (2010) in creating my own questions to serve as a framework for this curricular review. The following sub-questions emerged as I engaged with the materials.

1. Why did the Ministry of Education feel such a comprehensive rewrite was warranted at this time?
2. By looking at the new science curriculum through various curricular orientations or frameworks, does the curriculum heavily favour one or is it a mixture of approaches?

3. How is science presented in the new curriculum?

4. What assumptions are implicit in the curriculum?

5. What supports are proposed to help teachers and administrators with the implementation of the new curriculum?

6. How is the new curriculum and its implementation being evaluated, both in terms of the goals for student learning and related to its adoption across the province?

What is Criticism? Why is a Critical Approach Useful in this Context?

Criticism typically falls under Wikipedia’s first definition as “the practice of judging the merits and faults of something” (Criticism, n.d., para.1). It can also mean “the study, evaluation and interpretation of literature, artwork, film and social trends”, with the goal being “to understand the possible meanings of cultural phenomena, and the context in which they take shape” (Criticism, n.d., para. 6). A critical analysis of a curriculum, with curriculum viewed as a type of social trend, falls under this second definition. By examining the curriculum in a manner similar to how one would evaluate a theatre play or even a fine bottle of wine, the critic aims to convey the overall impression of the piece to their audience. If you read a critique of a play, you expect to find a sense of what it is about, who is appearing in it, and where it is being staged. But most of all, you want to know if it’s any good - if it’s worthwhile for you to attend, and if it appears to have at least met the explicit goals of the author.

Criticism is never value-neutral, for it is based on perception. Perception is “selective,” as Eisner writes, and influenced by the values and theoretical concepts of the critic (1985, p. 222). Therefore, it is important to acknowledge and recognize the assumptions both of the critic and
the curriculum writers, ideally noting not only what is present and taken for granted but also what is missing. The fact that criticism is value-laden does not mean that it is not worthwhile; it just requires a clear look at the underlying biases of the reviewer and what is being reviewed.

**Major Premises of this Study**

The first premise is that a curriculum can be viewed as a work of design. It is easy to think of design when related to physical objects that have been created with a certain purpose or goal in mind. But the practice of design is much more far-reaching than that. The noun ‘design’ means “the art or action of conceiving of and producing a plan or drawing of something before it is made” (Design, n.d.). ‘Design’ as a verb means “do or plan (something) with a specific purpose in mind” (Design, n.d.). Intentionality and purpose are present in both definitions, as is the fact that design can apply to most anything. A curriculum (a ‘something’) can be considered a work of design for it is a “series of planned events [or an arrangement of experiences and content] that are intended to have educational consequences for one or more students” (Eisner, 1985, p. 45). The curriculum is the plan or design by which schools attempt to achieve their purposes. Indeed, Eisner (1985) posits schools cannot work without such a plan or program.

The second premise of my study is that the BC K-9 Science curriculum is a work of design. Seeing as the new BC curriculum has been designed (planned with specific purposes in mind), and that I am focusing solely on the Science curriculum and not the entire rewrite of the provincial curriculum, the Science curriculum is the course of study under investigation. It is the work of design, the experiences, content, and educational goals, that will be used by the teachers in planning their educational units and lessons.

The third premise of this study is that the BC K-9 Science curriculum can be subjected to a critical review. Eisner has stated:
… it is possible to inspect the curriculum to see what its contents are and how they have been related. The curriculum in this context has a physical existence; it is embodied in a set of materials. These materials can be the subject of analysis and criticism in a measure similar to the criticism applied to books, paintings, symphonies, architecture, and the like (1985, p. 46).

**Personal Relevance**

While I’m not a scientist, I did my first undergraduate degree in biology, specialising in ecology, and had the pleasure of spending a few years in biology-related fieldwork. When I think about all the wonder, mystery, and awe that science can instill, and compare it with the drudgery and rote memorisation of my own experiences in science curriculum as a student, I again puzzle over the huge disconnection and ask, “Why would the subject that teaches the wonder of life be so lacking in anything wonderful or awe-inducing?”

I also am very interested in the power of stories, and definitely wanted that as a theme for my thesis. When I noticed that the BC Ministry of Education presents the new science curriculum as ‘The Story of Science’ (BC Ministry of Education, 2016), I immediately felt this was a perfect fit for my research topic; what, indeed, is the story being presented to so many students about science? After ten years of formal schooling, will they have an understanding and appreciation of the wonder and awe that are fundamental components of science? Are they able to see how science literacy is a fundamental skill for everyday living? Or is the story presented in such a way as to leave students with an understanding that science is a series of formulaic experiments and lectures and readings with long lists of words to be memorized?

I’ve always been drawn to education, in various forms, so the opportunity to delve deeply into a curriculum before implementation, to see what is planned and imagined for thousands of
students to experience over many years, is a real privilege. That said, the subtleties and nuances of the new curriculum that I am able to see, as well as those I likely miss, are a reflection of my generally positive engagement with school as a young person, and my continued interest in and involvement with schooling as an adult and concerned parent.

I also feel it is important to acknowledge my known biases as related to a Science curriculum. I strongly feel children ought to experience what is real before deeply delving into the virtual world. I see computer technology as having its place, but feel that place should be clearly delineated (and restricted). I think connecting children to what is right in front of them, or in their own backyards, is ideal in terms of starting scientific inquiry and even for growing recognition of and love for the world around them.

**Overview**

If the scope of this thesis were wider, I could look at the “big-picture” view of the new curriculum, and see if the individual parts (all the subjects) work together well as a whole. My examination of the K-9 Science curriculum presents an overview of just one of a number of rewrites of other required subjects in the BC curriculum. However, applying systems-thinking, this review may bring up questions that could relate to other subject areas or, in fact, the entire curriculum.

Chapter Two provides the contextual information, including definitions of curriculum and what purposes they may serve. Chapter Three sets the stage for the examination of the new curriculum, exploring some of the history behind it, outlining the new model and how it is intended to work, and defining some of the key concepts therein. The actual K-9 published Science curriculum is described in Chapter Four, with a reflective and critical analysis of the program in Chapter Five. Finally, Chapter Six summarizes and provides recommendations.
Chapter Two: The Background

“Nothing matters more than curriculum matters.” Elliot Eisner

What is a Curriculum? What Purposes Does it Serve?

As with many terms in the field of education, “curriculum” has multiple definitions. While Schubert provides an overarching vision by calling curriculum “a response to the question of how to live a good life” (1986, p. 116), often the term is initially defined by going back to its Latin roots; namely, currere, or “a course to be run” (Eisner, 1985, p. 39). Eisner’s definition, “a series of planned events that are intended to have educational consequences for one or more students” (1985, p. 45), builds on this notion, introducing deliberateness and thoughtfulness regarding what is included. “Planned events” are organized and thought-out -- the course to be run.

“Educational consequences,” however, is a term that could have multiple meanings. It may follow from Dewey’s concept of “intelligent activity” in terms of creating a curriculum. Intelligent activity is distinguished from aimless activity by the fact that it involves selection of means - analysis - out of the variety of conditions that are present, and their arrangement - synthesis - to reach an intended aim or purpose (1938, p. 84).

Here, the concept of “intelligent activity,” defined as the selection and arrangement of means to an end, is like a planned event to achieve an educational consequence. While the age of the learner affects how simple or complex the means and the ends have to be, this principle of intelligent design, really, applies to all learners. And, the course to be run applies here as well, with effort put into what the course may look like, and what the challenges may be.

Some curriculum theorists or planners felt the image of a course to be run was too narrow (Tyler, 1949; Eisner, 1985; Doll, 2004, Ebert, Ebert & Bentley, 2011). Numerous broader
definitions of curriculum have been proposed. The definition of curriculum can be expanded to include not only all the planned activities the school offers as part of its role in educating, but even the unplanned experiences in school as well (Ebert, Ebert & Bentley, 2011). Indeed, Eisner offers another definition as, “all the experiences the child has under the aegis of the school” (1985, p. 40).

Jacobs has stated, “As a lifelong student of curriculum, I am aware that curriculum has three basic elements: content, skills and assessment” (2010, p. 20). However, she also stressed that curriculum is inextricably linked with other components of the education system quite beyond educators’ and curriculum planners’ control. She defined these as key program structures, and they include: scheduling; how learners are grouped; how staffing is organized; and even the physical and virtual use of space (Jacobs, 2010).

Barrow believed that too broad a definition can be a real setback when trying to say anything meaningful about the curriculum, and brought the focus for the definition down to content only.

If ‘curriculum’ is taken to refer to everything that impinges on the child, whether planned or unplanned by teachers, whether the effects are intended or unintended, whether observers are aware or unaware of what is happening, then it is going to be difficult to find much to say that is both true and useful about curriculum as such… It is easier to recognise that a curriculum, defined relatively narrowly in terms of content, may have unintended consequences, and then to explore that issue (1984, p. 10).

On this last point, an important definition of curriculum that seems to keep with the tradition of content and a defined track with a defined end comes from BC’s Ministry of Education.
Curriculum defines for teachers what students are expected to learn and be able to demonstrate in their grade or course of study. It is an essential tool in providing consistency of educational experience and achievement for every student in B.C. (BC Ministry of Education, n.d., para. 1).

The Frequently Asked Questions (FAQ) document (previously housed under Tools in the BC Curriculum website) clarifies that the curriculum “provides the learning standards for students in BC schools” (BC Ministry of Education, 2016s, para.1). Again, the ends are implied; the curriculum is what students will learn and be able to demonstrate (standards). Interestingly, when the Ministry site refers to a “consistency of educational experience,” I assume they are including the means by which teachers will teach; however, the Science curriculum as written is anything but prescriptive in means.

**Curriculum Planning - Tyler's Four Questions for Any Curriculum**

In 1949, the singularity of a lone, defined track was challenged, this time by Ralph Tyler, a prominent American educator. He identified four fundamental questions that must be answered when developing curriculum. They are still often referenced by curriculum theorists.

“What educational purposes should the school seek to attain? What educational experiences can be provided that are likely to attain these purposes? How can these educational experiences be effectively organized? How can we determine whether these purposes are being attained?” (Tyler, 1949, p. 1).

Tyler acknowledged there is no one and true answer to these questions, for they vary based on circumstance. He maintained that the questions were but one way of “viewing, analyzing and interpreting the curriculum and instructional program of an educational institution” (Tyler, 1949,
p. 1). The four questions, however, still involve identifiable ends, with the means for getting to the ends known in advance.

William Doll challenged Tyler’s pre-set goals, methods and experiences for curriculum planning. Instead, his postmodern view proposed, “a curriculum generated not predefined, indeterminate yet bounded” (Doll, 2004, p. 254). He believed that a curriculum must be created by the classroom community, not imposed from above. He proposed that success required four R’s. First, the curriculum needed Richness, or sufficient depth to be transformative. It needed multiple layers and meanings and possibilities for interpretation. Second, success also required Recursion, the ability to reflect on one’s learning and use both the learning and the reflection in subsequent endeavours. Third, success entailed Relations to both pedagogy and culture. Pedagogically, the relations between the curriculum’s structure and richness require thought. Culturally, a more comprehensive and bigger-picture view of all the relations directly and indirectly involved in the unfolding of the curriculum must be included for a successful curriculum. Finally, Doll proposed that Rigor is required to keep a curriculum strong and meaningful. In such a postmodernist curriculum, “with its emphasis on indeterminacy, shifting relationships, and spontaneous organization, rigor … may be defined in terms of mixing indeterminacy with interpretation (Doll, 2004, pp. 259-60).

Like Tyler, Schubert identified key questions he believed were important to ask when creating curriculum. His three questions were centred on knowledge, not purpose. “What knowledge is most worthwhile? Why is it worthwhile? How is it acquired or created?” (1986, p. 1). Schubert went on to propose that when such fundamental questions are not addressed, education and its praxis end up being ruled by forces other than sound educational theory, forces such as government or business interests (Schubert, 1986).
Kieran Egan (1996) claimed that the job of the curriculum planner is set to fail as a result of three competing purposes of today’s schools. If a curriculum is to support personal development, induct students into societal rules and norms, and teach a classical education, he offered that the aims and goals of each of these three noble and worthwhile endeavours are at odds with each other and that curriculum planners’ intentions are unattainable.

Some believe excellent curriculum design requires a strong understanding and incorporation of the structure of knowledge, which then may be seen in the subsequent teaching and learning (Erickson, 2007). Eisner (1985) pointed to this position as a good example of one possible basic orientation to the curriculum; namely, the development of cognitive processes. If there is a hierarchy of knowledge, and the curriculum is designed to walk students along this hierarchy over time, the curriculum is there to strengthen those mental processes.

**Eisner’s Five Curriculum Orientations and Three Curricula**

‘Development of cognitive processes’ is only one of five basic orientations to curriculum proposed by Eisner (1985). His other orientations include academic rationalism, personal relevance, social adaptation and social reconstruction, and curriculum as technology. Within an orientation toward academic rationalism, a curriculum will reflect a position that students’ intelligence is best developed through the study of subjects deemed most worthy. In terms of curriculum orientation, Eisner described this as “one of the oldest and most basic” (1985, p. 66). The personal relevance orientation supports the idea that for a curriculum to work it has to have meaning for the student. Additionally, each student must be recognised for the individual she or he is and that schools must strive to provide engaging and meaningful learning opportunities and learning environments (Eisner, 1985). Social adaptation and social reconstruction orientations both operate with the assumption that schooling is intended to serve society, either by teaching
students to fit in (adaptation) or to learn how to identify and potentially remedy society’s pressing issues (reconstruction) (Eisner, 1985). The final orientation, curriculum as technology, has a more pragmatic view in which curriculum planning and teaching are essentially technological problems and therefore are solvable through technological or scientific means (Eisner, 1985).

Along with Eisner’s (1985) five orientations he also proposed three curricula as being taught by all schools: the explicit curriculum, the implicit curriculum and the null. The explicit curriculum is what the school says it will (and does) teach, and what the school claims students will learn. For BC, the new curriculum posted on the Ministry of Education’s website may be seen as the explicit curriculum.

The implicit curriculum refers to what is taught, but not deliberately stated or published. It deals more with the value system of schools, the often unchallenged assumptions on how we act, interact, and how we learn. Eisner (1985) argued that the implicit curriculum represented by the subtle and often unquestioned norms of school life, can have a far greater influence and long-term impact on learners than the explicit curriculum, both positive and negative. For instance, working hard for later gratification and punctuality are potentially positive impacts of the implicit school curriculum as are dress codes and rules about behaviour. The time and resources allocated to different aspects of the school program or elements of the curriculum are also reflections of the implicit curriculum. Students do not just learn about, they also learn through (Eisner, 1985).

The null curriculum, certainly the hardest element to pinpoint, is all that is left out of the learning experience. It relates to content or subject areas as well as learners’ intellectual processes. Eisner wrote:
If one mission of the school is to foster wisdom, weaken prejudice, and develop the ability to use a wide range of modes of thought, then it seems to me we ought to examine school programs to locate those areas of thought and those perspectives that are now absent in order to reassure ourselves that these omissions were not a result of ignorance but a product of choice (1985, p. 98).

**Schubert’s Curricular Images**

William Schubert (1986) expanded on Eisner’s three curricula when he described both inside and outside of school contexts as important considerations. For “inside of school,” the overt (explicit), hidden (implicit) and null curricula are joined by three other contexts, including frame factors, the actual physical building, and extracurricular activities. “Frame factors” are those things associated with the organization of the school that may affect student success, and include what lies beyond the teacher’s control (i.e. the school’s actual location, the school year calendar, and the students’ general ability) as well as what’s much more under his/her influence (i.e. how time is spent in any given classroom, or the time put into mixed-class events) (Schubert, 1986, p. 104).

Schubert also developed eight different images (or frames) with which to look upon curriculum and, in fact, also with which to define it. Depending on the goals and purposes of education, either one or a combination of these images would apply.

The first of Schubert’s images for looking upon curriculum sees it simply as comprised of the subject matter: which subjects and subject matter are included. The second considers curriculum as a program of planned activities, those that have been written down or thought about in advance of actual delivery. The third image or frame moves the emphasis from the delivery to the endpoint, that is, curriculum as intended learning outcomes.
Schubert’s sixth image views curriculum as discrete tasks and concepts. This is a very linear and straight-forward manner in which to frame a curriculum, and perhaps the one best representing the definition of curriculum as "the course to be run". It really supports the idea of schooling as simply training, where learning can be compartmentalized, cut into logical, bite-sized chunks and “fed,” one by one, to students as they are ready.

Moving from the more structured and traditional view of curriculum, we go to the fourth image that regards curriculum as cultural reproduction. With this view, “The community, state, or nation takes the lead in identifying the skills, knowledge, and appreciations to be taught” (Schubert, 1986, p. 29).

Curriculum as experience is Schubert’s fifth image, in which the goal of education is for the teacher to facilitate the students’ personal growth. This is done by imparting meaning and direction to the students’ learnings via the teacher-student relationship and it assumes the teacher knows and understands the students well enough to be sufficiently equipped for such a task.

Schubert’s seventh image is curriculum as an agenda for social reconstruction. Instead of accepting the status quo, curriculum can be designed to challenge it, to question underlying assumptions and norms with the aim of changing them, presumably for the better.

His final image views curriculum as a way in which the students can learn about themselves. Curriculum as “currere,” or a course, is deeply personal. Students themselves are an integral part of the experience, including their histories, dreams, and aspirations. Melding students’ past and future with present realities, the educational experience becomes deeply personal and reflective.

It is notable that there is considerable overlap between Eisner’s orientations and three curricula model and Schubert’s frames or images. Both scholars regard curricula as worthwhile
objects of critical review and study and also see school programs as having importance to the lives of students and society in general. To this day curricular criticism is alive and well and a variety of other frames or perspectives have been proposed. For my review in this thesis I have applied elements of both Schubert and Eisner’s concepts because I found them to provide manageable positions from which to stand while examining a work as complex as the newly revised BC K-9 Science Curriculum.
Preface to Chapters Three to Six

In the Chapters that follow I will be making many references to material found in the *BC’s New Curriculum* website (BCNC), with special attention to the K-9 Science curriculum sections of that site. In conducting a critical review of this sort it is important to work directly from the curriculum as published and in the case of the new BC K-9 curriculum, a reviewer must work from the online documentation since there is no other primary source.

Many websites are undated, unpaged, and lack numbering in sections or paragraphs. The *BC’s New Curriculum* site clearly illustrates these characteristics. While the BCNC site uses different type styles for main headings, section headings, and sub-headings, there is considerable diversity in approach, so it can be difficult to rely on section breaks and changes as navigational cues for the reader. As a result, it is difficult to reference cited passages or examples to specific locations within the site. This problem has been recognized in the recent Publication Manual of the American Psychological Association (APA, 6th Edition). In making reference to content published in the *BC’s New Curriculum* website I have attempted to provide readers with cues that will enable them to locate the specific material. I have included several figures that are taken directly from the Science sections of the BCNC site and have tried, as much as possible, to indicate the location of the material shown in the figures.

In some instances, the page URL will indicate at least in broad terms the location of a cited item of text or content, but scrolling through the equivalent of many pages of hard copy often does not result in a change to the URL. Moreover, some text passages only appear when the user places their mouse pointer on a section of text and disappear when the user moves on. Again, I’ve tried to indicate this feature by showing it in operation in some figures.
Thus, when citing the source of a particular item in the text of chapters I have followed this general format:

BC Ministry of Education, 2016g, Curriculum Model section, Big Ideas (Understand).

The BC Ministry of Education is the author. Because the Ministry has written many articles or sections in the same year for the BCNC website, the format for dating each section cited will be 2016a, 2016b, etc.

In the Reference list I have followed the recommendations made by the APA 6th Edition Publication Manual and treated the BC’s New Curriculum website as if it was an online journal within which there were many different “articles” or sections:


I have attempted also to check any links from the BCNC site that lead the user to other resources in order to ensure that they are current and operational but online publications often change location or are revised or even deleted without notification or indicated revision or edition numbers and dates.

I apologize to readers who may find it difficult to navigate to the material that I cite in text or who discover “broken” links. This thesis is based on upon extensive reviews conducted over time, with the latest review, on which this thesis is largely based, being made in the spring of 2017. I hope that my efforts have at least been helpful.
Chapter Three – General Context and Historical Background

Curriculum is not written in a vacuum. It is important to have a sense of the history behind a curriculum revision or change proposal, in terms of past work that informs it, as well as present-day justifications as to its need. Thus, part of my methodology for this review has been to review a number of documents and policy statements that appear to have affected the recent general curriculum redesign and revision. For example, in 1987 the BC Government commissioned Barry Sullivan Q.C. to report on the state of education in the province of British Columbia. His report, titled *A Legacy for Learners: Report of the Royal Commission on Education* (Sullivan, 1988) became generally known as the Sullivan Royal Commission Report or Sullivan Report. The government at the time “accepted nearly all of its 83 recommendations, including a blueprint for an innovative curriculum program known as the Year 2000” (Dunae, n.d., “1980s”). In 1996 the Public School Act [RSBC, c 412] and the Independent School Act [RSBC 216] were consolidated within the revised statutes of BC with a common preamble indicating the goal and purpose of the BC school system. The current School Act (1996), discussed below, also informed the new curriculum described in this thesis. In terms of present-day justification as to why this curriculum revision was necessary, online documents and the Minister of Education’s statements are reviewed below.

Basic Sources Used for this Chapter

BC’s New K-9 Curriculum is published and freely available online at the *BC’s New Curriculum* (BCNC) website (https://curriculum.gov.bc.ca/). The majority of information for the analysis presented in this thesis has come from the BC Ministry of Education’s online documents outlining the new curriculum (*Curriculum Overview* (BC Ministry of Education, 2016d) and Core Competency documents (BC Ministry of Education, 2013), *BC’s Education Plan* (BC

Other supporting documents from the BC Ministry of Education, related to the curriculum revision that are referenced here, are also posted online through the Ministry’s website. These include the Sullivan Report (Sullivan, 1988), the School Act (1996) and the 2016/17-2018/19 Service Plan (BC Ministry of Education, 2016a).

Unlike curricula of the past, the entire new curriculum is posted online and is easily accessible to teachers, parents, the general public and to students also. In addition, there is some use of social media related to the implementation of the new curriculum (for example, through online forums and discussions). This is a notable change for the province in terms of publishing and distributing curriculum. There are numerous advantages and potential issues with such an approach to disseminating a curriculum and supporting documents and resources. I discuss some of these issues in my concluding chapters.

**Historical Context – The 1988 Sullivan Royal Commission on Education**

As noted above, 1988 saw the publication of, *A Legacy for Learners: Report of the Royal Commission on Education* (Sullivan, 1988). It was the first major report on the BC education system to be commissioned since a Royal Commission was set up in January 1958 by the BC Minister of Education to "inquire into, assess, and report upon the Provincial educational system up to university level" (British Columbia, 1960). Perhaps because BC has not commissioned a similar report since *A Legacy for Learners*, the developers of BC’s New Curriculum used that 28-year old report on the state of education in the province as the basis for their work. There are many instances where Sullivan's findings and recommendations are evident in the new program.
I have chosen two examples to illustrate this point; the first being statements concerning what people felt an effective school system ought to look like, and the second on the importance of community involvement.

In 1987, as part of the work of the Sullivan Commission, British Columbians were interviewed to gather their thoughts on what makes a good public school system. There was wide consensus that student “achievement” was how schools, or a school system, were rated (Sullivan, 1988). Their statements offered a description that a “good” system:

Would allow youngsters to express their understandings and innermost feelings, to ask imaginative questions, to discriminate wisely among choices, to acquire a sense of the consequences of action, to know their culture and the culture of others, to enjoy their own and others’ sensibilities, to make their way in the world, and, ultimately, to contribute to the wider social, economic, and spiritual good of the community (Sullivan, 1988, p. 6).

It is interesting to note how the new 2016 curriculum, in its introduction on the curriculum website, has a shorter and much more limited synopsis on what students will do within the new program. “Every student will get hands-on experience in collaboration, critical thinking and communications - skills they'll need to succeed in college, university, and the workforce” (BC Ministry of Education, 2016h, para. 4).

The Sullivan Report also clearly recognized that the schools are mirrors of society and that student success is linked directly to community support (Sullivan, 1988). Throughout the new curriculum, “place-based learning” is emphasized, incorporating the local community and local environment in learning experiences. Mandated community involvement raises questions about equitable opportunity across communities. If student success does in fact mirror
community interest, the effect of this heightened focus on the local environment will be worth examining once the curriculum is implemented.

Other elements from the Sullivan report are also evident in the 2016 curriculum rewrite. Sullivan described the need to develop “a population that is well prepared to meet the rapidly changing challenges of everyday life in the 21st century” (1988, p. 1). In 2016, the new curriculum speaks of the need for the redesign, “so students can succeed in the 21st Century” (BC Ministry of Education, 2016h, para. 2). The Sullivan Commission also discussed the importance of recognizing the knowledge-based society of 1988. The first paragraph of the 2016’s curriculum’s detailed information states that knowledge “is growing and information is changing extremely quickly, creating new possibilities” (BC Ministry of Education, 2016g, para. 1). Both then and now, technological advances were referenced as changing our society as we know it, and hence the need for schools and the curriculum to respond accordingly. In addition, in 1988, “social, business and educational leaders emphasize[d] the concept of lifelong learning” (Sullivan, 1988, p. 11). BC’s Education Plan of 2015 describes a principle of the new curriculum as being that, “Learning is truly a life-long endeavor” (BC Ministry of Education, 2015a, p. 6).

The Mission and Mandate of the BC Public Schools

The Sullivan Commission report noted the need for the development of a mandate for the public schools because without a clear mandate schools might be expected to attain a range of purposes beyond their core charge to provide education and be faced with growing and often competing demands. Other suggestions of what should be included in a mandate were explicit details surrounding the curriculum (its nature and sequencing), the available long-term budget, identification of any specific goals of the Ministry, and who “assumes responsibility for leadership, change, and the renewal of the system” (Sullivan, 1988, p. 67).
Clear statement of goals.

In 1989, as part of its response to Sullivan, the BC Ministry of Education published the Statement of Education Policy Order for the province’s school system. The mission statement for the BC school system from the Mandate of 1989 provided considerable clarity as to the purposes to be met by the public schools. The Mandate was widely published and distributed and stated that schools should:

Enable learners to develop their individual potential and to acquire the knowledge, skills and attitudes needed to contribute to a healthy society and a prosperous and sustainable economy (Brummet, 1989, p. D-88).

The Statement continued to declare that, “A quality education system assists in the development of human potential and improves the well being of each individual person in British Columbia society” (Brummet, 1989, p.D-88). Further, looking to support BC’s social and economic goals, the development of “the educated citizen” is of paramount importance. Such people are described as being able to “think clearly and critically … adapt to change … accept the tolerant and multifaceted nature of Canadian society and … are motivated to participate actively in our democratic institutions” (Brummet, 1989, D-88). The Statement also provided a long list outlining the qualities and abilities well educated citizens ought to possess, such as the ability to think critically and creatively, work cooperatively and productively, and contribute meaningfully to society in general and the world of work specifically (Brummet, 1989).

In the newly revised curriculum not much has changed since 1989 in terms of expectations. The BC’s Ministry of Education’s 2016/17-2018/19 Service Plan states:

The purpose of the British Columbia school system is to enable the approximately 553,000 public school students, 81,000 independent school students, and over 2,200
home-schooled children enrolled each school year, to develop their individual potential and to acquire the knowledge, skills and abilities needed to contribute to a healthy society and a prosperous and sustainable economy (BC Ministry of Education, 2016a, p. 4).

In the same service plan, specific goals were identified that were necessary in order for the school system to work towards improving each learner’s outcomes. These goals included smooth and effective implementation of the new curriculum; personalized, flexible education; effective teacher support; and an education system that is “effective, accountable and responsive” (BC Ministry of Education, 2016a, p. 10).

**Responsibilities of schools, parents, and the community.**

In terms of the roles and responsibilities of the major participants, the school, the students, the teachers, and the parents, BC’s School Act of 1996 is explicit, though limited in detail. The school system is expected “to enable all learners to become literate, to develop their individual potential and to acquire the knowledge, skills and attitudes needed to contribute to a healthy, democratic and pluralistic society and a prosperous and sustainable economy” (School Act, 1996, p. C-12). In the *Statement of Education Policy Order* (i.e. the Mandate statement) the primary goal of public schools is to be *supported* by family and community in the development of the students’ intellect. This includes their ability to “analyze critically, reason and think independently, and acquire basic learning skills and bodies of knowledge; to develop in students a lifelong appreciation of learning, a curiosity about the world around them and a capacity for creative thought and expression” (Brummet, 1989, p. D-89). The two other listed goals of public schools interestingly are to be *shared* among schools, family and community. They include human and social development and career development.
According to the School Act, students are to “comply with the school rules authorized by the principal of the school or Provincial school attended by the student, and [comply] with the code of conduct and other rules and policies of the board or the Provincial school” (1996, p. C-20). They also must participate in the educational programs offered (School Act, 1996). According to the Statement of Education Policy Order, students’ duties, rights and responsibilities included the following.

The opportunity to avail themselves of a quality education consistent with their abilities, the opportunity to share in the shaping of their educational programs, and the opportunity to determine their career and occupational goals. They have a responsibility to make the most of their opportunities, to respect the rights of others, and to cooperate with fellow students in the achievement of their goals (Brummet, 1989, p. D-89).

The School Act states that teachers’, “responsibilities include designing, supervising and assessing educational programs and instructing, assessing and evaluating individual students and groups of students. [They also] must perform the duties set out in the regulations” (1996, p. C-29). However, the current Education Policy Order expands and makes explicit teachers’ duties, rights and responsibilities, including the exercise of their professional judgment, and responsibility to provide each student with quality instruction and communicate with both students and parents (Brummet, 1989).

Parents are entitled to both “be informed, in accordance with the orders of the Minister, of the student’s attendance, behaviour and progress in school, and to belong to a parents’ advisory council” (School Act, 1996, p.C-20). Parents also are to, “at the request of a teacher or principal, vice principal or director of instruction ... consult with the teacher, principal, vice principal, or director of instruction with respect to the student’s educational program (School
Act, 1996, p. C-20). However, parents’ ability to choose where their children go to school, if at all, and their subsequent responsibilities relating to ensuring their children receive a suitable education in an suitable learning environment are outlined in the *Education Policy Order* (Brummet, 1989).

Interestingly, the public is also included as a major player. The public can expect effective, efficient schools that regularly evaluate and report on their efforts. However, there are expectations placed on the public as well, including the “responsibility to provide schools with the necessary resources and moral support to fulfill their mission” (Brummet, 1989, p. D-91).

Taken all together the trend from the Sullivan Commission’s recommendation for the establishment of a mandate for the public schools through to the response of the Ministry of Education in 1989 and continuing into the current general curriculum descriptions is to define the roles and expectations of the public schools and the relationships among the major stakeholders, particularly parents and teachers (although with some mention also of the students themselves).

However it is important to put this work in context. Similarities in the expectations of the schools and for student development were even apparent in the mid-last century. In 1954 the Ministry of Education established a Provincial Curriculum Advisory Board which included “representatives from the agricultural sector, organized labour, and the business community” (Dunae, n.d., “1950s”). This Board published the first general statement of the *Aims of Education in BC*, which begins with the following.

The people of this Province have established schools for the primary purposes of developing that character of our young people, training them to be good citizens, and teaching them the fundamental skills of learning necessary for further education and adult life (British Columbia, 1956).
Further, the 1954 *Aims* statement also described some limits on what is expected of the schools.

The school, however, is not the only agency responsible for the education of children. Worthy influence of the home, the church, and the community must also be considered, since these are a vital part of the child's environment. The school must add to and strengthen the influence of these agencies, but it should not attempt to take their place. The home, the church, the community, and the school should work together to provide strong and worthy guidance for our children (British Columbia, 1956).

A question to be considered in my review of the new curriculum is the extent to which the Ministry has changed these expectations and concepts of roles and responsibilities.

**Why was Curriculum Change Necessary?**

While responsibilities of the Ministry of Education include its vow to “continue to work towards improving outcomes for every learner in the system” (BC Ministry of Education, 2016a, p. 5), there is a critical question as to why the need for an extensive curriculum rewrite was deemed to be necessary this time.

Since the start of the curriculum revision process, the Ministry solicited advice from interested parties and stakeholders as well as contemporary curriculum scholars and commentators. The theme of the need for curriculum change to prepare the youth of today for the sorts of societal and technological change that is underway is recurrent as a rationale for the new curriculum. It is clearly apparent in the following statement from the Ministry of Education documents explaining the need for the curriculum revision.

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 (BC Ministry of Education, 2015a, p. 3).

The BC’s New Curriculum website also provides a statement of rationale for the curriculum revision, referring to the advice of “experts in the field.” It is claimed that, “They agree that to prepare students for the future, the curriculum must be student-centred and flexible, and maintain a focus on literacy and math skills, while supporting deeper learning (BC Ministry of Education, 2016g, para. 2).

Other curriculum documents also recognize that the student of 2017 is not the same as the student of the 1990’s or earlier. Today’s students are described as having an understanding of technology, including social networking, and a degree of access to knowledge that is very different from that possessed by students even a decade earlier. BC’s Education Plan contrasts how schools operated in the past, in the era of “single room school houses” when (it is claimed) “it was a time when change was much more gradual than it is today” and “where every student simply memorized what their teacher told them” (BC Ministry of Education, 2015a, p. 3).

In contrast, today’s schools operate with students who “routinely navigate through more information in a single year than their predecessors likely encountered in a decade,” and “where information is updated continuously and a vast array of resources can be tailored to the learning needs of individual students” (BC Ministry of Education, 2015a, p. 3). Therefore, the curriculum change process is intended to prepare students to participate in the workforce in an industrialized society that is itself facing significant challenges.
However, the need for curriculum change is not only driven by new information technologies and by the demands of a changing economy that needs a workforce with new skills, but also by new knowledge about “how children and adolescents actually learn” (BC Ministry of Education, 2015a, p. 3). “There is a large and growing body of scientific research on learning and brain development that challenges us to re-think many of our assumptions and routines” (BC Ministry of Education, 2015a, p. 3). Further, we find support for the “personalized learning” orientation mentioned in the Minister’s message, a recurrent theme of the Plan.

This research reinforces our knowledge that no two students learn the same way or at the same pace and that effective learning is far more than just memorizing information – it is really about getting students to apply their knowledge in real-world settings (BC Ministry of Education, 2015a, p. 3).

The Plan also offers a description of the sorts of learning environments and teaching that will yield the “best outcomes”.

The best outcomes are achieved through learner-centred approaches that are sensitive to individual and group differences, that promote inclusive and collaborative learning, that harness students’ passions and interests, and that deliver tailored feedback and coaching (BC Ministry of Education, 2015a, p. 3).

Note that the then-Minister’s message also describes what the curriculum revision process will look like.

This is not a detailed blueprint or top-down transformation. Instead, it is an affirmation of the great things that are already happening in high-performing classrooms and schools right across our province (BC Ministry of Education, 2015a, p. 1).
Further, the Minister writes, “It confirms the vision for where we are going and supports an ongoing conversation on how we can get there together” (BC Ministry of Education, 2015a, p. 1).

When these statements are taken together, we can discover why the politicians felt that change was necessary even though the system was apparently already excellent and considered a leader in international comparisons. We can also discover the claim that “…many teachers were already moving in the directions described by BC’s Education Plan” and that “great things … are already happening in high-performing classrooms and schools right across our province” (BC Ministry of Education, 2015a, p. 1).

In only the first three pages of the Plan, we clearly see arguments about why there is a need for change to the current “excellent” curriculum (response to changing information technologies, preparation for a changing work world that requires particular skills, and the need to apply new knowledge from “scientific research” about the nature of learning). Further, we find claims that many teachers are already moving in these directions, and that the curriculum is still firmly grounded in the core areas “foundational skills” of reading, writing, and numeracy. Additionally, the Plan affirms that student learning, while personalized, will still be monitored and assessed

… through rigorous province-wide assessments. This is essential to student success and will be even more vital in a more personalized learning environment.

Ongoing formal and informal reporting to parents on student progress will remain essential (BC Ministry of Education, 2015a, p. 4).
Key Concepts Defined

Certain key concepts throughout the new curriculum are fundamental to understanding the big picture revision. Given the proliferation of jargon in educational discussions, the need for clear definitions is important. Some of the key concepts referred to in the new curriculum documents and websites are defined below.

**Personalized learning.**

“Personalized learning is at the heart of the new curriculum” (BC Ministry of Education, 2016h, para.5). For the BC Ministry of Education, 21st Century Learning is:

…Rooted in personalized learning. It focuses on providing all students, regardless of their economic, geographic, or ethnic background, the skills they need to participate in a knowledge-based society, while also allowing them to explore an educational path that is best suited to their interests, their capabilities, and their chosen future (Premier’s Technology Council, 2010, p. 20).

**21st Century Learning.**

For the BC Ministry of Education, personalized learning is inextricably linked with “21st Century Learning,” one of those catchall phrases in education that has many different meanings to different people. According to the “P21: Partnership for 21st Century Learning” (2015) website, aiming for student success in work and life is a collaboration of core academic concentrations underlying and supporting learning and innovation skills (the ability to think critically, communicate effectively, collaborate and create), life and career skills, as well as information, media and technology skills. Prakash Nair speaks of it as, “project-based learning, connections with peers around the world, service learning, independent research, design and creativity, and, more than anything else, critical thinking and challenges to old assumptions”
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(2009, para. 3), while the Organisation for Economic Cooperation and Development (OECD) defines it as the “skills and competencies young people will be required to have in order to be effective workers and citizens in the knowledge society of the 21st century” (Ananiadou & Claro, 2009, p. 8).

Descriptions of 21st Century Learning differ, but a key similarity is the acknowledgement of how “knowing” has shifted from being about remembering and recalling information to being able to find and use data and information to construct knowledge (Bransford, Brown & Cocking, 2000). The claim that we live in a knowledge-based society (Ananiadou & Claro, 2009; Premier’s Technology Council, 2010), is manifested in the reality that the access to knowledge has changed as dramatically as the tools available and used to do so. As well, the knowledge base from which we are working is constantly shifting and increasing.

Technology is expanding rapidly as well and 21st Century Learning includes the recognition of the role technology must play in education today. With the ballooning of our knowledge base, the ability to tap into our collective intelligence via new methods such as social media and other networking technologies presents a promising and as yet undeveloped potential for 21st Century Learning (Jacobs, 2010). The Premier’s Technology Council (2010) identifies needs for our knowledge-based society similar to the categories identified by the P21: Partnership for 21st Century Skills (2015) report, and includes in its vision personalized, discovery-based learning that champions love of (lifelong) learning. The goal of the curriculum is to maintain openness both for greater choice of what is studied and to allow the time to delve deeper into the topics and skills. The potentially superficial addressing of a plethora of prescribed learning outcomes is being replaced by teachers focusing on more in-depth or fewer
topics to allow for key concepts in the various disciplines to be better understood; a technique shown as being favourable to effective learning (Bransford, Brown & Cocking, 2000).

**Know/Do/Understand model.**

The Know/Do/Understand curriculum model represents how the essential learning of BC’s New Curriculum will be delivered.

![Diagram of Know-Do-Understand curriculum model](https://curriculum.gov.bc.ca/curriculum-info)

*Figure 1: Know-Do-Understand curriculum model.*


**Concept-based, competency-driven.**

The Know/Do/Understand triad is formed around the core of the model; it is concept-based and competency-driven. These two features, “that most educators agree are essential for
21st-century learning”, apparently support “deeper, more transferable learning” (BC Ministry of Education, 2016d, Curriculum Model section, Concept-based.) Together, they also supposedly support student engagement that is “active” and involved in “authentic tasks that connect learning to the real world” (BC Ministry of Education, 2016d, Curriculum Model section, Concept-based.) Concept-based learning “uses concepts to define standards of knowledge and skills associated with a given area of learning” (BC Ministry of Education, 2016d, Curriculum model section, Concept-based learning). It is “built around higher-order standards and key ideas” (BC Ministry of Education, 2016d, Curriculum model section, Concept-based learning), which it is claimed will allow for a deeper understanding of topics. While it includes the study of facts, this is complimented by concurrently working “with the development of conceptual understanding and disciplinary skills” (BC Ministry of Education, 2016d, Curriculum model section, Concept-based learning). It supports the transfer of learning, supposedly within and across disciplines.

Competency-driven learning is based on the idea that “students are competent in an area of learning to the extent that they understand and can apply knowledge to new contexts” (BC Ministry of Education, 2016d, Curriculum model section, Competency-driven learning). According to the BC Ministry of Education’s definition of 21st-century learning, competencies “represent a much broader and more adaptable achievement than a simple set of skills” and are thus defined as including “skills, processes, behaviours and habits of mind” (BC Ministry of Education, 2016d, Curriculum model section, Competency-driven learning).

**Deep learning.**

Encircling and supporting this core of concept-based and competency-driven learning is the triad of knowing, doing and understanding. These three pieces underpin the entire
curriculum rewrite, and “all work together to support deeper learning” (BC Ministry of Education, 2016d, Curriculum model section, para. 2.) “Knowing” represents the content piece of the curriculum, the “essential topics and knowledge” (BC Ministry of Education, 2016d, Curriculum model section, Content (Know). “Doing” is represented by the Curricular Competencies, “the skills, strategies, and processes that students develop over time”, as related to each particular subject area (BC Ministry of Education, 2016d, Curriculum model section, Curricular Competencies (Do). “Understanding” in the “Know-Do-Understand” model is represented by the remembrance and application of Big Ideas long past completion of a particular grade or year and is expected to help in the development of other Big Ideas in higher grades. Big Ideas “consist of generalizations and principles and the key concepts important in an area of learning (BC Ministry of Education, 2016d, Curriculum model section, Big Ideas (Understand).

Three Key Features of the New Curriculum

There are three key features to the curriculum rewrite - core competencies, literacy skills, and math skills - that require explanation.

Core Competencies.

Core Competencies span all the subjects and grades of the new curriculum: they “are directly related to the educated citizen” (BC Ministry of Education, 2016d, Key features of redesigned curriculum section, The Core Competencies.) Cross-curricular (core) competencies are defined as:

The set of intellectual, personal, and social skills that all students need to develop in order to engage in deeper learning - learning that encourages students to look at things from different perspectives, to see the relationships between their learning in different subjects,
and to make connections to their previous learning and to their own experiences, as members of their families, communities, and the larger society (BC Ministry of Education, 2013, p. 3).

The Core Competencies are divided into three broad categories: thinking, personal and social, and communication. The category of thinking is further subdivided to encompass critical and creative thinking while the personal and social category refers to students’ positive personal and cultural identity, their personal awareness and responsibility, and their social responsibility. These competencies are described as “interconnected” (BC Ministry of Education, 2013, p. 3), and “represent a holistic and unifying approach to learning, spanning all courses and grades in the common purpose of enriching students’ learning experiences and preparing students for the future” (BC Ministry of Education, 2013, p. 3). As stated on the website,

Competencies come into play when students are engaged in “doing” in any area of learning. This includes activities where students use thinking, collaboration, and communication to solve problems, address issues, or make decisions. The ultimate goal is for learners to employ the core competencies every day in school and in life, and for the core competencies to be an integral part of the learning in all curriculum areas (BC Ministry of Education, 2016c, para. 5).

That said, “Core competencies ... manifest themselves uniquely in each discipline” (BC Ministry of Education, 2016c, para. 5).

**Literacy and math skills foundations.**

Literacy and math skills foundations, described as “fundamental to all learning”, and applicable to “all areas of learning”, are the second and third features highlighted in the
Summary

Foundational to the new curriculum are essential learning, literacy skills and math skills (BC Ministry of Education, 2016g, Key Features section, para. 1). These three essentials contribute to “Deeper learning”, one of the major aims of the new curriculum. The Ministry of Education also states that it consulted “experts… [who] agree that to prepare students for the future, the curriculum must also be student-centred and flexible, and maintain a focus on literacy and math skills” (BC Ministry of Education, 2016g, para. 2). Therefore, this curriculum is designed to “enable and support increasingly personalized learning, through quality teaching and learning, flexibility and choice, and high standards” (BC Ministry of Education, 2016d, Education for the 21st Century section, para. 2).
Chapter Four: Details of the Officially Published 2016 BC K-9 Science Curriculum

This chapter presents a description of the BC science K-9 curriculum as published online. I have limited the scope of this inquiry to “what is planned in the way of aims, content, activities and sequence” (Eisner, 1985, p. 46), by looking at the written K-9 science curriculum solely as presented and published on websites supported by the BC Ministry of Education. The curriculum revision is mainly described and presented by means of a website titled, BC’s New Curriculum (BCNC) (Ministry of Education of BC, 2016e). This chapter is focused on a thorough description of the written and published science curriculum and does not attempt to describe how the curriculum is currently being implemented by teachers or received by students or parents in the schools. In this thesis I have not expanded the review to interview those with vested interests, such as teachers, administrators, parents or the like, nor have I spoken directly with anyone on the curriculum writing teams.¹ At the time of writing this thesis, 2016, the science curriculum was in its final, revised version for Grades K-9 and the curriculum for Grades 10-12 was still under development with full implementation not being anticipated until late 2017 or 2018. A study of the implementation of the K-9 curriculum would be worthwhile but is beyond the intentions or scope of this thesis. This Chapter provides a description of the K-9 Science published curriculum, while a critical review and commentary about the curriculum is offered in the next chapter.

As discussed in the previous chapter, the newly revised BC curriculum is largely being distributed and communicated to stakeholders by means of Ministry of Education websites. The entire revised curricula for Grades K-9 are found on the website BC’s New Curriculum at https://curriculum.gov.bc.ca/. In this Chapter, I will describe the curriculum as it is presented

¹The names of those involved in the K-9 Science Curriculum development had not been released or published at the time of this research. It is common practice for the BC Ministry of Education to not publish the names of the members of curriculum development teams.
online by moving through the webpages as though I was a science teacher searching for a particular grade’s curriculum while being open to and curious about the other links provided.

Although the K-9 Science curriculum as published at the BCNC website is the major point of contact, some information relevant to the Science curriculum is presented at various places and sometimes in varying forms. There appears to be a built-in redundancy to the structure of the online curriculum with the result that navigating the various links and sub links often feels circuitous and sometimes is confusing. Perhaps the redundancy is deliberate, with the designers wanting to ensure that no matter how a user enters the site, they will have numerous opportunities to find the descriptions of the 'backstory' or context to the revision which detail the purposes, aims and goals of the rewrite. The context and rationale for the current curriculum revision have been described in Chapter Three, and some of that information is available through the BCNC website via links from the Homepage for that key portal (BC Ministry of Education, 2016e). It is important to remind the reader that the BCNC site serves as a point of entry for the entire new curriculum and not just for Science. While I will attempt a sequential examination of the online Science curriculum, moving in a linear manner from one banner to the next, if I were to try to create an overview map of the curriculum’s online layout, it would be anything but straightforward.

The overall design of the BCNC Homepage is attractive and clearly suggests that the intended users could not only be teachers or education professionals, but also parents or generally interested members of the community at large. The site requires no registration from users nor does it seek detailed user information. Users can also select either English or French versions of the curriculum, and the general curriculum overview is offered in two additional

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2 It would be interesting to know what sort of “traffic analysis” of the BCNC site has been and is being conducted by the government’s IT staff.
languages, Punjabi and Mandarin. Along with ease of accessibility, another advantage of the web-based approach is that the site can easily be updated and revised—a significant advantage over the hard copy-based print publications of the past.

![BC's New Curriculum Website Screenshot](image)

**Figure 2.** Top menu/banner for the BC’s New Curriculum website.


The top menu, or banner, for the BCNC website (Figure 2) is a gateway allowing users to select their areas of interest. Thus, from the Home Screen a user can review the curriculum’s *Core Competencies*, elect to visit online Curricula (where the pull-down menu offers the user links to: *Detailed Information, Browse by Subject, the 10-12 Draft Documents, a Curriculum Search tool, Instructional Samples, Tools* to support learning and instruction, and *Educator Updates*). The last two headings allow users to find information on *Assessment & Reporting*, and on *Graduation* requirements.

The selecting *Home* from the banner leads users to an animated screen which changes to reveal several questions: *How and what will students learn? How will the new curriculum prepare students for the future? How will we measure success?* The Home screen also invites parents to participate in discussions about Report Cards via the caption, *Your Kid’s Progress Public Engagement* where parents are advised that until February 28, 2017, at 4:00 p.m. they may contribute to this discussion via online feedback or at community meetings that will be happening around the province. The site also provides updates and news items related to the overall project of revising the BC curriculum, as well as a “Fast Links” table including a
Curriculum Parent Guide that is downloadable in PDF format, as well as other downloadable documents of general interest. There is even a link to Feedback applicable to the latest Grades 10-12 curriculum drafts). Feedback can be sent from this link via email from the users.

As reached via the BCNC portal, the K-9 Science curriculum is presented in a manner that is very similar to the presentations for all the other subjects, where each grade within each subject is presented separately from the other grades for that subject. It is not possible to get a composite overview of the whole curriculum across all subjects for each grade, nor is each subject’s curriculum presented in any place as a coherent whole. That said, the Curriculum Search tool does allow the user to search the entire curriculum by grade(s), subject(s), as well as by Big Ideas and/or Content and/or Curricular Competencies. Users can export the results from these searches to their own computers to Excel® or Word® software formats.

No matter which grade level or even which subject is selected, the webpage that appears is very similar in organization and appearance. The page top banners (Figure 3) clearly show which subject and grade is being presented. On the left, below the subject heading, the web page presents links to three documents specific to the particular subject (K-9 Science in this case): An Introduction, the Goals and Rationale for the subject, a What’s New section, as well as a fourth link to the general Curriculum Overview, as shown in Figure 4.
Figure 3. Overview and elements of the BC’s New Curriculum webpage.
Figure 4. The four top banner items shown on the Science section of the BC’s New Curriculum web page.

This display results from clicking on the homepage titles Curriculum, Browse by Subject, and K under Science. The four items in the banner are linked to expanded information for each. See also #3 on the full page overview.


For K-9 Science, the first three links listed in the Banner house science-specific documents while Curriculum Overview links the site user to documents providing general information about the whole new curriculum for BC. These links contain a great deal of information explaining what the curriculum rewrite is about, how it is organized, and the intentions behind the changes. Before going into more detail on these topics, I should note that, at the bottom of each and every webpage of the new curriculum are links to Flexible Learning Environments, Instructional Samples, Student Supports, and Aboriginal Education. Aside from the second link, that brings the user to a site curated by the Ministry, showcasing teaching models of excellence for support and inspiration, the other three links tie to short (three or four page) pdf documents further explaining each concept.
Figure 5. The *Introduction* link in the Science curriculum page banner.


Selecting the *Introduction* link on the banner opens a page describing the *Features of the Science Curriculum; Design of the Science Curriculum: Big Ideas, Curricular Competencies, and Content; and Important Considerations: Inquiry in Science, Scientific habits of mind, and Considerations for classroom action*. The introductory paragraph from this page states the purpose of the K-9 Science curriculum.

Science and scientific literacy play a key role in educating citizens of today for the world tomorrow. Critical to succeeding in this endeavor are the core competencies that provide students with the ability to think critically, solve problems, and make ethical decisions; to communicate their questions, express opinions, and challenge ideas in a scientifically literate way; and to exercise an awareness of their role as an ecologically literate citizenry, engaged and competent in meeting the responsibilities of caring for living things and the planet.” (BC Ministry of Education, 2016o, para. 1).

This page also mentions three Features of the science curriculum. First is the curriculum’s focus on inquiry (BC Ministry of Education, 2016o). Through inquiry, students will apparently now be able to, “ask questions, identify their beliefs and
opinions, consider a range of views, work collaboratively, and ultimately make informed conclusions that lead to responsible choices for themselves, their families, and their communities” (BC Ministry of Education, 2016o, para. 2). Inquiry is championed as the way students learn content as well as “habits of mind and skills and processes associated with the doing of science” (BC Ministry of Education, 2016o, Important Considerations section, Inquiry in Science). They will also gain a deeper comprehension of the concepts presented in the Big Ideas, as well as “acquire core competencies as scientifically educated citizens” (BC Ministry of Education, 2016o, Important Considerations section, Scientific habits).

A second feature is the apparent story of science that is being told, “a journey that takes the students from becoming aware of their immediate environment to considering the impact of local actions and making decisions on a global scale” (BC Ministry of Education, 2016o, Features section). As described in the Introduction to science, the Big Ideas of the science curriculum are claimed to tell this story through the featured concepts (BC Ministry of Education, 2016o, Design section, Big Ideas). These “important concepts are introduced in kindergarten and expanded in subsequent grades, resulting in a deep understanding of the story of science” (BC Ministry of Education, 2016o, Design section, Big Ideas).

Finally, the third feature is a combination that includes First Peoples’ perspectives and knowledge being embedded in the new curriculum. This feature, along with “traditional ecological knowledge”, also includes the support for conceptual learning within the curriculum (BC Ministry of Education, 2016o, Features section). It is not explicitly stated how traditional ecological knowledge differs from First Peoples, nor why this acknowledgement of different ways of knowing is lumped together with support for conceptual learning. Regardless, together
they make up the third of the three key features highlighted in the Introduction to the new science curriculum with the other major headings in the Introduction, *Design of the Science curriculum* and *Important Considerations*, being addressed in other sections of the BCNC website and consequently they are discussed later in this thesis.

![Science Curriculum Page Banner](image)

Figure 6. *The Goals and Rationale link in the Science curriculum page banner.*


Selecting the Goals and Rationale link on the Science Curriculum page banner (Figure 6) opens a new page where a user will find two sub headings: *Rationale* and *Goals* (in that order).

Taken together the statements made on this page provide detailed statements as to the importance of science education in BC at the level of grades K-9.

**The Rationale for the Science Curriculum**

The statement of intent opens with a clear commitment to the purpose for a science curriculum. It is important to note the Ministry’s description and definition of scientific literacy.

The intent of the curriculum is to develop scientifically literate citizens who have a critical awareness of the role of science in society, combined with a caring and responsible disposition and an understanding of the social, health, ethical, and
environmental dimensions of issues (BC Ministry of Education, 2016n, Rationale section, para. 4).

This statement is then extended with a description of the attributes of a scientifically literate citizen.

Scientifically literate citizens are able to use scientific evidence, as well as their knowledge from other areas of learning, to develop their own views, discuss and debate, and make informed decisions in their daily lives and about broader issues, while maintaining their curiosity and wonder about the natural world (BC Ministry of Education, 2016n, Rationale section, para. 4).

It is notable that these descriptions refer to “citizens” rather than “people,” “students” or even “individuals”. The notion of the development of citizenship as a major goal of schooling in BC is consistent with the language of the School Act and the general Mission Statement for BC schools as described in Chapter Three. Citizenship suggests active engagement with community issues and political processes.

The second part of the document opened by the link to Goals and Rationale in the K-9 Science Curriculum page banner addresses the five goals that are to be achieved by students as an outcome of engaging with the science curriculum. The first goal is for students to “develop an understanding and appreciation of the nature of science as an evidence-based way of knowing the natural world that yields descriptions and explanations that are continually being improved within the context of our cultural values and ethics” (BC Ministry of Education, 2016n, Goals section, bullet 1).

The second goal is that students will develop “place-based knowledge and experiences about the natural world” (BC Ministry of Education, 2016n, Goals section, bullet 2). Although he
is not specifically referenced, David Sobel, who coined the term, defines place-based education as “the process of using the local community and environment as a starting point to teach concepts … across the curriculum, [where] hands-on, real-world learning experiences” are emphasized (2005, p. 7). Place-based knowledge is understood to create, “a basis for an intuitive relationship with and respect for the natural world; connections to [the student’s] ecosystem and community; and a sense of relatedness that encourages lifelong harmony with nature (BC Ministry of Education, 2016n, Rationale section, para. 2).

A third goal is for students to “…develop a solid foundation of conceptual and procedural knowledge in science that they can use to interpret the natural world and apply to new problems, issues, and events; to further learning; and to their lives” (BC Ministry of Education, 2016n, Goals section, bullet 3).

The fourth goal listed in this document refers to the development of “the habits of mind associated with science.” The habits of mind associated with science are proposed to include the following attributes.

A sustained curiosity; a valuing of questions; an openness to new ideas and consideration of alternatives; an appreciation of evidence; an awareness of assumptions and a questioning of given information; a healthy, informed skepticism; a seeking of patterns, connections, and understanding; and a consideration of social, ethical, and environmental implications (BC Ministry of Education, 2016n, Goals section, bullet 4).

Finally, the fifth stated goal of the science curriculum is to develop in students, “a lifelong interest in science and the attitudes that will make them scientifically literate citizens who bring a scientific perspective, as appropriate, to social, moral, and ethical
decisions and actions in their own lives, culture, and the environment” (BC Ministry of Education, 2016n, Goals section, bullet 5).

What’s New

![Science Curriculum Banner](https://curriculum.gov.bc.ca/curriculum/science/k)

*Figure 7. The What’s New link in the Science curriculum page banner.*


The third link on the Banner menu on the Science Curriculum section of the BCNC general web page is titled What’s New. Selecting this link will take the user to a section describing the general features of the overall curriculum (where there is more information and additional details along with the three Features listed above under the Introduction) as well as notices regarding the process by which the curriculum for Grades 10, 11, and 12 is being revised (*Drafts for Grades 10-12 curriculum*).

The first feature mentioned here is the organization of the K-9 Science curriculum around the four core science disciplines of biology (including ecology), chemistry, physics, and Earth/space science, a pattern similar to the previous science curriculum and, consequently, familiar to many. Notice is made that each grade level will include four Big Ideas - one for each of the four core science disciplines. Further, a focus on inquiry is stated as being apparent throughout the curricular competencies in the science program along with an emphasis on a place-based approach, with the concept of place being developed with students through the use of reflective questions to be considered at each grade level.
Finally, note is made that “First Peoples perspectives are reflected in the Curricular Competencies, Content learning standards, and Elaborations in each grade” (BC Ministry of Education, 2016q, K-9 curriculum section, bullet 7). A note is also made that the content of the curriculum is “aligned within the K-9 progression to provide a strong conceptual story of science” (BC Ministry of Education, 2016q, K-9 curriculum section, bullet 6). Presumably this means that students will develop their knowledge and understanding of core concepts through working with the Big Ideas incrementally as they progress from grade to grade.

The section of What’s New discussing the Grades 10-12 draft curriculum repeats the intention that the senior science curriculum will still be committed to the goal of fostering the “scientifically educated citizen”. Students may “complete their science learning during Grades 10–12, may go on to further science learning through post-secondary opportunities, or may enjoy lifelong science learning” (BC Ministry of Education, 2016q, Drafts section, para. 1). Presumably, the Science curriculum K-9 will have prepared the senior students to exercise these options.

Curriculum Overview

![Curriculum Overview](https://curriculum.gov.bc.ca/curriculum/science/k)

*Figure 8. The Curriculum Overview link on the Science curriculum page banner.*


As with the other elements of the banner menu on the K-9 Science Curriculum general page, selection of the Curriculum Overview heading (Figure 8) takes the user to a new
page/document. The Curriculum Overview page includes seven sections, starting with *Education for the 21st Century*, and *Student Success Through Curriculum Transformation*. This second section has two sub-headings: *The Educated Citizen* and *Personalized learning*. The third section, *Key features of redesigned curriculum*, has three sub-headings *The Core Competencies*, *Essential learning*, and *Literacy and numeracy foundations*. The fourth section, *Curriculum model*, has as four subheadings *Content (Know)*, *Curriculum Competencies (Do)*, *Big Ideas (Understand)*, and the *Concept-based, Competency-driven Curriculum*. The fifth section is *Redesigned Curriculum in Action*. This title includes discussion of *Flexible learning environments*, *ICT-enabled learning environments*, *Inquiry and question-based approaches*, and *Collaboration with community*. The final major headings in the rather lengthy and comprehensive Curriculum Overview section are *Aboriginal Perspectives and Knowledge* and *Program Considerations*. *Program Considerations* includes topics *Valuing Diversity*, *Supporting Diverse Learners*, *Personal Safety*, and *Alternative Delivery policy* (BC Ministry of Education, 2016d). Each of these headings is a complex topic on its own.

Many of these ideas are presented in other online sections of the general BCNC website and are linked from other areas of the site. Apparently the designers of the overall BC’s New Curriculum site wished to be sure that however a user approached the site they would eventually be led to the larger design concepts behind the whole curriculum revision project. Since these larger concepts have been discussed elsewhere in this Chapter and in Chapter Three, I will focus here only on the Curriculum Overview section’s heading on Aboriginal Perspectives and Knowledge.

This section of the Overview makes a clear statement about the intent to fully recognize Aboriginal perspectives and traditions throughout the revised BC curriculum.
British Columbia has long had the goal of improving school success for all Aboriginal students. Achieving this goal will require that the voices of Aboriginal people be heard in all aspects of the education system; the presence of Aboriginal languages, cultures, and histories be increased in provincial curricula; and leadership and informed practice be provided.

This commitment is extended through other statements made in this section. This means that from Kindergarten through graduation, students will experience Aboriginal perspectives and knowledge as part of what they are learning. And because Aboriginal perspectives and knowledge are embedded in the curriculum, they will naturally influence the ways in which students will be assessed (BC Ministry of Education, 2016d, Aboriginal Perspectives section, para. 3).

There was an embedded link in this section to a one-page poster entitled First Peoples Principles of Learning that lists nine fundamental truths of learning, including “learning involves patience and time” and “learning requires exploration of one’s identity” (First Nations Education Steering Committee, n.d.), however that link was no longer active as of April 29, 2017. As mentioned previously at the bottom of each page of the BCNC website there is a link entitled Aboriginal Education that houses a three-page resource publication of the same name. The importance of embedding First Peoples’ knowledge and perspectives in the actual curriculum is also emphasized in various ways throughout the documents explaining the new curriculum. For example, Under Goals and Rationale, it is stated that, “Linking traditional and contemporary First Peoples [sic] understandings and current scientific knowledge enables us to make meaningful connections to our everyday lives and the world beyond” (BC Ministry of Education, 2016n, para. 1).
Core Competencies

Figure 9 below illustrates an interactive menu that is located below the Banner Menu shown in Figure 8; this menu is devoted to the Core Competencies. The three broad Core Competencies are intended to be woven throughout the entire curriculum, and include the areas of Communication, Thinking, and Personal & Social competency. Each competency area is represented with a triangular icon that links the reader to a corresponding resource document.

![Core Competencies](image)

*Figure 9. The Core Competencies menu from the overall K-9 Science curriculum page. (Each of the 3 triangles is a link to a component of the Core Competencies that apply to the entire new curriculum.)*


The three categories of the Core Competencies were defined in a 2013 January Draft, although at that time they were referred to as Cross-Curricular Competencies. The 2013 draft clearly outlined the importance of the cross-curriculum competencies to the curriculum redesign and to the support of deeper learning for each individual.

At the heart of the definition of the cross-curricular competencies is the principle that education should lead to the development of the whole child—intellectually, personally, and socially. In a world of growing diversity and challenge, schools must do more than help students master the sets of knowledge and skills acquired through the standard subject areas. They must prepare students fully for their lives as individuals and as
members of society, with the capacity to achieve their goals, contribute to their communities and continue learning throughout their lives.

The cross-curricular competencies are the set of intellectual, personal, and social skills that all students need to develop in order to engage in deeper learning—learning that encourages students to look at things from different perspectives, to see the relationships between their learning in different subjects, and to make connections to their previous learning and to their own experiences, as members of their families, communities, and the larger society. (BC Ministry of Education, 2013, p. 3)

The 2016 Core Competency Profiles divide “Thinking” and the “Personal and Social” core competencies into more detailed components. The more recent versions of the supporting profile documents can be accessed from the three triangles of the website or from the Core Competencies tab from the top banner of the website. Most links take the user to the Core Competencies overview page with embedded links to the six components of the three core competencies. All six of the online Competency Profile documents are labelled DRAFT, are not dated, and no version information is provided. Each competency is supported by a downloadable Competency Profile, in PDF format, while each profile page includes Competency Illustrations broadly graded in levels of performance. The resources are provided in both English and French.

**Big Ideas as a Key Feature of the Science Curriculum**

Scrolling further down the BCNC website pages for subject areas the user will discover The Big Ideas (Figure 10). This is where grade-specific differences start to appear in the Science

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3 The core competencies are now listed as: Communication, Critical Thinking, Creative Thinking, Positive Personal and Cultural Identity, Personal Awareness and Responsibility, and Social Responsibility
K-9 curriculum. Each grade is indicated by four large circle graphics, one for each of the Big Ideas for that year. Figure 10 shows the Big Ideas listed for Kindergarten in Science.

Figure 10. The section of the BCNC science webpage showing Big Ideas for K science.

Note: The colored labels have been inserted for this figure in order to indicate that for all grade levels (K-9) there are Big Ideas associated with biology, chemistry, physics, and Earth/space science (and in that order) even though they are not identified that way on the website.


The text in the circles stating the Big Ideas can be expanded by moving the mouse cursor over the circle graphic to show Sample questions to support inquiry with students, presumably to help guide the teacher. For example, on the Science webpage for Grade 1, a Big Idea is that “Matter is useful because of its properties”. The expansion contains the sample questions:
What makes the properties of matter useful? How do the properties of materials help connect to the function of materials?” (BC Ministry of Education, 2016i).

**Learning Standards**

The Learning Standards section of the webpage obtained for any year of the K-9 Science curriculum will include a list of Curricular Competencies and Content, as shown in Figure 11.

**Learning Standards--Curricular Competencies**.

Below the Big Ideas for any given year of the curriculum the site presents a Learning Standards table, which lists Curricular Competencies on the left and Content on the right (Figure 11). The Curricular Competencies are claimed to have a prominent place in the redesign, where the active “doing” of science now accounts for almost 65% of the science learning standards (as compared to about a quarter before) (BC Ministry of Education, 2016o). Under Curricular Competencies heading, “Students are expected to be able to do the following”, the user will find the curricular competencies listed in categories ranging from five expected (in Kindergarten) to six (by Grade nine, with the addition of Evaluating). For Kindergarten, the five categories are Questioning and predicting; Planning and conducting; Processing and analyzing data and information; Applying and innovating; and Communicating. Each of these is followed by two to eight skills, strategies and processes.

From being introduced in Kindergarten, the Curricular Competencies are then “expanded in a developmental continuum focused on the “doing” of science learning” (BC Ministry of Education, 2016o, Curriculum Competencies section). For example, in the category of “Evaluating” that appears first in Grade 1, students are to “compare observations with those of others”, and “consider some environmental consequences of their actions” (BC Ministry of Education, 2016i). There are more skills, strategies and processes as the grades increase. In
Figure 11. The Learning Standards table for Science Grade 1 in the Science section of the BCNC webpage.

Note: the Curricular Competencies and the Content headings have been highlighted to make them more visible in this figure. The lower section shows how a Curricular Competency, “Questioning and predicting”, can be expanded to reveal information and definitions about that competency.

Grade 3, again under *Evaluating*, students are to “make simple inferences based on their results and prior knowledge, reflect on whether an investigation was a fair test, demonstrate an understanding and appreciation of evidence, and identify some simple environmental implications of their and others’ actions” (BC Ministry of Education, 2016j). By Grade 9, nine processes and activities are listed under *Evaluating*, with many more expectations including exercising, “a healthy, informed skepticism,” and “identifying sources of error or uncertainty”, and the ability to “critically analyze the validity of information in secondary sources” to name but a few (BC Ministry of Education, 2016m).

Elaborations (shown by a yellow star and indicated as an “Expansion” in Figure 11), are indicated on the web page by underlined and purple-colored text, and are in place for some of the curricular competencies for given grades. The purple underlining cues the user to hover their mouse to reveal the elaboration. There are only a few elaborations under the Curricular Competency heading. One of note, apparent throughout the ten years, is found by hovering over the word *place* under the competency *Communicating*. Doing so will reveal the Ministry’s definition:

> Place is any environment, locality, or context with which people interact to learn, create memory, reflect on history, connect with culture, and establish identity. The connection between people and place is foundational to First Peoples perspectives of the world (BC Ministry of Education, 2016p).

It also will reveal key questions related to the concept of place:

> What is place? What are some ways in which people experience place? How can you gain a sense of place in your local environment? How can you share your observations and
ideas about living things in your local environment to help someone else learn about place?” (BC Ministry of Education, 2016p).

By Grade 5, the concept of secondary sources is introduced, though no reference to primary sources is found earlier in the curriculum. This concept comes with an elaboration (“secondary sources of evidence could include anthropological and contemporary accounts of First Peoples of BC, news media, archives, journals, etc.” (BC Ministry of Education, 2016k).

In Grade 7 more text under Curricular Competencies comes with elaborations, including qualitative, quantitative, accuracy, precision, and ways of knowing. This last topic, under the subheading Processing and analyzing data and information, is elaborated upon as “the various beliefs about the nature of knowledge that people have; (these beliefs) can include, but are not limited to, Aboriginal, gender-related, subject/discipline specific, cultural, embodied and intuitive beliefs about knowledge” (BC Ministry of Education, 2016l).

Interestingly, Questioning and predicting is the only Curricular Competency presented with elaborations, and this is done consistently throughout the K-9 curriculum. The information in these elaborations is worthy of note, and is presented for all grades, K-9, in shown in Table 1 (Appendix 1, pp. 126-127). Thus, for Grade 1, Questioning and Predicting can be expanded as shown in Figure 12, to reveal more information about form and function. What is then displayed includes a circular definition cum clarification on form and function, as well as “Key questions about form and function” (BC Ministry of Education (2016i). These elaborations appear to be directed at teachers.
Figure 12: Curriculum Competencies for Grade 1 Science in the Science section of the BCNC Web page.

An important consideration here is how the information revealed behind the *Questioning and predicting* competency in each grade is, in fact, partially hidden and only available one grade at a time. Nowhere on the Ministry’s website are these elaborations presented in their entirety, as shown in Table 1 (Appendix 1). Nowhere are these concepts highlighted as important for the teacher to find, though in the Introduction to Science they are described as “relevant in science [and] can be applied across numerous areas of learning [to] further expand science learning” (BC Ministry of Education, 2016o, Design section, Content).

**Learning Standards—Content.**

The final column of the Learning Standards Table for each grade, Content, lists up to 14 concepts students are expected to know by the end of each grade. There seems to be no logical progression or reasoning behind the varying numbers: all grades have ten content areas/topics except Grades 4 and 6, which each have eight, and Grade 8 that tops out with 14 (Appendix 1, Table 2, p. 128). Content is linked with the Big Ideas for each grade, though the linking is not explicitly stated. While the total number of Content topics is very similar from grade to grade, with some minor exceptions as noted for Grades 4, 6, and 8, the distribution of content among the four science fields differs from grade to grade. As a field, chemistry receives somewhat less attention than the others, with Earth/space getting the greatest number of content topics. That number likely reflects that Earth/space science is a large and hybrid field encompassing several disciplines.

Many of these content items are also presented as bolded and in colour. For example, in Grade 5, one topic to be explored is that of power, defined as “the rate at which energy is transferred” (BC Ministry of Education, 2016k). When the elaboration is revealed, the text only reveals “examples include students racing up a hill, machine power ratings, motors” (BC
Ministry of Education, 2016k). Another Grade 5 content topic area concerns *earth materials*. The elaboration there simply lists some earth materials, including “mineral, rock, clay, boulder, gravel, sand, soil” (BC Ministry of Education, 2016k).

Altogether, through its focus on inquiry learning, the science curriculum is meant to “provide students with opportunities to ask questions, identify their beliefs and opinions, consider a range of views, work collaboratively, and ultimately make informed conclusions that lead to responsible choices” (BC Ministry of Education, 2016o, Features section, bullet 1). Additionally, the K-9 Science curriculum is designed to support conceptual learning, with “both traditional ecological knowledge and First Peoples [sic] perspectives … embedded” within (BC Ministry of Education, 2016o, Features section, bullet 3). As previously mentioned, the curriculum apparently tells the “story of science” through the grades, moving from initial awareness of the local environment through to seeing the impacts of local actions on a global level (BC Ministry of Education, 2016o, Features section, bullet 2). To see how this may work, we can take an example from biology. The Big Ideas related to biology supposedly carry the story of the biological sciences (see Appendix 1, Table 3, p. 129). This story starts in Kindergarten with students seeking to understand that “plants and animals have observable features” (BC Ministry of Education, 2016p). Some content that accompanies this hopefully enduring understanding is knowledge about the “basic needs of plants and animals”, “adaptations of local plants and animals”, and “local First Peoples [sic] uses of plants and animals” (BC Ministry of Education, 2016p). If someone wanted more clarity on that last content piece, for instance, the extra information found by hovering one’s mouse over the text “local First Peoples uses” would reveal “First Peoples [sic] practice and knowledge of plant and animal use (e.g.
local berries or food, plants and animals, conservation of resources)” (BC Ministry of Education, 2016p).

From plants’ and animals’ observable features, the Big Ideas change so that, at the end of Grade 1, students will understand that, “Living things have features and behaviors that help them survive in their environment” (BC Ministry of Education, 2016i). By Grades 5 and 6, students are looking closely at multi-cellular organisms, their internal systems, and how they survive and interact with their environment. The Theory of Evolution is the Big Idea for Grade 7 biology, and Grades 8 and 9 study cells. This is the plotline, if you will, of the Story of Biology.

If we look at the science Curricular Competencies, they apply to all streams of science in the curriculum, whereas the Core Competencies cut across the various ages and subjects. However, the Science section of the BCNC webpage clarifies the relationship between the specific curricular competencies, and the cross-cutting Core Competencies by stating, “The Core Competencies — Thinking, Communication, and Personal and Social — are embedded in the Curricular Competencies” [emphasis mine] (BC Ministry of Education, 2016o, Design section. Curricular Competencies). Notable also with the description of the Design of the Science curriculum is a table showing how the Core Competencies of Thinking, Communication, and Personal and Social might be developed across the years of the Science curriculum from K to 3, 6, and 10 (see Appendix 1, Table 4, p. 130).

The Curricular Competencies are expected to be developed while students study biology as well as chemistry, physics, and Earth and space science. As previously mentioned, there are five broad competencies to be developed in Kindergarten, with the sixth competency, Evaluating, first presented in Grade 1. From Grades 1-9, as with Big Ideas, the number of Curricular Competencies stays constant at six. However, the bullet-points under each of these five (in
Kindergarten) to six (for Grades 1-9) Curricular Competencies increase in number (and complexity) as the students increase in age. From Grade 1 on, the particular bullet-points for each of the competencies at play change on the odd grade year only, so Grades 1 and 2, 3 and 4, etc. have the same Competencies. Kindergarteners are supposedly working with 14 subcategories (bullet-points) under the five Curricular Competencies, while Grade 9s have 26 for the six competencies. As an example, under *Questioning and predicting*, Kindergarteners are working to, “Demonstrate curiosity and a sense of wonder about the world, observe objects and events in familiar contexts, and ask simple questions about familiar objects and events” (BC Ministry of Education, 2016p). In Grade 1, the questions they are to ask are no longer defined as “simple”, and a new sub heading has been added: “Make simple predictions about familiar objects and events” (BC Ministry of Education, 2016i). By Grade 3, “wonder” has been removed, for students are now expected to simply “demonstrate curiosity about the natural world” (BC Ministry of Education, 2016j). They still are to “identify questions about familiar objects and events,” from Grades 1 and 2, but now these questions are to be ones “that can be investigated *scientifically*” [emphasis mine] (BC Ministry of Education, 2016j). By Grade 9, the expectations related to the *Questioning and predicting* component of the science curricular competencies have increased in number as well as complexity, detail and depth. Now, students are to

Demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal interest, make observations aimed at identifying their own questions about the natural world, and formulate multiple hypotheses and predict multiple outcomes” (BC Ministry of Education, 2016m).
This pattern of increasing the amount and detail included in the Curricular Competencies occurs for almost all the subheadings in the Science curriculum. However, there are a couple of exceptions to this general trend. Throughout the ten years, students always are expected to “experience and interpret the local environment”, a sub heading of the Processing and analyzing data and information Competency. So too are they to “express and reflect on personal experiences of place” throughout, though at Grade 9 “personal experiences” changes to include “a variety of experiences, perspectives and worldviews of place” (BC Ministry of Education, 2016m).

In this chapter I have attempted to provide the reader with a relatively complete description both of the content of the curriculum as it is published and presented on the BCNC website, and also to reveal how a user of the site is expected to interact with the site in order to take full advantage of the considerable resources offered in this curriculum. As has been noted before, the Minister of Education, on announcing the new curriculum, claimed that it was not the intention to provide a “blueprint” of requirements and activities for teachers. Nonetheless, as I hope I have shown in this chapter, the web based curriculum offers the material in layers of varying detail depending on how a user chooses to interact with the science component of the BCNC site. Overall, this curriculum may be considered to be more detailed than any previous print-based curriculum. An issue to be considered is how teacher-users will interpret the expectations that are at least implicit in the levels of detail and the resources provided. In Chapters Five and Six I will reflect critically on my inspection and exploration of the K-9 Science curriculum as it is published and presented online.
Chapter Five: The Critical Analysis

Eisner makes two essential points about criticism. First, he believes it to be “an empirical undertaking,” meaning that what is discussed by the critic must be able to be found in the actual work. “It is not abstraction that one understands through criticism but rather qualities and their relationships” (1985, p. 217). The second point is that anything can be subjected to critical analysis, meaning “the illumination of something’s qualities so that an appraisal of its value can be made” (Eisner, 1985, p. 218).

As proposed in Chapter One, a curriculum can be viewed as a work of design. Petroski has written, “Though there may be no perfect design, we can still speak of good design” (2003, p. 16). Though the manners in which to achieve this good design may vary, most have a common thread where the problem or issue is first identified, a creative component or response follows, the output or “solution” is developed and tested, and a certain looking back or evaluation ensue. Some designers focus on the user, some on the use for the designed product. Design principles are far-ranging and highly adaptable to almost any creative endeavor, curriculum development included.

Regardless of the approach taken, when critiquing a work of design one should think about the apparent intentions of the designer, and if those intentions are clearly and consistently apparent in the final work. Was the designer working forward, thinking about the user and then working out, or working backwards, looking inwards after inventorying available materials and technology? Did the form of the final product follow function, or were the two more entwined in terms of importance as the final product took shape? Did the final product match the intended outcomes and intentions determined from the preliminary design stages?
The new BC K-9 Science curriculum, part of the whole curriculum rewrite for the BC education system, represents a plan for a course of study. This curriculum outlines a map by which schools can achieve their purposes as related to science education. Seeing as the BC K-9 Science curriculum is a work of design, it can be critically analyzed. Eisner cites Dewey when he wrote, “the end of criticism is the reeducation of the perception of the work of art” (1985, p. 217) or, put another way, that criticism strives to “lift the veils that keep the eyes from seeing” (Eisner, 1985, p. 217).

Schubert states that while curriculum development teams often speak of following a known design approach, by being mindful of clear purposes, learning experiences, arrangement and assessment, their actually doing so occurs far less frequently (1986, p. 95). Consequently, I wanted to look at the curriculum through the lens of curriculum as design. A very widely used and popular design model is known as the ADDIE process where the acronym stands for steps proposed in the design process; namely, Analysis, Design, Development, Implementation, and Evaluation (Morrison, Ross, Kalman, & Kimp, 2011). In developing and framing my critique of the science curriculum I found it useful to apply questions informed by the key steps in the ADDIE model.

I looked at six questions represented in ADDIE’s five categories. From the first category, Analysis, I was led to wonder about the timing of this redesign. From Design, step two, I had two questions. The first is: What frame or orientation best represents the new curriculum, or is it a blending of several? The second: How does the new curriculum present science as a field of knowledge and a way of knowing the world? My question related to the third category, Development, asked what are the explicit and implicit assumptions apparent in the redesign? Implementation, the fourth category in the ADDIE model, felt like the crux of the entire
endeavor, and I asked what is expected of teachers based on the new curriculum, in terms of ways of teaching, approaches to assessment, and increased communication with parents, and what supports are in place to help shoulder the load, especially since some of these processes are presented as departures from former practice. For the final category, Evaluation, I asked what is included in the design to provide for an evaluation of the work done so far, to gauge successes and failures of the new curriculum. I also asked what is in place, if anything, to respond to potential issues or concerns with the new curriculum as it gains a foothold in the schools across BC. Those questions structure the following sections.

As has been noted in the Introduction to this thesis my review of the K-9 Science Curriculum was based on the published versions of that curriculum and supporting documents. This means that my critique did not involve inspection of the curriculum in action in real classroom settings nor did it include interviews with teachers and other school personnel involved in the implementation of the new program. The following sections on Analysis, Design, and Development can readily be based on a review of the published curriculum. However, it is not as easy to review the Implementation and Evaluation aspects of the curriculum as designed and published in the absence of a review of the curriculum in action. My approach in those final sections has been to focus on how the designers and developers of the new Science curriculum have attended to or considered the requirements for its implementation and evaluation inasmuch as those considerations can be seen in the published version, especially online at the BC’s New Curriculum (BCNC) website (https://curriculum.gov.bc.ca).
Analysis - Why now?

In the ADDIE design process, the first step is to identify the needs to which the design project will attend. Often, this involves focusing on addressing a clear problem or issue, and may be driven by a needs analysis. According to the Minister of Education’s statements and measures of actual student performance, BC is already doing well with its education system. Both the Sullivan Report (Sullivan, 1988) and the Ministry’s Service Plan (BC Ministry of Education, 2016a) discuss “new social and economic realities” and the need for students to be “versatile and flexible”. It would seem that not much has changed in the past 30 years in terms of aims and goals. Likewise, the education system in which these proposed changes are to be made is not slated for major restructuring. In this context, my first question about the new BC Science K-9 Science curriculum, and in fact the entire K-12 project of general curriculum revision was: “Why now?”

As discussed in Chapter One and as stated by the then-Minister of Education in the preface to BC’s Education Plan (BC Ministry of Education, 2015a) the province’s education system ranked well in assessments comparing education systems in a number of nations and across Canadian jurisdictions. In fact, new international rankings were generated during the writing of this thesis. The 2016 report of 15-year-olds’ science, math and reading abilities, compared across 72 countries and conducted every three years, focused on science. An article on the report stated, “Canadian students rank fourth for science performance,” tied with Finland (Alphonso, 2016). Given the data reported for the international assessment, as well as the former Minister of Education’s description of BC’s education system as “world class,” I was perplexed that the BC school curriculum, including the Science curriculum, was apparently viewed as needing extensive revision.
Perhaps the need for the curriculum revision was realized through the identification of new goals in education, focused on personalized learning and student success via 21st Century learning. In addition, BC’s Education Plan claimed student achievement must be grounded on both solid foundations in reading, writing, and arithmetic as well as student engagement in collaboration, critical thinking and communication (BC Ministry of Education, 2015a). Presumably, the Ministry must have looked at what was currently offered, whether working or not, and determined a rewrite was in order. However, I wonder if the revision was decided upon before a comprehensive analysis of the current situation was conducted. As stated earlier in this thesis, much of the language and reasoning behind this “new” curriculum is informed by Sullivan’s report, both the Legacy for Learners and the government’s response in the Year 2000: A Framework for learning. The old curriculum’s direction and goals sound remarkably similar to that mentioned in the redesign.

In view of the new social and economic realities, all students, regardless of their immediate plans following school, will need to develop a flexibility and versatility undreamed of by previous generations. Increasingly, they will need to be able to employ critical and creative thinking skills to solve problems and make decisions, to be technologically literate as well as literate in the traditional sense, and to be good communicators. Equally, they will need to have well developed interpersonal skills and be able to work cooperatively with others. Finally, they will need to be lifelong learners (BC Ministry of Education, 1990, p. 2).

In spite of the powerful statements made in the Plan concerning the impact of new technologies on learning, it is interesting how so much of today’s schooling, including the curriculum, is still very much based on the ideas and needs of the distant past. Schools today are
mostly run in the same manner as they have been for well over one hundred years. Much of what is taught is offered by focusing on similar subjects, and suggestions as to how the teaching is to be done, with teacher-as-expert in same-aged classrooms. The school calendar still runs almost on an agrarian schedule. The school buildings are often similar, too, with separated classrooms, long hallways, and one or two large inside spaces to allow for the entire school population to meet on occasion. Clearly, the needs of a society involved with and benefiting from the massive changes brought on by the Industrial Revolution may no longer match the needs of today’s Internet and Digital society. Indeed, many have noted how schools today are reminiscent of industrial era factories, and are still mirroring the factory model of pumping out workers able to turn right around and fill the factory jobs required after the start of the Industrial Revolution.

Additionally, many components of the Know-Do-Understand model of learning in science are similar to what was prescribed in the previous curriculum, sometimes, but not necessarily, having been moved to a different grade level (see Appendix 1, Table 5, pp. 131-2), to see how biology has changed). A great deal of this “new” curriculum is the old curriculum, repackaged. The same subjects remain, with much of the same subject material, delivered in the same one to two-grade classrooms within the same school-day timetable and led by the same teachers. It is true that the new model shows a drastic decrease in the number of prescribed learning outcomes, and that it is striving for more “doing”, less “knowing” (or, less rote memorization). However dramatic a change that may seem, when weighed against all that remains the same, its potential to cause systemic change seems altogether less likely.

Theoretical models of design are often tempered by constraints, be they social, political, economic, practical or technical. As Petroski has written, “All design involves choice, and the choices often have to be made to satisfy competing constraints” (2003, p. 11). Schubert has noted
that “the influence of politics on education generally and curriculum in particular has become more widely acknowledged” and further states that curriculum is “laden with political and ideological values” (1986, p. 127). I have no way of knowing what sort of analysis led to the decision for changes, nor all the constraints imposed on the curriculum designers. Having no access to any record of the reasoning behind such decisions leaves the critic to base their review only on the results of such decisions, combined with conjecture and reflection. ⁴

**Design – What Curriculum Orientation/Framework Best Applies?**

The Design phase of the ADDIE model moves beyond the initial grasping of the task at hand, ascertaining of the needs of those involved, and the identification of the project’s goals and objectives as seen in the Analysis phase. The Design phase is often when the concept plan is developed - a broad outline, “storyboard”, or concept sketch of the project. By looking more closely at what has been included from this stage, it is possible to check if the stated, explicit goals from the introductory documents are embedded or expressed within the actual curriculum rewrite - if the curriculum developers are walking the talk, if you will.

Eisner proposed that specific and different goals and content arise from each of his five curricular orientations represented in a given curriculum (1985, p. 84). Additionally, he claimed that understanding the curriculum’s orientation is of utmost importance, for orientation influences which learning opportunities occur, and with the learning opportunities comes the content actually delivered (Eisner, 1985). His proposed curriculum orientations have been discussed in Chapter Two (Eisner’s Five Curriculum Orientations and Three Curricula). He makes the argument that, “The function of these descriptions is to make vivid the major ways in which individuals think about the aims and content of the curriculum, the role that teachers

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⁴ Critics and historians must often rely on records of the processes and decisions made. However, in BC curriculum committees appear keep no Minutes or archive of correspondence, etc.
should play in schools, and the criteria that should be applied to assess the quality of schooling” (1985, p. 62).

In developing my critique of the K-9 Science curriculum, I have asked whether the design of the new curriculum best represents a particular image or orientation, as described by Schubert and Eisner respectively, or if it is a blending of more than one. While both perspectives are useful, I have decided to focus on Schubert’s images. In my opinion, Eisner’s five orientations are represented within Schubert’s eight images. Additionally, Eisner himself cautioned that his orientations are described, “More pointedly than one is likely to find in any school”, and that results in their description being more “vivid”, or “oversimplified” (1985, p. 62). As mentioned in Chapter Two (Schubert’s Curriculum Images), Schubert (1986) described eight images, or frames for considering curriculum that he believed can reveal the variations possible in terms of what a curriculum does and aims to achieve. They are: Curriculum as Content or Subject Matter; Curriculum as a Program of Planned Activities; Curriculum as Intended Learning Outcomes: Curriculum as Cultural Reproduction; Curriculum as Experience; Curriculum as Discrete Tasks and Concepts; Curriculum as an Agenda for Social Reconstruction; and Curriculum as “Currere” (1986). He explained that this exercise was done in the name of economy, wanting to simply “categorize major conceptions of curriculum, with examples, intents, and criticisms of each (1986, p. 26). I will briefly examine the eight, starting with those more relevant to the new curriculum. By conducting such an exercise, perhaps a better understanding of the meaning behind and intention of the redesign can be gleamed. It becomes apparent that BC’s new curriculum doesn’t fit particularly well to any one image; in fact, it feels spread thin among many. I will discuss the potential consequences of this as well.
Curriculum as content or subject matter.

While Schubert’s image, Curriculum as Content or Subject Matter, is apparent and relevant to BC’s new curriculum, it does not encapsulate it. Certainly, BC’s curriculum has content. In the Know-Do-Understand model, the Big Ideas are described as the “enduring” learning, and the accompanying Content is related to them (though that is not explicitly stated). Indeed, if using Schubert’s definition here, where “curriculum is equated with the subjects to be taught” (1986, p. 26), all components of the Know-Do-Understand curriculum model would fit into curriculum as content, for “Science” is the content.

With that in mind, it is apparent that this Science curriculum still represents a classic model of education. While the US counterparts are stressing linking science with engineering and technology, and have kept physics and chemistry combined as the ‘physical sciences’, here in BC physics and chemistry have been separated and emphasized with a greater percentage of content requirements than before. Additionally, thinking of Eisner’s null curriculum, this new Science curriculum pays no mention to the recent work made by STEM committees that strongly believe science must be linked with math, engineering and technology. In a province where the Premier, Christie Clark recently announced that all public-school students will be learning coding, this absence is confusing, if not troubling. It also feels like a real opportunity has been missed by not combining science and engineering in the new curriculum when speaking loudly of learning in (and for) the 21st century.

In the online Introduction to the Science curriculum, the writers speak of how “important concepts are introduced in Kindergarten and expanded in subsequent grades” (BC Ministry of Education, 2016o, Design section, Big Ideas), though this only seems applicable to the Curricular Competencies. While I presume some scaffolding of knowledge is required as the
content develops throughout the grades, this is not made explicit. In Science: What’s New? the writers speak of a “thoughtful flow of concepts” (BC Ministry of Education, 2016q, para. 1) as related to multi-grade classrooms, and that, “Content has been aligned within the K–9 progression to provide a strong conceptual story of science” (BC Ministry of Education, 2016q, K-9 curriculum, bullet 6). However, for me a great deal of the content introduced each year feels more stand-alone than part of a bigger, comprehensive whole.

It is of note, that the Curriculum Competencies (the “doing” of science) have taken a much more prominent role in the current redesign, acknowledging their importance in science learning. However, other key pieces, such as the history of science, science as a form of knowledge, understanding what science can do or be expected to do, as well as its limitations, are notably absent.

**Curriculum as intended learning outcomes.**

Schubert’s image, Curriculum as Intended Learning Outcomes, is still applicable to the redesigned science K-9 curriculum, though the language for the entire curriculum rewrite has moved away from “prescribed” learning outcomes For Schubert the Learning Outcomes image, “shifts emphasis from means to ends” and makes curriculum “the realm of intentionality that fosters the intended learning outcomes” (1986, pp. 28-29).

By year’s end students are expected to understand the Science Big Ideas for that year of the curriculum. Throughout all grades, students are expected to develop scientific habits of mind and scientific literacy through engagement with the progression of the Know-Do-Understand model. As they age, the curricular competencies increase in complexity and detail, and it is expected students will be able to demonstrate these, too. Presumably, then, students are to
demonstrate learning and understanding of the content to which the Know-Do-Understand model is applied.

Students also are to “develop place-based knowledge of the natural world and experience the local area in which they live by accessing and building on existing understandings, including those of First Peoples” (BC Ministry of Education, 2016n, Goals section, bullet 2). At the same time, the BC Ministry is committed to developing a strong foundation in the basics (reading, writing, oral language, numeracy).

In its totality the new curriculum has sophisticated goals for student learning and development. However, I note that the equally sophisticated assessment system required to determine the extent to which students attain these goals is still under active consideration by the Ministry. The Ministry is committed to retaining the Foundational Skills Assessment, but that also is under review. At the same time, it is championing personalized learning across all grades and subjects in the curriculum. This begs the question whether personalized learning will be supported by the assessment practices (and, indeed, the instructional approaches) on the part of the teachers and through the organization of the school. And while the commitment to the “basics” is seen more clearly in the lower grades, and a commitment to personalized learning develops as the students mature, this is not made explicit in the curriculum (BC Ministry of Education, 2015a).

Curriculum as cultural reproduction.

The new Science curriculum may also be viewed through Schubert’s image of Curriculum as Cultural Reproduction, where “the job of schooling is to reproduce salient knowledge and values for the succeeding generation (1986, p. 29). This image is very similar to Eisner’s Social Adaptation orientation, described as determining “its aims and content from an
analysis of the society the school is designed to serve. In this orientation it is argued that schools are essentially institutions created to serve the interests of the society” (1985, p. 74).

General programmatic goals such as achieving BC’s social and economic goals, accepting Canada’s mixed and tolerant society, and participating in our democratic institutions are all goals in support of supposed Canadian values (BC Ministry of Education, 2015b, p. 2). Interestingly, while the social implications of science can be read into any area, they are not often listed explicitly in the K-9 Science curriculum except when First People's knowledge is referenced, and in a few other topics such as the Grade 5 Content piece “The nature of sustainable practices around BC’s resources” (BC Ministry of Education, 2016k), part of the Kindergarten Big Idea that, “Humans interact with matter every day through familiar materials” (BC Ministry of Education, 2016p), and “caring for the environment” in the Social Responsibility Core Competency Profile (BC Ministry of Education, 2016r, p. 3). I find this to be an interesting disconnect.

Cultural reproduction is also seen through the promotion of social responsibility, one of the Core Competencies that runs across the subjects of the entire curriculum. Table 4 (Appendix 1, p. 130), taken from the Curricular Competency section of the Science curriculum, outlines how this may look. The Core Competencies - Thinking, Communication, and Personal and Social - are described as “embedded” in the Curricular Competencies for Science (BC Ministry of Education, 2016o, Design section, Curricular Competencies). While it is of note that these competencies do not directly relate to the Big Ideas or Content from the Science curriculum, the curriculum designers felt that the Core Competencies do contribute to “scientifically literate citizens who have a … caring and responsible disposition” (BC Ministry of Education, 2016n, Rationale section, para. 4).
Cultural reproduction is also seen through what appears to be appeasement to parents’ concerns and expectations related to student progression to higher learning. The Homepage of the BC’s New Curriculum website notes the commitment to “the basics” (reading, writing, and arithmetic) as an expectation of parents. “Parents expect their kids to learn the basics - reading, writing and arithmetic” (BC Ministry of Education, 2016e, New Curriculum, para. 3).

It also states that students will gain experience in “collaboration, critical thinking and communications - skills they’ll need to succeed in college, university, and the workforce” (BC Ministry of Education, 2016f, New Curriculum, para.4). Note the order of these three last concepts - college, university, and workforce: although college and university degrees are no longer any guarantee of well-paying, stable work, they remain firmly entrenched and often unchallenged as the best answer to what students are expected to do upon graduation.

Curriculum as an agenda for social reconstruction.

Instead of curriculum supporting the status quo, Schubert’s (1986) image of Curriculum as an Agenda for Social Reconstruction applies to a more radical notion of what a curriculum does or may do. It is similar to Eisner’s term Social Reconstructionism, where, “This orientation is basically aimed at developing levels of critical consciousness among children and youth so that they become aware of the kind of ills that the society has and become motivated to learn how to alleviate them.” (1985, p. 76.)

While there are many examples of the curriculum as applicable to the social reproduction framework, there is a clear orientation towards social reconstruction found directly through the emphasis given throughout the curriculum to Aboriginal Education and the inclusion of more First Peoples’ perspectives and knowledge. In fact, for each grade in the Science curriculum as it now stands, there is at least one content piece linked to First People’s knowledge (this wasn’t
always the case, a previous version had First People’s knowledge referenced in most, but not all grades).

A clear goal of the redesigned curriculum is that the “Aboriginal voice be heard in all aspects of the education system” (BC Ministry of Education, 2015b, p. 7). A glaring omission is the use of the word “voice” rather than the plural, voices. This neglect brings up all kinds of questions as to the intentions and understanding of the designers to this aim, for surely inclusion of the First Peoples must recognize that there is not one First Peoples perspective or one Story. This point will be further explored under ‘assumptions’.

The commitment to including First People’s voices in the new curriculum is not the only socially transformative element. Valuing diversity is a major theme as well, where teachers are to ensure their classrooms “reflect sensitivity to diversity and incorporate positive role portrayals, relevant issues, and themes such as inclusion, respect, and acceptance. This includes diversity in family composition and gender orientation” (BC Ministry of Education, 2015b, p. 8). The Ministry also remains committed to its ERASE Bullying program (BC Ministry of Education, 2015a).

Curriculum as experience.

Schubert’s image, Curriculum as Experience (1986), can be seen as a way of connecting to the emphasis in BC’s new curriculum on personalized learning, which can be seen as an important contribution to personal growth. According to Schubert, through this image, “The teacher is a facilitator of personal growth, and the curriculum is the process of experiencing the sense of meaning and direction that ensues from teacher and student dialogue” (1986, p. 30). This frame supports a means-end curriculum delivery, where both are important and the curriculum remains fluid to respond to the students’ growth through experience and self-
reflection. This image makes contact with Eisner’s (1985) Development of Cognitive Processes orientation and with his Personal Relevance orientation as well.

The inquiry process, also championed in the new curriculum, fits well here. Students are assumed to have a natural sense of wonder and curiosity. By being allowed to ask their own questions and do their own investigating, with the teacher as guide, students play a greater and greater role in designing their learning as they move up the grades.

By supporting personalized learning, and providing teachers with more freedom to use time and space in creative ways, the new curriculum supports flexible learning environments. This recognizes that “learning can take place anywhere, not just in classrooms” (BC Ministry of Education, 2016g, Flexible Learning section, para.1). So too is place-based learning encouraged. It appears as a Curricular Competency throughout the 10 grades, and is elaborated upon as follows.

Place is any environment, locality, or context with which people interact to learn, create memory, reflect on history, connect with culture, and establish identity. The connection between people and place is foundational to First Peoples perspectives of the world. (BC Ministry of Education, 2016p, Curricular Competencies table, Communicating).

Curriculum as “currere”.

Instead of focusing on curriculum as a race to be run, the emphasis here is on curriculum as “the interpretation of lived experiences” (Schubert, 1986, p. 33). Personalized learning is a cornerstone of the curriculum rewrite, and inquiry is emphasized, so Curriculum as “Currere”, a way to develop self-knowledge, is also applicable (Schubert, 1986). Additionally, the Personal and Social Competency explicitly states a goal of students as being to “achieve their purposes in the world” (BC Ministry of Education, 2013, p. 7).
Schubert’s remaining images.

In consideration of the power of Eisner’s null curriculum, I will quickly outline the images I felt were not particularly relevant to the new BC Science curriculum. *Curriculum as a Program of Planned Activities* does not really apply (Schubert, 1986). This image describes curriculum as “a comprehensive view of all activities planned for delivery to students” (Schubert, 1986, p. 27). Planning is obviously mentioned in the curriculum but it is not part of the explicit curriculum as presented on the website. The new curriculum might be seen as offering a rich menu of options and possibilities rather than being a “blueprint” or system of prescribed activities presented in a determined sequence.

The image of *Curriculum as Discrete Tasks and Concepts*, where “the curriculum is seen as a set of tasks to be mastered”, is also not relevant to the new curriculum (Schubert, 1986, p. 31) unless some of the personal characteristics and habits of mind described in the Core Competencies and Curricular Competencies also are seen as forming an agenda for enhanced behavior and performance.

Synthesis.

If indeed identification of the frame(s) or orientation(s) that best exemplify a curriculum is an effective way in which to understand the goals and aims of the designers, it is interesting to see just how many frames are represented by the K-9 Science curriculum, at least in part. I wonder if the inclusion of multiple goals, topics, and approaches is an example of trying to please as many interest groups and concerned parties as possible, and if the curriculum is getting stretched thin in terms of realizing its goals and intentions. I also wonder if a curriculum can fall short of achieving any of its goals if it tries to realize too many disparate ones. Egan (1996) claimed that schools are jinxed by attempting to achieve three important yet incompatible goals
of education: to socialize the individual (which might be seen as cultural reproduction); to help the individual realize their own potential (personalized learning); and to impart the wisdom of the ages (Big Ideas, Content). BC’s new curriculum attempts these three facets of education and more. Without clear boundaries of what schools can and ought to do, an ever-increasing pile of expectations may be heaped at the feet of our school system. By attempting to please everyone, I fear the curriculum may fall short of pleasing anyone.

Egan (1996) also believed that unless the theoretical issues are addressed first when creating or recreating curricula, the ensuing discussions about more practical aspects of the curriculum are not worthwhile. In the process of designing the new curriculum I wonder how much time, if any, went into considering the theoretical realm of curriculum design, including identifying, or narrowing in on the framework for the curriculum that would best serve to achieve the designers’ goal of educating the young.

**Design - How is Science Presented in the New Curriculum?**

When designing a science curriculum, it would be reasonable to hope that a clear understanding of what science is, what it means, and how it works is present. Additionally, and equally important, would be an understanding of what science is not and what it cannot do. I found inconsistencies and omissions in the definition of terms. The “cross-cutting concepts”, that are applicable to both intra- and interdisciplinary learning and are a key piece of science learning, tucked away as pop-up elaborations behind a particular curricular competency. Finally, I could not find a compelling and understandable “Story of Science” (BC Ministry of Education, 2016o, Features section) as promised.

That said, throughout the new Science curriculum, there is a real push to engage students in hands-on science. It is an honest, albeit confused, effort to clearly direct science learning to
not be limited to rote memorization and an emphasis on “just the facts”. However, while these are attempts to improve the delivery of science; the actual term “science” still isn’t clearly defined. The first paragraph of the Introduction to Science on the BCNC website states:

Science and scientific literacy play a key role in educating citizens of today for the world tomorrow. Critical to succeeding in this endeavor are the core competencies that provide students with the ability to think critically, solve problems, and make ethical decisions; to communicate their questions, express opinions, and challenge ideas in a scientifically literate way; and to exercise an awareness of their role as an ecologically literate citizenry, engaged and competent in meeting the responsibilities of caring for living things and the planet. (BC Ministry of Education, 2016o, Introduction, para 1).

It is notable that this statement describes what “science” or “scientific literacy” do, but not what science is—how it differs from other forms of knowledge. To effectively teach “science” and “science literacy”, all stakeholders must be speaking the same language. If a goal of the new Science curriculum is to grow or develop scientifically literate citizens, all interested parties must know what that means. However, the terms “science” and “scientific literacy” are not clearly defined. Nowhere is it made clear how a scientifically literate person may think differently from someone who is not scientifically literate.

The terms “scientifically literate citizens” and “scientifically educated citizens” are both used in the new curriculum, and are defined, however vaguely. “Scientifically literate citizens” are able to use scientific evidence, along with their own knowledge and understanding, to make informed decisions (BC Ministry of Education, 2016n, Rationale section). In other words, they are able to distinguish evidence derived from the scientific inquiry process as compared with other types of knowledge; they can understand what science does, and what type of knowledge it
can generate, and can juxtapose or compare and contrast it with other forms of knowledge. If science as a form of knowledge isn’t clearly defined, the above seems impossible to ask of students.

Scientifically literate citizens also are to understand the role of science in society, and ought to “maintain their curiosity and wonder about the natural world” (BC Ministry of Education, 2016n, Rationale section, para. 4). Interestingly, “scientifically literate citizens” also are caring and responsible, understand “the social, health, ethical and environmental dimensions of issues”, and “maintain their curiosity and wonder about the natural world” (BC Ministry of Education, 2016n). These are desirable attributes for citizens, but they are not unique to science.

“Scientifically educated citizens”, presumably meaning people educated about the results of science and the science process, are described as “place-conscious”, understand they are part of the Earth’s systems, maintain an interest in scientific developments, and recognize how science affects the planet and all its systems (BC Ministry of Education, 2016o, Important Considerations section, Scientific habits of mind, last para.). It would seem a goal for educating citizens in science would be science literacy, meaning understanding science as a form of knowledge, and knowledge of the results, history, and ethical problems of science.

The use of these two terms is confusing. Additionally, I would argue the definition of ‘scientific literacy’ is being grossly overstretched here, and that “scientifically educated citizens” are defined basically as having scientific literacy. This makes the definition somewhat circuitous, particularly juxtaposed against what a “scientifically educated citizen” is expected to be.

Another term with which I had issue is “scientific habits of mind”. These are recognized as one of the five goals of the new K-9 Science curriculum, and include a whole list of desirable traits (BC Ministry of Education, 2016o, Important Considerations section, Scientific habits of
mind, para. 2). Some make sense to me, when applied to the field of science, such as recognizing the importance of evidence, skepticism, and assumptions. To be clear, however, these traits certainly aren’t exclusive to the field of science. Being able to maintain curiosity, being open to new ideas, and valuing questions are also included among the scientific habits of mind. Again, these habits may be important and desirable curricular outcomes, but they are not exclusive to science. Interestingly, “social, ethical, and environmental implications” are also listed as habits of mind associated with science, as well as looking for patterns and connections. While these certainly can be important in science, surely they represent a much broader scope of human thinking than just science? Consequently, I find their placement under “scientific” habits of mind confusing or unhelpful to helping students appreciate the nature of science.

I find that while all of these goals and definitions aim for desirable learning outcomes, they show a lack of understanding of what science is, and how it can be defined. There appears to be no mention of the fact science is one among several forms of knowledge, nor is time spent differentiating it from other forms of knowledge such as the aesthetic or the historical. Carl Sagan is often quoted as having said, “Science is not so much a body of knowledge but a way of thinking”. In fact, it is both. It is really important that students understand this. They must be able to determine what knowledge or evidence can be seen as scientifically valid, and what cannot. They need to know the limits of science as well. The National Research Council (NRC) wrote of understanding science and how it works as involving content and procedural knowledge as well as epistemic knowledge, the “knowledge of construction and values intrinsic to science” (2012, p. 79). Another key piece of science, referenced in the NRC report as well as elsewhere, is the importance of the imagination, both to the field of Science in general as well as to its’
teaching (NRC, 2012). However, imagination may be necessary to scientific endeavor, but it is not sufficient (or restricted) to it.

The terminology in the science curriculum is problematic. So too is how some of the curriculum is structured or shaped, through its online presentation and organization. A piece from the new science curriculum that I find most confusing is the placement of “cross-cutting concepts”, explained under Content in the Introduction to Science link. They are described as “relevant in science” and applicable “across numerous areas of learning” (BC Ministry of Education, 2016o, Design section, Content). They are very similar to the cross-cutting concepts outlined in the Framework for K-12 Science Education (NRC, 2012), as outlined in Table 1 (Appendix 1, pp. 126-7) and include concepts such as patterns, cause and effect, and interaction. However, in BC’s new curriculum, these concepts are housed (or, hidden) under the Questioning and predicting curricular competencies across the grades. This seems very peculiar. In Kindergarten, we find the Elaboration about patterns starting with, “Patterns are natural configurations, designs, arrangements or sequences” (BC Ministry of Education, 2016p). Patterns are not referenced in later grades. Grade 1 speaks of Form and Function, Grade 2 of Cycles. These deep, supposedly inter- and intra-disciplinary concepts are hidden under the elaborations for one of the six curricular competencies. Again, they are important but certainly are not exclusive to science. Even worse, they’re eked out grade by grade, representing more piece-by-piece learning as opposed to an holistic, emerging and coherent interchange of such ideas within the curriculum over the grades.

The final issue I have with how science is represented in this K-9 Science curriculum is through the aforementioned Story of Science as presented through the Big Ideas (BC Ministry of Education, 2016o, Design section, Big Ideas). I imagine this as a story that links the learning
with the heart of the subject. However, there is no Story of Science that I could find. This actually breaks my heart, for the Story of Science could be utterly fascinating, full of mystery, interesting personalities, intrigue and adventure. What I did find was an example of how the Big Ideas in Chemistry were developed across the grades, as displayed in Table 6 (Appendix 1, p. 133).

When you consider how much of science also involves creativity, imagination, passion and sheer dumb luck, you know the story presented could be really engaging. Matthew Johnson, a theoretical physicist, was asked to say what word or words come up when he hears the word “science”. His immediate answer was, “Fun” (Kennedy & Johnson, 2015). Where’s the imagination, the fun and the wonder in this curriculum, for they certainly are part of science’s story and, I would argue, are sorely lacking in so many schools delivery of the science curriculum. For that matter, what are the key elements of the scientific process and way of seeking knowledge, assessing and interpreting experiences, and testing claims? What are its uses and limitations?

Development – What Assumptions are in the New Curriculum?

As a stage in the ADDIE process, Development entails creation of a detailed plan that is a complete and true representation of the work already accomplished in the preceding stages. It therefore must be a plan that represents and addresses the goals and objectives from the Analysis phase and one that is consistent with the Design concepts as well. In the Development phase it is important to question whether the curriculum as developed is a faithful representation of the goals and needs that were identified in the Analysis phase, and is it a sensible extension of the broad storyboard of the Design phase. Also, at the end of the Development stage, there should be a detailed blueprint of the design. This point is interesting in the case of the new curriculum, for
there is explicit mention, more than once, that it is not in fact a detailed blueprint (BC Ministry of Education, 2015a, p. 1). However, the curriculum itself as written is the end product from this stage. As a result, as part of the development of this new curriculum I was curious as to the assumptions inherent in it.

Delving into the question of assumptions is no easy task. Clearly, numerous assumptions form the cornerstones of the curriculum, many made explicit, even more not so. My ability to even see these, particularly the implicit assumptions, is limited. That said, taking the time to notice the assumptions upon which such a design is founded, the assumptions of the designers, of the Ministry, and of the users, is fundamental work to a critical understanding of said design. Obviously, I did not have time to delve into all the potential assumptions, ranging from whether there was an assumption that courses that have been taught in the past ought to still be taught, or whether there was an assumption that there should be a focus on academics at the expense of the emotional and spiritual, or an assumption that in our advanced technological society everyone ought to aim for higher education or even grow up to be employed. However, as part of the Development phase in the ADDIE model, I will highlight the assumptions that struck me as most worthy of note. It so happens these assumptions pertain to the overall curriculum rewrite, not just to the Science curriculum.

At a basic level I believe there are many assumptions related to word choices and word definitions in the new curriculum. First, the field of education seems fraught with jargon, jargon without necessarily a commonly-agreed upon definition. Terms such as “place-based education”, “21st Century Learning”, and “inquiry learning”, terms that often mean different things to different people are key components of the description of this new curriculum. These terms are often used without clear definitions. Consequently, the use of these terms with accompanying
assumptions as to their meaning could be highly problematic. If we’re not even speaking the same language as we’re trying to make sense of this work, or worse, if we think we are speaking the same language but in fact are not, our work as educators may be fraught with yet another level of difficulty.

Second, the curriculum uses terms such as “success”, “capable”, and “thriving” in such a way as to assume everyone agrees on what these may look like. As related to the student characteristics or outcomes, these terms are frequently used. However, what exactly is meant by student success, what exactly determines a capable human, and what are the attributes of thriving? The meanings of these terms are simply assumed to be widely understood and agreed upon. I feel that’s an assumption that ought to be challenged, especially since the curriculum as developed views these qualities as important and valued goals.

The introduction to BC’s Education Plan contains another interesting (or problematic) assumption, namely that the curriculum will help students in the future enter the fast-paced, ever-changing world that is unpredictable and almost unknowable. This assumption bothers me on two fronts. First, the students are already in that world, not getting ready to somehow enter it at some point. Secondly, I honestly don’t think young people find the world as fast-paced and unpredictable as do the older generations (or, at the very least, as do the writers of the curriculum). Imposing fears or uncertainties on younger generations, and assuming they feel anxious and worried about technology, innovation and social change seems misguided and unhelpful. Most students in the school system now either weren’t born before iPhones were developed or at the very least don’t remember life without them! The present reality is their world. Further, a careful review of human history might suggest in many ways that the world has often, if not always, been changing and challenging - sometimes perhaps even more than it is
now. Making such an assumption begs the question of how much the curriculum designers engaged with the ultimate curriculum users, the students. Were the students’ understandings of the world and how they view themselves in it even taken into consideration?

Referenced before, but worthy of being repeated here, is the assumption that including the “voice” of First Peoples will provide a benefit towards greater success of indigenous students in schools and will contribute towards a general national project of reconciliation.

Acknowledging that for students in BC to better understand Canada and our place in the world must involve a more nuanced and wider-scoped appreciation of various worldviews is without dispute. It is time (indeed, past the time) to be recognizing that the First Peoples of Canada have been close to invisible in the program at public schools and that rectification is required. Forgetting the ‘s’ in voices seems a glaring omission. First Nations does not describe a monoculture. Even within the province of BC there are significantly different cultural and language groups among our First Peoples and I feel those differences are important to acknowledge. To do otherwise may be to promote tokenism. That said, perhaps a key part of developing a place-based approach to the curriculum will be to appreciate the unique places of local First Nations peoples in the diverse cultures and biogeography of BC.

**Implementation – What Supports are Proposed to be Helpful in this Stage?**

The Implementation step in the ADDIE process supports the successful adoption of a new design. The critical tasks of implementation are often described as determining that the necessary resources and support systems are available to enable the actual construction or use of the new design. The implementation process also may entail the training and orientation of the people who will actually construct the new design, or make it work in practice. It is usually in implementation that the old phrase that the Devil is in the Details begins to take on relevance.
With designs such as a new curriculum it is crucial that time and effort go into planning or visioning how successful implementation of the curriculum will look, and how the designers can best ensure that this vision is realized. Considerations including whether or not the resources, orientation and training to the new design are sufficient, and if there’s a contingency plan in case they are not. By looking through the intended, published K-9 Science curriculum at what is expected of educators, both stated and assumed, I am persuaded that this curriculum has grand plans for the educator-users in terms of their buy-in.

A highlight of the new curriculum is evident faith in teachers’ competence and commitment. Instead of a huge list of prescribed learning outcomes that must be ticked off by year’s end, the new model relies highly on teachers sorting out what to teach, how to teach it, and how to allocate resources, including time, among the different subject areas and topics within the K-9 Science curriculum. As Bransford, Brown & Cocking (2000) have stated, there is no one best teaching practice, and different teaching methods are best at different times; it is heartening to see curriculum designers acknowledge this. Experienced teachers may have no problems changing their teaching practices to in order to accommodate the new curriculum. Further, teachers may well experience creativity and excitement based on the freedom and trust inherent in the design. That said, new teachers and teachers not fully trained in the sciences may be met with a real professional challenge trying to sort out the expectations and learning in the K-9 Science curriculum. Even the language of the Big Ideas is not always written for an enthusiastic competent generalist teacher with limited background in science.

Educators are also expected to sort out how to implement personalized learning, a pillar of the entire new curriculum revision (BC Ministry of Education, 2015a). The effective implementation of personalized learning will entail changes to teachers’ roles moving from
“teacher driven to teacher managed to teacher facilitated” (BC Ministry of Education, 2015a, p. 5), and new technology is also forcing teachers to innovate and adapt (BC Ministry of Education, 2015a, p. 8). As noted below, student assessment methods and standards are still being developed, with reference made to a need for greater flexibility and much more communication between teacher and parent, in the form of an “ongoing conversation” (BC Ministry of Education, 2015a, p. 8).

Although not as commonly the case in the middle school grades, most teachers of younger students are expected to be generalists, able to deliver most, if not all, of the curriculum to their students. Science is but one of a number of subjects that elementary school teachers are required to teach. Reviewing the Science K-9 curriculum I had to scratch my head as to how teachers are expected to deliver the program as presented. Further, I have been fortunate to have the time and energy to make a critical review of this single subject and to discover the complexity of its content and potential instructional approaches. Juggling the new expectations of the K-9 Science curriculum along with all the other subject rewrites is likely to be quite daunting, and has to happen alongside regular teaching duties and increased expectations about communication with parents. Elementary grade teachers may be communicating with up to 30 families while junior high school teachers (Grades 7-9) could be having “ongoing conversations” with upwards of 120.

While the curriculum seems to embody expectations on teachers as to delivery, it may also present challenges in regard to their ability to navigate the curriculum’s new online interactive format. Perhaps teachers will find the new layout to be equally challenging and delightful. It is certainly timely and technologically appropriate that the new curriculum be presented and published online. This is the first time that BC has had an extensive online general
curriculum. The perks of the online format include ease of access and availability to any interested party (including parents and students). The format is to some extent user-adaptable and the layout is slick and often pleasing to the eye. However, there is no online location where the whole curriculum (whether for all the main subjects or even just for K-9 Science) is presented in its entirety, to help those ‘big-picture learners’ who need to see the elephant before understanding the parts of the animal. This may be an important drawback. Putting grades and the subject matter in silos, along with the built-in redundancy in the site makes negotiating the site challenging. Additionally, the fact it is easy for the Ministry officials to change the online version means that when changes or revisions are made they aren’t always clearly noted or documented with dates and revision numbers. By revisiting pages I had previously printed out during my research, I was able to note and track some changes that had been made to the online Curriculum Competencies and First Peoples’ knowledge sections, to list two examples. The website does have a link to the Release Notes table (in small print, at the very bottom of the BCNC websites page template). In it, changes made have been documented, but in a very generalized manner and only show to May 2016 (with earlier work not mentioned).

Another problematic piece of the implementation puzzle for the new curriculum in general is the planners’ apparent reliance on educators’ willingness and ability to provide appropriate and useful examples of their instructional practices and experiences to share with other teachers. As described above as an important piece from the Development phase of the website, the new curriculum has an Instructional Samples link shown at the bottom of the general page for the science curriculum (https://curriculum.gov.bc.ca/instructional-samples). In a perfect world, this part of the online curriculum will now be filling up with relevant and useful examples contributed by working teachers and by expert consultants concerning their
experiences in how to actually implement the new curriculum in the classroom. As of December 8, 2016, only two examples were posted for all of Science K-9: *Getting Started with Student Inquiry in Science*, a nine-minute illustrated whiteboard presentation, and *Snow Smarter*, a chemistry lesson for grades 3-6 that is designed to work with the inquiry process. By February 23, 2017, one additional lesson, entitled “Quarks and Leptons” had been added (BC Ministry of Education, 2016f). That said, this hardly is the only platform where teachers may choose to share their work; it may be that they prefer to contribute their ideas to forums and publications being provided by the BC Teachers Federation and its various subject and topic area specialist organizations.

In regard to implementation I am also concerned that as of March 2017 student assessment policies and practices are still to be determined. The new curriculum was rolled out province-wide in September 2016 with no concrete plans written as to how students were to be assessed. Even the most elegant design, whether of objects, processes, or programs, will ultimately be tested in the reality of use. The new BC K-9 Science curriculum has features that are intended to enable teacher decision-making and planning at the classroom level. However, the design assumes that teachers will be prepared to make those decisions in ways that ensure some level of coherence in the students’ experiences of science. Teachers will need to select how to allocate time and resources among the Big Ideas and Content listed for the Science curriculum in the year(s) they teach. In making those decisions they will have to also consider how to balance attention to the goals of the Science curriculum against the need to attend to the goals of the rest of the elementary school curriculum. It is important to remember that each year of the K-9 Science curriculum describes Big Ideas and Content topics for each of the major Science fields: Biology, Chemistry, Physics, and Earth/space Sciences. Ultimately, this organization
suggests that attention to these areas during the school year is not optional, but is a necessary element of a comprehensive science education. Whether or not evaluation standards will ultimately involve assessment of student understandings (and knowledge) across these four main fields remains to be seen. It is to be expected that evaluation standards will ultimately affect implementation. The current Science K-9 curriculum is largely silent on this.

**Evaluation – Where is it?**

In examining how the published design of the K-9 Science curriculum addresses the Evaluation step in the ADDIE process it is important to define several general concepts about the evaluation of designs for educational programs. A key question about the evaluation phase of design concerns the purpose of the evaluation—that is, what are the goals of the process and who will be the main users of the information provided. There is a difference between the evaluation of a program design such as the Science K-9 curriculum and the evaluation of the students whose learning the program is intended to affect and support. Earlier I have cited Ralph Tyler’s (1949) key curriculum questions, the fourth of which was how shall we know whether or not the curriculum is achieving its purposes?

A second important concept about program evaluation is whether it is intended to be formative or summative (Scriven, 1993). Formative evaluation is intended to provide information about a program during its development and implementation in order to make adjustments and enhancements to its structures and to foster on-going improvements based on the results from actual use of the design or program. Summative evaluation is usually performed as a general check on the status of a program at a particular point in time. Summative evaluations can draw on a variety of data about the performance of the program, including, in the case of
educational programs and curricula, data about student performance. Summative evaluations are episodic rather than continuing or on-going.

Ideally, evaluation is woven throughout the entire design process, for knowing what questions should be asked at the end and paying attention to them throughout the design process will only strengthen the final outcome. It is important to know the users’ responses to the implemented design. However, once implemented, it is critical that the evaluation stage of the design process looks at the design in terms of whether it truly represents the purposes and aims from the Analysis stage. I cannot say how committed the designers of the K-9 Science curriculum were or have been to the evaluation phase of the design process. While it is claimed that drafts of the curriculum were sent out to various experts and interested parties and changes were made to the draft versions of the curriculum as a result, that approach very well could simply represent an integral and important step in the Development phase. Therefore, my last question asks what is in place to evaluate the success of the new curriculum.

Looking back to the original goals of the rewrite, namely to get students ready for a changing world, to prepare students for the workforce, and to recognize developments in the understanding of how students learn, I have not been able to find references as to how the Ministry and the curriculum developers are going to assess whether these goals are being realized as the implementation of the new curriculum progresses. Further, the total new curriculum describes a considerable list of general, cross curricular goals including outcomes from the Core Competencies, the ERASE Bullying initiative, and the Indigenization of the curriculum to name only a few.

As I have not been able to find how the developers of the K-9 Science curriculum will be assessing their work of design, so too have the curriculum developers failed to describe how
teachers are to assess their students based on the new curriculum. A more comprehensive overview appeared on the BCNC webpage “Assessment and Reporting” in the fall of 2016 (BC Ministry of Education, 2016b), after the curriculum was formally adopted province-wide. However, even this webpage provides more questions than answers. Indeed, up to February 28, 2017, on the homepage of the new curriculum (BC Ministry of Education, 2016e), the Ministry was requesting parent feedback as to what report cards should look like. The assessment of the students performance in school is a vital component of a curriculum, with some curriculum designers even saying it should be the first part of the design process (Wiggins & McTighe, 2005; Jacobs, 2010), and certainly not be the last and absolutely should not be at the stage where it now seems to be in BC though the K-9 Science curriculum is already in all schools across the province.

Since my approach in this thesis was to conduct a critical review or critique of the K-9 Science curriculum as written and published I can take into consideration any indications from the written curriculum about how teachers and students are expected to engage with each other in the learning process and as to the forms of student evaluation that are suggested or implied. For example, Grade 9 the Curricular Competencies want students able to “demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal interest”, and to “contribute to care for self, others, community, and world through individual or collaborative approaches” (BC Ministry of Education, 2016m). Clearly, these attributes are not easily subjected to a summative assessment and will likely require teachers to apply a framework of structured observations over time—an approach likely to be formative, especially in the context of active and continual communications between students and teachers (and possibly parents as well). Further, the description of scientific habits of mind found in the Introduction to the Science
Curriculum includes attributes such as “An openness to new ideas and consideration of alternatives — an attitude of wonder and interest in new concepts, coupled with a willingness to rethink notions and form new opinions based on evidence” (BC Ministry of Education, 2016o, Important Considerations section, Scientific habits). Here again, the evaluation of whether or not, and to what extent, students will demonstrate these attributes or “habits of mind” will require that the relationships between students and teachers and the roles of each in that relationship be subject to on-going formative assessment.

To summarize, while the policy and detail around the assessment and reporting of student progress and performance is still under development at the level of the Ministry of Education, the BC K-9 Science Curriculum appears to embody notions about how teachers will work with students in order to help them develop these personal attributes. Descriptions of earlier curricula as contained in Ministry rationales for the entire program of curricular revision suggest a desire to move away from an emphasis on the recall and memorization of “facts” and assessment based on a large number of intended learning outcomes. Like other curriculum areas, and perhaps more than some, science does involve a certain amount of factual information, although that is proposed to be developed in the context of Big Ideas or through concepts such as Cause and Effect, Change, Matter and Energy, and Systems. While “the redesigned Science curriculum is rooted in inquiry” (BC Ministry of Education, 2016o, Important Considerations section, Inquiry), it is largely silent as to how teachers should assess student learning and understanding of these major concepts. Further, “inquiry has been emphasized in the redesigned curriculum, with learning standards focused on “doing,” Curricular Competencies structured within an inquiry process model, and numerous Elaborations providing sample questions for students to explore” (BC Ministry of Education, 2016o).
In such a context, the teacher is expected to engage in ongoing feedback and communication with students, a highly formative, and likely very personalized, process. It remains to be seen whether at the provincial level new general summative assessments will be implemented in order to provide indications of system-level performance.
Chapter Six: Conclusion

In the United States, the National Research Council has recently developed a framework of expectations for student learning in science. It states the following expectations:

…that by the end of 12th grade, all students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering, and technology (2012, p. 1).

By comparison, the curriculum designers for the BC K-9 science curriculum proposed as goals that students develop:

… an understanding and appreciation of the nature of science … place-based knowledge

… a solid foundation of conceptual and procedural knowledge [in the various science disciplines], the habits of mind associated with science, [and] a lifelong interest in science and attitudes that will make them scientifically literate citizens (BC Ministry of Education, 2016n, Goals section).

Have the designers of the BC K-9 science curriculum succeeded in their goals and intentions? As noted in Chapter Five under the topic of Evaluation many of the goals both in the US and BC statements are very qualitative in nature and have a lot to do with attributes of character more than with skill or content acquisition. Both these statements of intended outcomes offer very holistic pictures of the students who will result if these programs are successful. I am left wondering whether the new BC curriculum even has reasonable expectations for the schools and
teachers, or if the school mandate has been expanded to the point to create unattainable expectations and demands.

**Recommendations**

Having the opportunity to study the curriculum in action in the schools, that is the operational curriculum, would be a fantastic next step. As stated out front in the Introduction to this thesis, there is value in looking at the written recipe that is the intended curriculum, but the proof is in the pudding: seeing the curriculum as it plays out in the schools. Glen Hansman, President of the BC Teachers’ Federation (BCTF) stated:

> A quick scan of education change in BC shows many educational initiatives arriving with great fanfare, but then falling flat, or ending up partially implemented. Teachers have witnessed the pendulum swing in education before, so it is no surprise that ideas once in favour are re-emerging (Hansman, 2016).

He elaborated, saying that while some support is already offered, teachers need more of it for successful implementation of the new curriculum,

> … particularly since all curricular areas are changing at the same time, and since a number of other aspects connected to curricula (the Provincial Assessment Program, graduation requirements, reporting, etc.) are also in flux. New teaching resources, more time for teachers to meet and collaborate during the implementation process, increased mentorship and in-service opportunities, improved working conditions—all of these factors are important if implementation is to be sustained and successful. We’ve been through this before! (Hansman, 2016)
Interviewing teachers and students and possibly parents as well to learn more about curriculum uptake would be very valuable, as would inventorying the supports available in terms of workshops, teacher-training, professional development opportunities, and resources.

**Final Words**

In doing this critical analysis of BC’s new K-9 science curriculum, three red flags emerged for me. First, I worry about what is being asked of the classroom teachers, and wonder what resources and supports are in place to help them in transitioning to implementing the new curriculum. Second, I feel the actual heart of the curriculum, science itself, is poorly defined and weakly communicated as a unique way of knowing, different from social studies, or mathematics, or the fine arts. Third, while science as a field and a discipline can be seen as embodying a rich and utterly compelling narrative, full of wonder and intrigue, I see none of that referenced or apparent in the written documents of the new curriculum. Many of the Big Ideas and key Concepts that are the core structure of the new curriculum did not emerge from a vacuum. They were the result of the inspiration, hard work, and at times, good luck of pioneers in the field of science, some of whom had to pursue their work against entrenched tradition and ignorance. These stories are worth telling and having students consider and explore in depth. There seems little room for them in this new curriculum.

Likening the new curriculum (not just the science curriculum) to a teacher-led field trip on a local hike, mandated by the Ministry, is an effective way in which to present an overview of what I see as being asked of the teachers. At first glance, it certainly seems appealing, for teachers are being given the autonomy and trust to venture into potentially unknown territory and have an adventure with the students, and the students are being encouraged to make this learning journey their own.
Teachers have been told that the hike is important and that they are to help all students reach the destination. The Ministry has provided some guidelines, markers to look out for along the trail that indicate what Big Ideas students should be learning en route. However, the Ministry has provided but a rudimentary trail map for the teachers, and has not given them guide books, hiking equipment, or a First Aid kit. They haven’t even given teachers a course on “How to hike safely and effectively with your class”. The Ministry does however have the expectation that teachers will recruit parent and community helpers; this hike would be unsafe and inappropriate for an adult to run by themselves.

Another layer of complexity is the personalised learning component. In theory, each student could find their own way to the destination. Some could straggle behind and others run ahead. Students could hike in a group, pairs, or solo, depending on their own interests and passions. They even could choose whether they stayed on the path or ventured off. That said there is an expectation that by reaching certain markers along the trail, a certain amount of content will be known by all the hikers.

Teachers already experienced in hiking will know what to do. They will have resources already in place to facilitate a successful outing, including awareness of some of the learning opportunities that will come up on the trail, as well as being equipped both for successful hiking and in case of an emergency. Additionally, they will be fully aware that, while embracing each student’s uniqueness, catering to a fully personalised learning experience in such a setting is impossible with a class of students.

For the purposes of this metaphorical excursion, I imagined the Pulpit Rock Trail in Nelson, BC. It’s a well-used, well-loved trail that many students in the area have previously hiked. Once they reach their destination, Pulpit Rock (in this example represents Grade 9
graduation), there certainly is room to stop at the rock outcrop and admire the view before continuing on the trail that heads to the top of Elephant Mountain. Teachers who are sufficiently resourced, keen, and aware of hiking are already taking classes up there for a myriad of reasons above and beyond physical training, such as studying local geography, flora and fauna, and local history. Such teachers are probably excited, or at the least nonplussed about the changes to the curriculum - they’re already doing the hike, figuratively or literally, and now it’s mandated. But what about all the teachers who aren’t comfortable outdoors let alone leading their class on a hike? What about the discrepancy between schools that are more resourced, both in terms of having an active and large parent body as well as supplies and equipment, compared with those less resourced schools? And, what about the potential that some teachers’ special talents, those that don’t fall in the realm of the great outdoors, will go unnoticed or underused because these teachers are so busy trying to get the kids outside and up that trail?

The Pulpit Rock analogy really resonated for me in regards to the implementation of the science curriculum. Seeing where the curriculum will really play out, having a sense of what the educators have to work with and what tools have been provided to help them transition, is at the crux of the ADDIE process. It is important to clearly acknowledge that the changes desired will require time, training, tools and potentially effective mentorship for teachers.

My second red flag is specific to the science curriculum. The published curriculum does try to define science; however the definitions are circuitous and vague. Additionally, the designers have included many positive personal and social elements desired in students, as well as general ways of knowing and doing, that aren’t in any way exclusive to science as being part of “scientifically literate” and “scientifically educated” citizens (weighing evidence, looking for patterns, and respecting the environment, to name but a few of many examples). It feels as
though there is not a solid understanding of science as a discipline, let alone as a discrete form of knowledge. This reminded me of the often-used analogy of the blind men and the elephant. If a clear and understandable appreciation of the elephant (science) is not apparent in the design, how are people who aren’t science experts possibly expected to work with this new curriculum? What are students, after 10 years of formal schooling, going to understand of science, both in terms of what it is, is not, and what can be done with it (and perhaps what should possibly not be done)?

The United States has been doing a great deal of work redefining science learning in their school systems. A recent publication highlights a big difference between what BC is doing, and how they are progressing. For the States,

To be science literate is to be able to see how and why science and engineering really matter, to know how to reason from evidence, and to have a sense of how scientists and engineers do what they do (Beatty & Schweingruber, 2017, p. 5).

It’s clear, succinct, and limited to just science. Presumably, educators in the US also want their students to be exemplary, conscientious and meaningful contributors to society - they just aren’t meeting such demands via the content of the discipline that is science.

Finally, I wonder where the Wonder went. Physicist Neil Turok, on a CBC Ideas episode about science, described how taking the geometric mean of the Planck, the smallest measurement of length in physics, and the size of the observed universe, the resulting value is the size of the human cell. His point is that we humans literally are living right in the middle, and while we have been quite good at learning about the tiniest and the largest components of our existence, it is the human-sized questions in the middle that continue to stump us; for example: How does life originate? How does it work? What is consciousness? (Coulter, 2016)
Mark Kingwell, in that same Ideas episode, quoted Immanuel Kant in saying that maybe the mind that asks such big questions is not in fact big enough to find the answers and that that is okay. But asking such questions is in fact what makes us human. And science is one way, though certainly not the only way, to search for answers (Coulter, 2016). Science is one way to revel in the wonder that is life. And the new K-9 science curriculum has removed the need for students to show “wonder” by Grade 3 (BC Ministry of Education, 2016j), although, to be fair, wonder may well emerge whether or not it is prescribed in a written curriculum.

As a formal academic discipline science is evidence-based, and relies on rigorous testing and peer review. Science is constantly evolving as our understanding grows. Science is questioning the nature and scope of the natural world, and of our place in it. At its core, however, science inspires wonder and awe, from the tiniest particles known, such as quarks and electrons, all the way out to the reaches of our measured universe… and beyond. While a school science curriculum in no way can fully encapsulate all this breadth, depth, beauty and indeed wonder that truly is the hallmark of science, to fail to even try to go there, to not even attempt engaging the teachers and the students in sharing in the majesty of this most powerful narrative seems a shame. For me, who was tempted by the carrot of the Story of Science to be presented through this curriculum, the fact I could not find such a story is a disappointment.
References


Egan, K. (1996). Competing voices for the curriculum. In M. Wideen & M. Courtland (Eds.), *Education, the state, and the corporate sector: The struggle for the curriculum* (pp. 7–26). Ottawa, Canada: Canadian Association for Curriculum Studies and the Institute for Studies in Teacher Education, SFU.


School Act, RSBC 1996, c 412, s 6. Retrieved from
http://www2.gov.bc.ca/assets/gov/education/administration/legislation-
policy/legislation/schoollaw/revisedstatutescontents.pdf


Macmillan Publishing Company.

Barrington, MA: The Orion Society.

http://www.stemedcoalition.org/about-us/our-purpose/

Retrieved from crofsblogs.typepad.com/files/legacyforlearnerssummary.pdf

Tyler, R. (1949). Basic principles of curriculum and instruction. Chicago: University of Chicago
Press.

Association for Supervision and Curriculum Development.
### Appendix 1: Tables

**Elaborations presented by expanding the Questioning and predicting Curricular Competency for Science, K-9.**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Concept</th>
<th>Concept defined</th>
<th>Key Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>Patterns</td>
<td>Patterns are natural configurations, designs, arrangements or sequences. Many patterns indicate an underlying scientific principle or unifying idea. People identify patterns and look for relationships behind the patterns they find. They use this information to extend their understanding.</td>
<td>- What patterns do you see in plant life in your local environment - What weather patterns can you observe?</td>
</tr>
<tr>
<td>1</td>
<td>Form &amp; function</td>
<td>Form and function refer to something being designed, structured or shaped in a way that will help it perform a certain function or functions. For example, the fins of fish help them propel themselves through the water. the human skeleton provides protection for organs, and support for muscles, and allows people to stand upright. Science recognizes this important relationship between form and function.</td>
<td>- What structural features of plants and animals in your local environment help those plants and animals to function well? - How do the properties of natural materials (e.g. wood) help determine useful functions for the materials?</td>
</tr>
<tr>
<td>2</td>
<td>Cycles</td>
<td>Cycles are sequences or series of events that repeat/reoccur over time. A subset of pattern, cycles are looping or circular (cyclical) in nature. Cycles help people make predictions and hypothesis about the cyclical nature of the observable patterns.</td>
<td>- How do First Peoples use their knowledge of life cycles to ensure sustainability in their local environments? - How does the water cycle impact weather?</td>
</tr>
<tr>
<td>3</td>
<td>Cause &amp; Effect</td>
<td>Cause and effect is the basic principle that an action will result in a consequence. In science, this concept is closely related to the concepts of patterns and change. However, cause and effect may or may not have a predictable outcome.</td>
<td>- What are some causes of biodiversity in BC’s wetlands? - What is the effect of wind on mountains?</td>
</tr>
<tr>
<td>4</td>
<td>Order</td>
<td>Order is a pattern that can be recognized as having levels – big to small, simple to complex – or as a process with a sequence of steps.</td>
<td>- How is order apparent in the adaptations of forest animals in BC? - How does the order of seasons impact local plants and animals?</td>
</tr>
<tr>
<td>5</td>
<td>Systems</td>
<td>A system is a set of interacting or interdependent pieces or components that come together to form a whole. A system occupies a physical or a temporal space within a set environment, has a representative form and possesses a purpose or function.</td>
<td>- How do the systems of the human body work together? - How can you observe the concept of interconnectedness within ecosystems in your local area?</td>
</tr>
<tr>
<td>6</td>
<td>Change</td>
<td>Change is making the form, nature, content or future course of something different from what it is or what it would be if left alone. For example, Newton’s third law, the idea</td>
<td>- How has our solar system changed over time? - How has the exploration of extreme environments on Earth and</td>
</tr>
</tbody>
</table>
that for every action there is an equal and opposite reaction describes the changes that occur in response to pushes and pulls.

<table>
<thead>
<tr>
<th>7</th>
<th>Evolution</th>
<th>Evolution is the change that occurs in living things over long periods of time. This change is a result of organisms being suited to their environment. Evolution is an important concept in biological science, as scientists are always searching for the underlying laws, reasons, or explanations for their observations of living things.</th>
</tr>
</thead>
</table>
|   |   | - How have species on Earth evolved due to natural selection?  
|   |   | - How does fossil evidence support the evolution of geological time? |

Evolution is the change that occurs in living things over long periods of time. This change is a result of organisms being suited to their environment. Evolution is an important concept in biological science, as scientists are always searching for the underlying laws, reasons, or explanations for their observations of living things.

- How have species on Earth evolved due to natural selection?  
- How does fossil evidence support the evolution of geological time?  

Matter is anything that has mass and takes up space. Energy is the ability to cause change or do work. The universe is made up of matter and energy.

<table>
<thead>
<tr>
<th>8</th>
<th>Matter &amp; Energy</th>
<th>Matter is anything that has mass and takes up space. Energy is the ability to cause change or do work. The universe is made up of matter and energy.</th>
</tr>
</thead>
</table>
|   |   | - What is the relationship between matter and energy and the cell theory?  
|   |   | - How do matter and energy connect to the kinetic molecular theory? |

An interaction is a kind of action that occurs when two or more objects have an effect on one another. The interaction may be direct or indirect. In a direct interaction, A has a direct effect on B. An example of a direct interaction is wolves preying on elk. In an indirect interaction, A has an effect on B that affects C. For example, ladybugs have an indirect effect on plants because they eat aphids.

<table>
<thead>
<tr>
<th>9</th>
<th>Interaction</th>
<th>An interaction is a kind of action that occurs when two or more objects have an effect on one another. The interaction may be direct or indirect. In a direct interaction, A has a direct effect on B. An example of a direct interaction is wolves preying on elk. In an indirect interaction, A has an effect on B that affects C. For example, ladybugs have an indirect effect on plants because they eat aphids.</th>
</tr>
</thead>
</table>
|   |   | - How do the four spheres of the Earth interact?  
|   |   | - How can understanding the interactions of Earth’s spheres help us prepare for natural disasters? |
Appendix 1. Table 2
Numerical distribution of Content topics by Science Field across the grades of the K-9 Science Program.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Biology</th>
<th>Chemistry</th>
<th>Physics</th>
<th>Earth/Space</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>10</td>
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<td>6</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>18</td>
<td>22</td>
<td>34</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 1. Table 3
Description of the Big Ideas for each Grade for Science K-9 showing the different ideas for each of the four disciplines supported by the science curriculum.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Biology</th>
<th>Chemistry</th>
<th>Physics</th>
<th>Earth/Space Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>Plants and animals have observable features</td>
<td>Humans interact with matter every day through familiar materials.</td>
<td>The motion of objects depends on their properties.</td>
<td>Daily and seasonal changes affect all living things.</td>
</tr>
<tr>
<td>1</td>
<td>Living things have features and behaviours that help them survive in their environment.</td>
<td>Matter is useful because of its properties.</td>
<td>Light and sound can be produced and their properties can be changed.</td>
<td>Observable patterns and cycles occur in the local sky and landscape.</td>
</tr>
<tr>
<td>2</td>
<td>All living things have a life cycle. Living things have life cycles adapted to their environment.</td>
<td>Materials can be changed through physical and chemical processes.</td>
<td>Forces influence the motion of an object.</td>
<td>Water is essential to all living things, and it cycles through the environment.</td>
</tr>
<tr>
<td>3</td>
<td>Living things are diverse, can be grouped, and interact in their ecosystems</td>
<td>All matter is made up of particles.</td>
<td>Thermal energy can be produced and transferred.</td>
<td>Wind, water and ice change the shape of the land.</td>
</tr>
<tr>
<td>4</td>
<td>All living things and their environment are interdependent. All living things sense and respond to their environment</td>
<td>Matter has mass, takes up space, and can change phase</td>
<td>Energy comes in a variety of forms that can be transferred from one object to another. Energy can be transformed</td>
<td>The motion of Earth and the moon cause observable patterns that affect living and non-living systems</td>
</tr>
<tr>
<td>5</td>
<td>Multi-cellular organisms have organ systems that enable them to survive and interact within their environment.</td>
<td>Solutions are homogeneous mixtures.</td>
<td>Machines are devices that transfer force and energy.</td>
<td>Humans use earth materials as natural resources. Earth materials change as they move through the rock cycle and can be used as natural resources.</td>
</tr>
<tr>
<td>6</td>
<td>Multicellular organisms rely on internal systems to survive, reproduce and interact with their environment.</td>
<td>Everyday materials are often homogeneous solutions and heterogeneous mixtures.</td>
<td>Newton's three laws of motion describe the relationship between force and motion.</td>
<td>The solar system is part of the Milky Way, which is one of billions of galaxies.</td>
</tr>
<tr>
<td>7</td>
<td>The theory of evolution by natural selection provides an explanation for the diversity and survival of living things.</td>
<td>Elements consist of one type of atom, and compounds consist of atoms of different elements chemically combined.</td>
<td>The electromagnetic force produces both electricity and magnetism.</td>
<td>Earth and its climate have changed over geological time.</td>
</tr>
<tr>
<td>8</td>
<td>Cells are a basic unit of life. Life processes are performed at the cellular level.</td>
<td>The kinetic molecular theory and the theory of atoms explain the behaviour of matter. The behaviour of matter can be explained by the kinetic molecular theory and atomic theory</td>
<td>Energy can be transferred as both a particle and a wave.</td>
<td>The theory of plate tectonics is the unifying theory that explains Earth's geological processes.</td>
</tr>
<tr>
<td>9</td>
<td>Cells are derived from cells.</td>
<td>The electron arrangement of atoms impacts their chemical nature.</td>
<td>Electricity Electric current is the flow of electrons electric charge.</td>
<td>The biosphere, geosphere, hydrosphere and atmosphere are interconnected, as matter cycles and energy flows through them.</td>
</tr>
</tbody>
</table>
Appendix 1. Table 4.
Linkage of Personal and Social Core Competency to the science curriculum.
Table adapted from the Curricular Competency section of the science section, retrieved from https://curriculum.gov.bc.ca/curriculum/science/introduction

<table>
<thead>
<tr>
<th>K</th>
<th>3</th>
<th>6</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribute to care for self, family, classroom, and school through individual approaches</td>
<td>Contribute to care for self, others, school, and neighbourhood through individual or collaborative approaches</td>
<td>Contribute to care for self, others, and community through individual or collaborative approaches</td>
<td>Contribute to care for self, others, community, and world through individual or collaborative approaches</td>
</tr>
</tbody>
</table>
### Appendix 1. Table 5

*Comparison of Life Sciences Prescribed Learning Outcomes (PLOs) from the previous curriculum with Biology Big Ideas and Content from the new curriculum.*

<table>
<thead>
<tr>
<th>Grade</th>
<th>PLOs (Life Science)</th>
<th>Life Science/Biology</th>
<th>Content (Biology)</th>
</tr>
</thead>
</table>
| K     | - describe features of local plants and animals (e.g., colour, shape, size, texture)  
- compare local plants  
- compare common animals | Plants and animals have observable features | - basic needs of plants and animals  
- adaptations of local plants and animals  
- local First Peoples uses of plants and animals |
| 1     | - classify living and non-living things  
- describe the basic needs of local plants and animals (e.g., food, water, light)  
- describe how the basic needs of plants and animals are met in their environment | Living things have features and behaviours that help them survive in their environment. | - classification of living and non-living things  
- names of local plants and animals  
- structural features of living things in the local environment  
- behavioural adaptations of animals in the local environment |
| 2     | - classify familiar animals according to similarities and differences in appearance, behaviour, and life cycles describe some changes that affect animals (e.g., hibernation, migration, decline in population)  
- describe how animals are important in the lives Aboriginal peoples in BC  
- describe ways in which animals are important to other living things and the environment | Living things have life cycles adapted to their environment. | - metamorphic and non-metamorphic life cycles of different organisms  
- similarities and differences between offspring and parent  
- First Peoples use of their knowledge of life cycles |
| 3     | - compare familiar plants according to similarities and differences in appearance and life cycles  
- describe ways in which plants are important to other living things and the environment  
- describe how plants are harvested and used throughout the seasons | Living things are diverse, can be grouped, and interact in their ecosystems. | - biodiversity in the local environment  
- the knowledge of local First Peoples of ecosystems |
| 4     | - compare the structures and behaviours of local animals and plants in different habitats and communities  
- analyse simple food chains  
- demonstrate awareness of the Aboriginal concept of respect for the environment  
- determine how personal choices and actions have environmental consequences | All living things sense and respond to their environment. | sensing and responding:  
humans  
other animals  
plants  
biomes as large regions with similar environmental features |
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- describe the basic structure and functions of the human respiratory, digestive, circulatory, skeletal, muscular, and nervous systems</td>
<td>Multicellular organisms have organ systems that enable them to survive and interact within their environment.</td>
</tr>
<tr>
<td></td>
<td>- explain how the different body systems are interconnected</td>
<td>Multicellular organisms rely on internal systems to survive, reproduce, and interact with their environment.</td>
</tr>
<tr>
<td></td>
<td>- demonstrate the appropriate use of tools to examine living things that cannot be seen with the naked eye</td>
<td>Evolution by natural selection provides an explanation for the diversity and survival of living things.</td>
</tr>
<tr>
<td></td>
<td>- analyse how different organisms adapt to their environments</td>
<td>- organisms have evolved over time</td>
</tr>
<tr>
<td></td>
<td>- distinguish between life forms as single or multi-celled organisms and belonging to one of five kingdoms: Plantae, Animalia, Monera, Protista, Fungi</td>
<td>- survival needs</td>
</tr>
<tr>
<td></td>
<td>- demonstrate knowledge of the characteristics of living things</td>
<td>- natural selection</td>
</tr>
<tr>
<td></td>
<td>- relate the main features and properties of cells to their functions</td>
<td>Life processes are performed at the cellular level.</td>
</tr>
<tr>
<td></td>
<td>- explain the relationship between cells, tissues, organs, and organ systems</td>
<td>- characteristics of life</td>
</tr>
<tr>
<td></td>
<td>- explain the functioning of the immune system, and the roles of the primary, secondary, and tertiary defence systems</td>
<td>- cell theory and types of cells</td>
</tr>
<tr>
<td></td>
<td>- explain the process of cell division and emerging reproductive technologies to embryonic development</td>
<td>- photosynthesis and cellular respiration</td>
</tr>
<tr>
<td></td>
<td>- compare sexual and asexual reproduction in terms of advantages and disadvantages</td>
<td>- the relationship of micro-organisms with living things:</td>
</tr>
<tr>
<td></td>
<td>- relate the processes of cell division and emerging reproductive technologies to embryonic development</td>
<td>- basic functions of the immune system</td>
</tr>
<tr>
<td></td>
<td>- evaluate human impacts on local ecosystems</td>
<td>- vaccination and antibiotics</td>
</tr>
<tr>
<td></td>
<td>- assess survival needs and interactions between organisms and the environment</td>
<td>- impacts of epidemics and pandemics on human populations</td>
</tr>
</tbody>
</table>
Appendix 1. Table 6.
*Chemistry’s story, as told through the Big Ideas.*
Table from https://curriculum.gov.bc.ca/curriculum/science/introduction

<table>
<thead>
<tr>
<th>Story of Science, Chemistry.</th>
<th>K</th>
<th>3</th>
<th>6</th>
<th>8</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humans interact with matter every day through familiar materials</td>
<td>All matter is composed of particles.</td>
<td>Everyday materials are often mixtures.</td>
<td>The behaviour of matter can be explained by the kinetic molecular theory and the atomic theory.</td>
<td>The behaviour of matter can be explained by the kinetic molecular theory and the atomic theory.</td>
<td></td>
</tr>
</tbody>
</table>