

**ANSWER GETTING OR INQUIRY:
TEXTBOOKS AND THE CORPORATE DISCOURSE**

By

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Abstract

This thesis examines the disconnect between the 2007 Ontario Science and Technology Curriculum and a textbook written specifically to support it, *Investigating Science and Technology 7*. The paper illustrates the suggested teaching strategies contained in the curriculum, their exclusion from the text, and the possible causes for the striking differences between the two.

Keywords – inquiry, textbook, curriculum, corporate discourse.

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Chapter One: Revelation

In 2005 I was in teacher's college – 41 years old, having already sent two boys through the public school system and on to college and university. I had spent over 25 years in other professions, ranging from the military to the media to car sales. I went into the room with the idea that I knew how school worked, although I also realized that my perspective on school was from a parent's and student's view and not from the "insider's" point of view.

The year I went to teacher's college was also the year that the Peel District School Board, under the direction of the Ontario Ministry of Education, began instituting what they called "Transformational Practices". Transformational Practices were going to change the classroom because it was no longer acceptable to the "sage on the stage" imparting knowledge on a classroom full of children as my university professor lectured to us. Transformational Practices were going to allow students to be in charge and engaged with their own learning; make teachers fellow learners in the classroom and allow for more differentiated learning, taking the individual into account rather than just addressing the class as a whole. My first thought was, "wasn't this what we were supposed to do in the first place?"

As I found out, it wasn't.

Nonetheless, I was excited by the idea of learning alongside my students, spending time allowing them to explore their world in ways that made sense to them, and reporting those discoveries in ways that reflected their personalities and strengths. That is why, when I was offered the opportunity to teach a dedicated Science and Technology program with a strong application component, I was not only excited, I thought I had

found the program that would be perfect for me to develop Transformational Practices of my own. The new Science and Technology Curriculum, released in 2007, openly celebrated the use of inquiry and constructivist teaching practices as an anchor to teaching 21st Century students, unlike the document that was released in 1998. I thought that my students would be excited to be released from the bounds of “regurgitating answers” to the teacher, refreshed by my willingness to accept alternative ways of presenting learning and exploring the world.

They weren't. They wanted me to “tell them what I wanted them to know, “how many pages should this report be,” and “couldn't you just tell me what the answer is?” Answer-getting was at the top of their learning agenda. They didn't have to know where, how or even why, just what. Worse yet, once they answered the question and showed their acquired knowledge, they forgot it like a computer clears its cache, in order to move onto the next task. This made accessing previously learned material difficult and frustrating for the students, who seemed to be both upset that they didn't remember the material, and indifferent to it at the same time.

Despite my attempts, I hadn't really engaged the students in my class through inquiry; I had only taken a “tourist's exploration” of the concept – touched on some of the ideas, followed the assignments and experiments in the text *Investigating Science and Technology*, enjoyed the feeling that I was doing something “student-centered,” but never really allowing the full concept to take hold in the classroom. After all, I had to move onto the next part of the curriculum.

Then, in my third year of teaching Science and Technology, “G” was placed in my class.

There is no doubt that “G” has challenges. Identified as a student with ADHD, he also suffers from Foetal Alcohol Syndrome (FAS). This affects “G” in many ways. Unable to control impulses due to FAS, “G” will often engage in activities that the rest of the class find distracting or difficult to understand. “G’s” consistent blurting out, task avoidance and inability to engage in group activities has made “G” difficult to place in the class, as well as a source of frustration for anyone who teaches or attempts to learn near him.

He did possess, however, a rather impressive intellect, and a set of coping mechanisms second to none. His favourite is to get himself “thrown out” of class just before he is expected to do anything academic. He’s been known to sit in the back of the class loudly yelling out phrases like “Chicken Wings and Butter” until the teacher can take no more. He has been known to do this for 30 and 40 minutes at a time. He has found a way for school to work for him.

Over a few months however, I was able to make some headway with “G”. It began when my Vice Principal told “G” that I thought that “G” was very intelligent.

“He does?” he answered, not believing what had been said.

“Yes, he does. And he thinks you can be a really good student in his class if you wanted to be.”

That was the start.

The next day, during a lunchtime showing of one of the six Star Wars movies in my class, he proceeded to whisper each and every upcoming plot twist to me before they happened. I made sure he thought he was letting me in on a secret each time. I still haven’t told him I’ve probably seen each movie a couple of dozen times each.

This continued to one extent or another for two months, and it began to show some, albeit infrequent fruit in class. I learned one very important lesson where he was concerned however – If I could engage him with an academic task within minutes of his peak of excitement with a more “hands on” activity, he would not only do the writing or reading task, he would do it well.

The unit we were exploring – *Flight* – requires that students not only have a knowledge of how an airfoil works in terms of how it provides lift to an aircraft, but also how building it out of different materials and adding flaps changes its performance. I provided each student with pieces of manila file folders, newsprint, construction paper and paper from my printer. They were to loop paper strips made from each of the materials over pencils, forming the airfoil shape, then blow over them to observe the lift produced. Then, by adding an additional piece of paper on the top of the airfoil, they could recreate the affect a flap would have on a plane on take-off and landing by adding additional lift.

Along with the wing building material, I gave each student a sheet that they could record the amount of lift they observed with both the flap and without it for each material, along with anything else they wanted to record. When they were done testing the “wings,” each student was given an additional sheet of guiding questions to aid them in reflecting on the test. They included:

1. What material made the best wing?
2. List the materials from lightest to heaviest.
3. What gave better lift – the wings with or without flaps?

The goal was to allow the students to discover that lighter materials made better and more efficient airfoils, and that flaps added to a wing's ability to lift heavy aircraft.

That's not what "G" found.

"G" proudly walked right up to his ISSP (In-School Support Person) teacher and me, and announced that he had finished the work. I had already seen the work handed in by the members of the class who routinely outperform their peers, and each one had made the discoveries that had been predicted – light materials were superior for airfoils, flaps added lift. "G" contradicted every one of their assertions.

"G" I asked, "why did you say that the manila folder made the best wing?" I thought that I was going to have a chance to discuss it with him until he could make the "correct" connections himself.

"Well, it's a wing, and it's going to have to support a lot of weight and be out there in the high winds, so I thought that it should be the strongest material it could be, even though it wouldn't get a lot of lift. I thought it would be better to add a more powerful engine than have the wing rip off the plane."

I was dumbfounded, and more than a little embarrassed. Here was a student I was ready to convince that he was wrong, just because I wanted the students to discover what I thought they "needed to know," completely ignoring the concept that scientific inquiry, indeed all inquiry, is fundamentally about the inquirer finding their own way through their investigation, developing their own hypotheses and explanations for what they have observed.

"What about the flaps ... did you find they helped or hurt the lift you got from the wing?"

“Well, they helped ... only they have to come out from inside the wing ‘cause they would get torn off by the air moving too fast on top making lower pressure on top the wing.” Again, not the answer that was prescribed, but clearly well considered.

“I like the way you think, ‘G’. Drop your sheet in the class in-bin.” I said as he skipped off. It was then that his ISSP teacher turned to me and said, “You know, he got the answers all wrong.”

Although “G” had taken his learning where he felt he had to go, and despite the efforts that “G” had made to show his understanding of the concepts we had been working on, his ISSP teacher was correct. According to the text and the prescribed answers and questions, “G” did not merit an A, B, or in some cases even a C.

I gave him an A. And I felt like a “teacher” for the first time in a while.

Of all the subjects taught at the Middle School level, no field of study lends itself better to the use of “inquiry” than Science and Technology. At its core, Science requires that students explore an idea, develop a hypothesis and a way of testing it, then experiment and record the observations. This is based on the scientific method, which has for millennia been the basis of scientific exploration. It suggests that the student ask questions related to the subject, decide upon what answers could be found through experimentation, develop a way to test that question, experiment, analyze, interpret and form conclusions based on the results of the experiment.

Technology is the second and equal part of the field of study, one that has been largely left out of the equation. The previous versions of the curriculum stressed the acquisition of knowledge. The newer version of the document went along with the

Transformation Practices theme and tried not only the acquisition of knowledge, but the application of it as well.

Inquiry as has been described as a teaching strategy, a philosophy, and a mode of thinking among other definitions. Jerry Harste said that when viewing curriculum as inquiry, he means, “that I envision classrooms as sites of inquiry, or as communities of learners. Inquiry is not a technical skill to be applied at will, but rather a philosophical stance that permeates the kinds of lives we choose to live.” (Harste, 1994) When discussing Inquiry as a basis on which to build project-based learning, as is suggested in the 2007 Ontario Science and Technology curriculum, it clearly becomes the starting point and sustaining element that propels a classroom project itself and thus emerges as the driving force of project-based learning.

Education as Inquiry follows the example of the scientific method and Transformational Practices as prescribed by the Ministry of Education, albeit with a much broader base. As in the scientific method, the inquirer requires the curiosity, requisite skills and willingness to accept the challenge of open-ended learning. This view of education defines the student as an explorer who sets their own itinerary, the teacher as researcher and leader rather than the “sage on the stage.”

Education as inquiry, while respecting the disciplines and what it is we think we know, is fundamentally about changing the way we think about instruction. Significantly, education as inquiry suggests that the personal and collective questions of learners ought to be the heart of curriculum. Rather than framing curriculum in terms of the content areas, learners’ inquiry questions become the organizational device for curriculum. Integration occurs in the head of the learner, rather than in the daily schedule of the teacher. (Harste, 2001)

According to these definitions, inquiry, scientific or otherwise, clearly refers to a form of exploring the world without prejudice by the student, guided by the student's curiosity, limited only by the student's inquisitiveness.

The process of Inquiry, stated in brief, with associated scientific method connection:

1. Begin with what students already know –
This connects directly with the “observation” of the scientific method, where an experimenter must first refer to an event or idea that they have seen or experienced in order to develop a hypothesis as to why it took place.
2. Encourage multiple responses to learning events –
The development of a hypothesis can take any form the student wishes, and can be communicated in the way best fitting the students ideas.
3. Allow students to help shape the curriculum –
Students are expected to develop their own way of testing their hypotheses, as well as ways in which to analyze the data they gather from their experiments.
4. Monitor collaborative work and develop students' ability to monitor their own work –
Students are not only expected to communicate their findings through experimentation, but to consider those of others in the class and within their working groups. These differing opinions are used to develop a more

rounded perspective on the experiment, data analysis and conclusions of the testing group.

Why then, does the textbook, which is supposed to reflect the accepted pedagogy, seem to contradict itself by suggesting inquiry as a model, then steering students to explore only those things that will lead them toward a specific result? Has the Ministry, through the seemingly opposing messages given in both the curricula and related texts made “answer-getting” the primary goal of the program rather than encouraging student curiosity and questioning of natural phenomena?

Moreover, if “inquiry is more about unpacking the complexity of issues than it is about coming up with simple solutions to complex questions,” (Harste, 2001) then why would it not be explicitly discussed in a document that clearly states the need for issue analysis?

One of the primary objectives of elementary science and technology curricula has always been, and must continue to be, development of curiosity and wonder. Students come to school with a natural curiosity. They also bring with them individual interests and abilities as well as diverse personal and cultural experiences, all of which have an impact on their prior knowledge about science, technology, the environment, and the world in which they live. Effective instructional approaches and learning activities draw on students’ prior knowledge, capture their interest, and encourage meaningful practice both inside and outside the classroom. Students will be engaged when they are able to see the connection between the scientific and technological concepts they are learning and their application in the world around them and in real-life situations. (Ontario Ministry of Education, 2007, p. 28)

It would seem apparent that the connection between Science and Technology and the concept of “inquiry” as presented is not only strong, but interdependent. If this is so, why is there no explicit discussion of either the use, or even the definition, of inquiry in either the curriculum that sets out the goals for this subject, or the approved text that

teachers and students alike, use to guide their learning of it? Are we to assume that the gathering of answers is still more important than the development of understanding in our science classrooms?

Overview

Chapter Two will explore the changes in the atmosphere in which the 2007 Ontario Science and Technology curriculum was written, as well as its effects on the text. The chapter will also consider the process by which texts are judged for use in classrooms in Ontario.

Chapter Three compares and contrasts the major elements of *Investigating Science & Technology 7* with the curriculum, activity by activity, in order to determine if the text is in step with the curriculum, both in content and spirit.

Basil Bernstein becomes the focus of Chapter Four, as the same activities are examined through his theories of the Pedagogical Device, Divergent School Cultures, Modalities of Control, and how social class shapes school culture. By understanding Bernstein's theories in relation to the exploration of the text, a possible explanation for the disconnect between the curriculum and the book may be made.

Finally, the conclusion presents the argument for a possible third discourse, a "boss discourse" that exerts its power over the established stakeholders of education in Ontario.

Chapter Two: 2007 – A Change in the Air and in the Classroom

In this chapter I will explore the shift in Ontario's curriculum policy towards more student-centered teaching strategies, as well as the process by which textbooks are chosen to support the curriculum.

To understand the attitudinal change in Ontario's schools and curriculum, we must first explore the pedagogical shifts brought on by political change.

From 1995 until 2004, Ontario's education system under the Conservative Government of Premier Mike Harris and his successor Ernie Eaves had experienced one of the most tumultuous periods in its history. Labour disputes ignited by hard-line tactics in collective bargaining, the formation of the unpopular Ontario College of Teachers and new measures to increase educator's "accountability" such as province-wide testing of students, teacher certification tests, requirements for certain types of professional development to retain certification and deep budget cuts handcuffed a system that had begun to show great promise under the NDP government of Bob Rae. Moreover, the Conservative's "accountability first" approach contributed to a stripping of the "*Common Curriculum*" of the previous New Democratic government that emphasized life-long learning and an implemented an agenda based on the three "R's" and test scores as a indication of system-wide success.

Two thousand and seven however, marked a watershed in Ontario's education agenda. The newly elected government under Premier Dalton McGuinty promised significant changes in the education agenda. Along with increases in funding, mandatory attendance until the age of 18 and the implementation of full-day kindergarten, the Liberals promised to, "create a curriculum council, an independent organization to

develop curriculum.” (Moore, 2003) The council “is a group of knowledgeable, committed community leaders and education experts who were first brought together in March, 2007 to advise the Minister of Education. They provide strategic policy advice on the elementary and secondary curriculum.” (Ontario Ministry of Education, 2013)

Since its inception in March, 2007 the council has advised the government on environmental education and the elementary curriculum as a whole. One of the council’s first efforts was the development of a new science and technology curriculum in the fall of 2007.

The new curriculum was indicative of the more open educator- and student-friendly approach chosen by the governing party. The previous provincial government under Premier Mike Harris, had stressed accountability, control and knowledge and skill acquisition over critical literacy, and inquiry skills. The new curriculum was to stress the development of inquiry and critical thinking within science and technology.

At first blush, the goals of the two publications seem to be in agreement:

1998 Science and Technology Curriculum	2007 Science and Technology Curriculum
1. To understand the basic concepts of science and technology	1. To relate science and technology to society and the environment
2. To develop the skills, strategies, and habits of mind required for scientific inquiry and technological design	2. To develop the skills, strategies, and habits of mind required for scientific inquiry and technological problem solving
3. To relate scientific and technological knowledge to each other and to the world outside the school. (Ontario Ministry of Education and Training, 1998, p. 4)	3. To understand the basic concepts of science and technology (Ontario Ministry of Education, 2007, p. 3)

The order of the goals differ; that and the reference to “technological problem solving” in the 2007 edition rather than “design” in that of 1998. However, when looking at the detail of the policy documents, there are striking differences.

In the 1998 document, the Ministry stresses knowledge and skills as indicators of success, and emphasizes this by making them the basis on which teachers should assess achievement.

Students graduating from Ontario schools require the scientific and technological knowledge and skills that will enable them to be productive members of society. They also need to develop attitudes that will motivate them to use their knowledge and skills in a responsible manner. The Ontario Curriculum, Grades 1-8: Science and Technology, 1998 outlines the knowledge and skills that students must develop in Grades 1 to 8, as well as the levels of achievement at which they are expected to master them. It is these levels that teachers will use to assess students’ achievement. (Ontario Ministry of Education and Training, 1998, p. 3)

With the publication of the 2007 document, the agenda had widened. Knowledge and skill acquisition were still important aspects of the curriculum, however now the development and application of inquiry skills is specified as being integral to student success.

Along with a knowledge foundation, the study of science and technology offers students varied opportunities to learn and master skills that are relevant to their everyday world. In the specific expectations, reference is made to the following three skill areas:

- scientific inquiry/experimentation skills
- scientific inquiry/research skills
- technological problem-solving skills.

(Ontario Ministry of Education, 2007, p. 12)

These skills were set out in detail:

- initiating and planning (e.g., asking questions, clarifying problems, planning procedures)
- performing and recording (e.g., following procedures, accessing information, recording observations and findings)
- analysing and interpreting (e.g., organizing data, reflecting on the effectiveness of actions performed, drawing conclusions)
- communicating (e.g., using appropriate vocabulary, communicating findings in a variety of ways)

To say these changes resulted in a significant change in assessment would be an understatement on a colossal scale.

Achievement Levels: Science and Technology, Grades 1-8				
Knowledge/Skills	Level 1	Level 2	Level 3	Level 4
Understanding of basic concepts	The student:			
	- shows understanding of few of the basic concepts	- shows understanding of some of the basic concepts	- shows understanding of most of the basic concepts	- shows understanding of all of the basic concepts
	- demonstrates significant misconceptions	- demonstrates minor misconceptions	- demonstrates no significant misconceptions	- demonstrates no misconceptions
	- gives explanations showing limited understanding of the concepts	- gives partial explanations	- usually gives complete or nearly complete explanations	- always gives complete explanations
Inquiry and design skills (including skills in the safe use of tools, equipment, and materials)*	The student:			
	- applies few of the required skills and strategies	- applies some of the required skills and strategies	- applies most of the required skills and strategies	- applies all (or almost all) of the required skills and strategies
	- shows little awareness of safety procedures	- shows some awareness of safety procedures	- usually shows awareness of safety procedures	- consistently shows awareness of safety procedures
	- uses tools, equipment, and materials correctly only with assistance	- uses tools, equipment, and materials correctly with some assistance	- uses tools, equipment, and materials correctly with only occasional assistance	- uses tools, equipment, and materials correctly with little or no assistance
Communication of required knowledge	The student:			
	- communicates with little clarity and precision	- communicates with some clarity and precision	- generally communicates with clarity and precision	- consistently communicates with clarity and precision
	- rarely uses appropriate science and technology terminology and units of measurement	- sometimes uses appropriate science and technology terminology and units of measurement	- usually uses appropriate science and technology terminology and units of measurement	- consistently uses appropriate science and technology terminology and units of measurement
Relating of science and technology to each other and to the world outside the school	The student:			
	- shows little understanding of connections between science and technology in familiar contexts	- shows some understanding of connections between science and technology in familiar contexts	- shows understanding of connections between science and technology in familiar contexts	- shows understanding of connections between science and technology in both familiar and unfamiliar contexts
	- shows little understanding of connections between science and technology and the world outside the school	- shows some understanding of connections between science and technology and the world outside the school	- shows understanding of connections between science and technology and the world outside the school	- shows understanding of connections between science and technology and the world outside the school, as well as their implications

* It should be noted that all students, regardless of their level of achievement, receive basic instruction in the safe use of tools, equipment, and materials.

Figure 1: Ontario Ministry of Education Training 1998, p. 13

The recommended rubric offered in the 1998 document concentrates on quantitative measurement of all categories; including a simple, one-line reference to scientific inquiry. Throughout the rubric, the emphasis is on the acquisition of knowledge and rote skills. The rubric seems to favour a “checklist” approach that allows the teacher to recognize the student’s repetition of what has been covered in class as “learning.”

Moreover, in the section entitled, “Inquiry and Design Skills” (including skills in the safe use of tools, equipment, and materials) there is no specific mention of inquiry skills. The descriptor for achievement at level three only refers to a student who “applies most of the required skills and strategies.” In other areas of the chart, there is a definite

tendency towards the use of quantitative modifiers (few, some, partial, most, all) rather than qualitative descriptors. Although this may be seen as semantics, it does reflect the political agenda of the time, where accountability – both of the student *and* teacher – was often in question.

The Achievement Charts included in the 2007 curriculum were a radical departure from those of 1998. In 1998, there were four basic knowledge/skill areas to assess. The new curriculum had 12, with only 1 of those areas dedicated to the acquisition of knowledge. The rest of the assessment tool is dedicated to the application of concepts and ideas, inquiry and communication.

ACHIEVEMENT CHART – SCIENCE AND TECHNOLOGY, GRADES 1–8

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

Figure 2: Ontario Ministry of Education 2007, p. 26

Categories	Level 1	Level 2	Level 3	Level 4
Communication (continued)				
	The student:			
Communication for different audiences (e.g., peers, adults) and purposes (e.g., to inform, to persuade) in oral, visual, and/or written forms	communicates for different audiences and purposes with limited effectiveness	communicates for different audiences and purposes with some effectiveness	communicates for different audiences and purposes with considerable effectiveness	communicates for different audiences and purposes with a high degree of effectiveness
Use of conventions, vocabulary, and terminology of the discipline in oral, visual, and/or written forms (e.g., symbols, formulae, scientific notation, SI units)	uses conventions, vocabulary, and terminology of the discipline with limited effectiveness	uses conventions, vocabulary, and terminology of the discipline with some effectiveness	uses conventions, vocabulary, and terminology of the discipline with considerable effectiveness	uses conventions, vocabulary, and terminology of the discipline with a high degree of effectiveness
Application – The use of knowledge and skills to make connections within and between various contexts				
	The student:			
Application of knowledge and skills (e.g., concepts and processes, safe use of equipment and technology, investigation skills) in familiar contexts	applies knowledge and skills in familiar contexts with limited effectiveness	applies knowledge and skills in familiar contexts with some effectiveness	applies knowledge and skills in familiar contexts with considerable effectiveness	applies knowledge and skills in familiar contexts with a high degree of effectiveness
Transfer of knowledge and skills (e.g., concepts and processes, safe use of equipment and technology, investigation skills) to unfamiliar contexts	transfers knowledge and skills to unfamiliar contexts with limited effectiveness	transfers knowledge and skills to unfamiliar contexts with some effectiveness	transfers knowledge and skills to unfamiliar contexts with considerable effectiveness	transfers knowledge and skills to unfamiliar contexts with a high degree of effectiveness
Making connections between science, technology, society, and the environment (e.g., assessing the impact of science and technology on people, other living things, and the environment)	makes connections between science, technology, society, and the environment with limited effectiveness	makes connections between science, technology, society, and the environment with some effectiveness	makes connections between science, technology, society, and the environment with considerable effectiveness	makes connections between science, technology, society, and the environment with a high degree of effectiveness
Proposing courses of practical action to deal with problems relating to science, technology, society, and the environment	proposes courses of practical action of limited effectiveness	proposes courses of practical action of some effectiveness	proposes courses of practical action of considerable effectiveness	proposes highly effective courses of practical action

Figure 3: Ontario Ministry of Education 2007, p. 27

The 2007 Science and Technology Curriculum’s emphasis on inquiry, critical thinking, communication and application of knowledge and skills is clear and delineated. More importantly, the student is openly encouraged to explore and question and the teacher is expected to provide opportunities for both.

Using a variety of instructional, assessment, and evaluation strategies, teachers provide numerous hands-on opportunities for students to develop and refine their inquiry skills, problem-solving skills, critical and creative thinking skills, and communication skills, while discovering fundamental concepts through investigation, exploration, observation, and experimentation. The activities offered should enable students to relate and apply these concepts to the social, environmental, and economic conditions and concerns of the world in which they live. Opportunities to relate knowledge and skills to these wider contexts will motivate students

to learn in a meaningful way and to become lifelong learners. (Ontario Ministry of Education, 2007, p. 9)

The most important difference between the 1998 and 2007 versions of the Achievement Chart is the more recent version leaves much more room for differentiation, open-ended learning and student success. Where the 1998 curriculum was confining in its scope, allowing for assessment in only four areas, students with different strengths could find a place within the course of study to excel. Rote knowledge of the facts now makes up less than 10% of the expectations, with the ability to apply, communicate and investigate – skills that can be used in all the curricula of any grade level – making up the majority of the assessment criteria.

2.1 *Texts and the Trillium List*

In 2002, the Liberal Ontario Government replaced the former “yardstick” to determine the suitability of texts for use in the province’s classrooms – Circular 14, 1995 – with the *Trillium List*. As with many jurisdictions, the Trillium List’s function was to provide a selection of vetted text books for use in elementary and secondary schools in the Province of Ontario that would be regularly updated as new books became approved, and others fell into disuse or became obsolete.

The Ministry also recognized the changing state of classrooms in Ontario, as well as the emergence of other educational media – software, video, audio, etc. Circular 14 had been written when most of these media, especially digital media and computer-based teaching material were not used in the same numbers as they are in a 21st Century classroom.

The Trillium List falls under the authority of the Education Act, Regulation 298

relating to the selection and use of textbooks in Ontario Schools:

Under subsection 8(1), the Minister may,

(4) establish procedures by which and the conditions under which books and other learning materials are selected and approved by the Minister;

(5) purchase and distribute textbooks and other learning materials for use in schools;

(6) select and approve for use in schools textbooks, library books, reference books and other learning materials;

(7) cause to be published from time to time lists of textbooks, learning materials, reference books and library books, selected and approved by the Minister for use in elementary and secondary schools;

(23) enter into an agreement with any board, person or organization in respect of the development and production of learning materials, and pay all or part of the costs in connection herewith.

Under subsection 264 (1), it is the duty of a teacher and a temporary teacher,

(k) to use and permit to be used as a textbook in a class that he or she teaches in an elementary or secondary school,

(i) in a subject area for which textbooks are approved by the Minister, only textbooks that are approved by the Minister, and,

(ii) in all subject areas, only textbooks that are approved by the board.

Under subsection 265 (1), it is the duty of a principal of a school, in addition to the principal's duties as a teacher,

(h) to ensure that all textbooks used by pupils are those approved by the board and, in the case of subject areas for which the Minister approves textbooks, those approved by the Minister.

In addition to the stipulations listed above, Section 7 of Regulation 298 deals with how principals and teachers should choose books from the Trillium List, what to do should there be no approved book on the list for a given course of study, and explanation

of the preference for Canadian writers, editors and publishers, and the right of all pupils to use these texts free of charge.

The term *textbook* is defined as a “comprehensive learning resource that is in print or electronic form, or that consists of any combination of print, electronic, and non-print materials collectively designed to support a substantial portion of the Ontario curriculum, expectations for a specific grade and subject in elementary school or for a course in secondary school, or a substantial portion of the expectations for a learning area in the Ontario Kindergarten Program.” (Ontario Ministry of Education, 2008, p. 4)

In all cases, texts are vetted to discover whether they adhere to the Ministry’s “Congruence with Curriculum Policy.” The policy has three main pillars:

1. The content in the text must be consistent with the elementary, secondary or Kindergarten area of study, and must support at least 85% of the expectations set out in the curriculum documents.
2. In the case of series of texts, at least one title must adhere to the above stipulations. The titles that do not achieve the 85% expectation support mark are not eligible for evaluation.
3. Non-print materials and multi-media packages also must adhere to the 85% rule.

Other provisions:

- All references to URLs (Internet links placed in the text) must conform to the Ministry policy on Placement of URLs
- There must be an accompanying Teacher’s resource Guide

- The text must have a Canadian orientation, including spelling conventions, measurement units and Canadian examples and references wherever possible.
- The text must be manufactured in Canada, and have Canadian writers and editors on the production team.

The quality of the scholarship, reference to technology, health and safety, environmental responsibility, language level, instructional and assessment strategies, lack of bias and the physical format of the text all come under the scrutiny of the Ministry when texts are being considered for the Trillium List.

The text I will be discussing was approved by the Ministry on January 30, 2009, months after the adoption of the new Science and Technology curriculum in the fall of 2007. *Pearson Investigating Science & Technology 7* was beta tested by some of my colleagues at the school where I currently teach, and as a result, they are accredited with aiding in its production. When I asked them what their contribution was to the development of the text, they said, “Well, they told us if we used it and gave it our approval, we would get a substantial discount when the book was published.”

Nothing else was asked for or expected of the “contributing teachers” mentioned in the front pages of the text. The question at hand is – do the texts approved by the Trillium List actually pass the “Congruence with Curriculum Policy” as authored by the Ministry, and if not, why not?

If a text used in a classroom is suggesting a transmissive model of teaching when the curriculum is clearly encouraging a model of inquiry, are we seeing Bernstein’s Pedagogical Device – the combination of discourses between the pedagogical and

regulative, as well as pedagogy, curriculum and assessment – at work, with the associated socio-economic influences, or something completely different?

As a starting point, the text of the “achievement” sections of the curricula from both 1998 and 2007 were made into Wordles, a web-based application that generates, “‘word clouds’ from text that you provide. The clouds give greater prominence to words that appear more frequently in the source text” (Feinberg, 2013) with the option of removing the most common English words. By making a “Wordle” of these sections, a graphical representation of the priorities of each curriculum can be better observed.



Figure 4: Wordle of Achievement Section of 1998 Science and Technology Curriculum

The 1998 curriculum stresses skills, safety, knowledge and expectations.

Secondarily it mentions the importance of achievement, teachers, grades and activities. It is only when looking at tertiary items that the word “inquiry” appears, with no mention of questions or questioning, experimentation or discovery.

Which leads us back to our central question – if the text is supposed to reflect the curriculum, and the curriculum’s three “Big Ideas” (Figure 7) are not being addressed, not even in the Teacher’s Edition – how does that text become an approved book on the Trillium List?

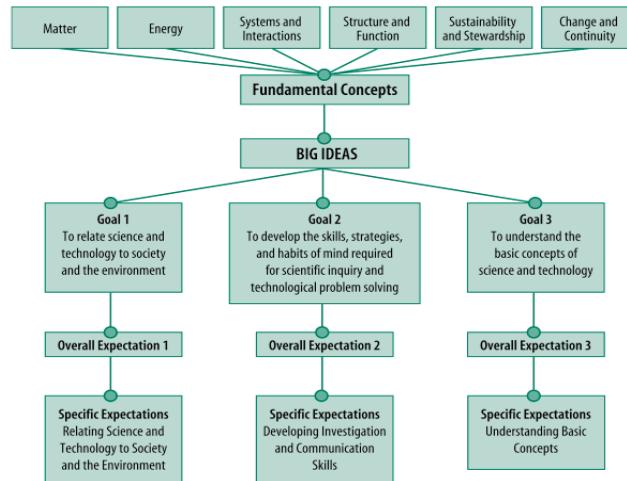


Figure 8: Fundamental Concepts and Big Ideas 2007 Science and Technology Curriculum
(Ontario Ministry of Education, 2007, p. 6)

Chapter Three: Curriculum/Text Comparison

This chapter will explore the differences found between the 2007 Ontario Science and Technology curriculum and the approach taken by the textbook through its suggested activities.

A simple word search may leave us with questions, but it answers very few. In order to adequately investigate the disconnect between the regulatory discourse at the ministerial/governmental level and what shows up at the pedagogical level, we need to unpack the text's activities, unit by unit, to not only compare what words are being used, but the contexts they are being used in.

The 2007 Science and Technology curriculum consists of four "strands" or themes for each grade, following from grade to grade under four major concepts. For Grade 7, the four strands (with concepts in parentheses) are "Interactions in the Environment" (Understanding Life Systems), "Form and Function" (Understanding Structures and Mechanisms), "Heat in the Environment" (Understanding Earth and Space Systems), and "Pure Substances and Mixtures" (Understanding Matter and Energy). As a student moves through each year, the curriculum naturally follows a continuum from basic to more comprehensive study of each concept, and contributes to the basic understanding of the studies of chemistry, physics, engineering, environmental sciences and biology.

Each strand's expectations are arranged under three headings:

1. Relating Science and Technology to Society and the Environment
2. Developing Investigation and Communication Skills
3. Understanding Basic Concepts

The expectations listed under these headings give a detailed view of what should be covered in class, as well as suggestions for approaches by the teacher. These are not given as prescription; they are samples to “prime the pump” for teachers and their students.

The text uses various types of activities to reflect the requirements of the curriculum. According to the Teacher’s Edition of the text, “Each feature in the Pearson Investigating Science and Technology Program supports an aspect of the goals of science and technology and the development of scientifically and technologically literate students.” (2008, pp. PO-16) These features include:

- “Thinking About activities form an interconnected series that gives students an opportunity to develop their understanding of the STSE ideas in the chapter.
- Starting Point activities are short, informal activities used to engage students at the beginning of each section. These activities are related to the Skills Continua.
- Learning Checkpoint activities give students a chance to stop and consider the information they have just read.
- Quick Labs provide students with a short, hands-on introduction to key concepts.
- Inquiry activities provide students with the opportunity to work in a formal lab setting so they can develop skills stressed in the Skills Continua. Safety is emphasized throughout.
- Problem-Solving activities provide students with opportunities to solve practical problems that arise from human needs or wants. Usually, students build a device or system to solve a problem.
- Decision-Making Analysis activities have students explore the social, economic, environmental, political, ethical, and moral impacts of a real-world issue related to the unit being studied.
- Design a Lab activities are either scientific inquiry or problem-solving in nature. In general, these labs are more open-ended.
- Words Matter margin items are literacy features that give students additional information on terms used in the text.
- Suggested Activity margin items indicate at what point in the text a teacher may want to insert an activity from the section.
- Take It Further is a Web research feature designed to link student learning with the real world.

- Science and Technology in Your World features present careers, historical information, interesting current events, and possible future innovations that are related to the topics in the chapter.
- Making Connections features are engaging pieces written by Jay Ingram of Discovery Channel.
- Unit Task Links at the end of each chapter help students connect the content of the chapter they have just completed with the task they will do at the end of the unit.” (2008, pp. PO-16)

Of the activities suggested by the text, four seem to suggest that they are representative of “Inquiry-based Learning” – Inquiry Activities (if only by name), Problem Solving, Decision Making and Design a Lab assignments. These will be the focus of the comparison between the text and curriculum document.

In order to compare the two, we must first develop a list of criteria on which to assess the activities. In order to do so, we must first look to the definition set out in the curriculum:

In developing the skills of scientific inquiry/research, students must ask good questions to frame their research, interpret information, and detect bias. Depending on the topic, they may be required to consider the values and perspectives of a variety of groups and individuals. (Ontario Ministry of Education, 2007)

Based on this definition, an inquiry-based activity should have the following:

- An opportunity for students to develop their own guiding questions for research, based on that student’s interest and curiosity;
- A set of questions to help in the interpretation of findings in an experiment or research project, as well as those to determine whether the findings are biased;

- A mechanism, preferably student developed, to bring the viewpoints or perspectives of the various stakeholders into account when unpacking an issue or situation.

At the forefront is the need for involvement by the student in all aspects of developing the assignment – from its purpose to the success criteria, from the procedure to be used to the format to be used to communicate the findings. It is in this complete involvement that students develop a greater understanding of the concepts that are being discussed and a better probability of applying the concepts in a meaningful way.

3.1 Inquiry Activities

3.1.1 Interactions in the Environment

The overview for the first strand in the Grade 7 curriculum, *Interactions in the Environment* presages the unit:

By Grade 7, students realize that humans have many impacts on the environment. In the study of this topic, they will analyse some of these impacts and their consequences, while reflecting upon their personal responsibility to protect the environment. During investigations, the students will observe existing ecosystems and investigate factors that may affect balances within the system. Students will learn that ecosystems consist of communities of plants and animals that are dependent on each other as well as on the non-living parts of the environment. (Ontario Ministry of Education, 2007, p. 126)

The student is tasked to develop their understanding of these concepts through scientific inquiry, as defined in the curriculum:

In scientific inquiry, students engage in activities that allow them to develop knowledge and understanding of scientific ideas in much the same way as scientists would. Like scientists, students must also develop skills in the two major components of scientific inquiry – experimentation and research. Experimentation involves conducting “fair tests” to determine whether changing one factor in the experimental set-up affects the results,

and, if so, in what ways. In a fair test, the scientist/student identifies variables that may affect the results of the experiment; selects one variable to be altered (tested), and keeps other variables constant; measures all trials in the same way; and repeats tests to determine the validity of the results. (Ontario Ministry of Education, 2007, p. 12)

This view of teaching/learning the curriculum seems to be clearly shown in section 2.2 of the section of the curriculum dealing with Interactions in the Environment. There is a recommendation of the use of a model ecosystem, but no stipulation of its type. In addition, there are no requirements for specific ways of reporting the findings of the experiment. What are included are suggestions of guiding questions to begin the search for understanding. These questions are open-ended and lead to other, deeper questions to be investigated.

2.2 design and construct a model ecosystem
(e.g., a composter, a classroom terrarium, a greenhouse), and use it to investigate interactions between the biotic and abiotic components in an ecosystem

Sample guiding questions: What are some biotic components of this ecosystem? What are some abiotic components? How do these components affect each other (abiotic and abiotic; biotic and biotic; abiotic and biotic)? What are some of the interactions that are occurring in the model ecosystem?

Figure 9: Ontario Ministry of Education 2007, p. 127

Moreover, throughout the Developing Investigation and Communication Skills section there are suggestions for inquiries, investigations and varying ways of reporting findings made in them:

“2.3 use scientific inquiry/research skills to investigate occurrences (e.g., a forest fire, a drought, an infestation of invasive species such as zebra mussels in a local lake or purple loosestrife in a wetland habitat) that affect the balance within a local ecosystem. **Sample guiding questions:** Should naturally caused fires in national parks be allowed to burn to their natural end? How do human activities and natural occurrences contribute to droughts? What happens in a drought? What is the impact of invasive species such as zebra mussels, spiny water fleas, round gobies, and sea lampreys on Ontario lakes and what can be done to lessen the impact?

2.4 use appropriate science and technology vocabulary, including sustainability, biotic, ecosystem, community, population, and producer, in oral and written communication

2.5 use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes (e.g., design a multimedia presentation explaining the interrelationships between biotic and abiotic components in a specific ecosystem)” (Ontario Ministry of Education, 2007, p. 127)

The above would suggest an opportunity to conduct an experiment that would be built on the curiosity of the student, have open-ended questions allowing the student to explore without restrictions, and allow innovative, non-traditional ways of reporting student discoveries. Unfortunately, the text does not reflect these ideas.

A16 Inquiry Activity **Toolkit 2** **SKILLS YOU WILL USE**
■ Predicting
■ Recording and Organizing Data

Ecosystem in a Jar, Part 1

Question
What biotic and abiotic elements can you put into a sealed container to make a healthy ecosystem?

Materials & Equipment

- glass jar or clear container with lid
- clean gravel or small rocks
- pond water
- distilled water or tap water that has sat for 24 h
- small aquatic organisms such as pond snails
- aquatic plants such as duckweed or *Elodea*
- duct tape

Procedure

1. Look at the things your teacher has brought in as possible items to go into the ecosystem jar. With your group, determine the following:
 - (a) which things are biotic
 - (b) which things are abiotic
2. In your group, identify which biotic elements and which abiotic elements should be placed in the sealed jar.
3. Before creating your ecosystem, identify any precautions you should take when preparing your materials. For example, should the jar be cleaned with soap or just rinsed with water?
4. Organize your group to make sure that everyone has a role in preparing the sealed-jar ecosystem.
5. Assemble your ecosystem and seal it. Store it in a place where it can be observed easily.




Figure 1.29 Pond snail

6. Make a sketch or take a photograph of your sealed ecosystem to record its appearance at the beginning of this activity.

Analyzing and Interpreting

7. Discuss with your group the biotic and abiotic elements of your ecosystem and how you think they will interact over the next three weeks. Record these ideas and prepare a drawing of what you think the jar will look like after three weeks.
8. Create a chart that will allow you to record any changes you observe in the sealed-jar ecosystem over the next three weeks. Include a section in your chart to describe any observations of the types of interactions that can occur in an ecosystem.

Skill Builder

9. How does what you already know about ecosystems help you make reasonable predictions?

Forming Conclusions

10. For any changes you observe in the ecosystem, suggest reasons that might explain what is happening.

Ecosystems are communities where biotic and abiotic elements interact. 29

Figure 10: Sandor, 2008

In the first “Inquiry Activity” in the text, students are, as in the curriculum, encouraged to build an “ecosystem in a jar.” However, unlike the curriculum, the suggestion becomes a prescription, as the assignment is spelled out from the beginning in detail. There is no suggestion of the students designing the model ecosystem, no investigation of what a model ecosystem should consist of. The directions for building the experiment is set out much like a recipe, as are the instructions for conducting the experiment and reporting the findings.

Specifically, the “Inquiry Activity” proposes the following:

Question

What biotic and abiotic elements can you put into a sealed container to make a healthy ecosystem?

Procedure

1. Look at the things your teacher has brought in as possible items to go into the ecosystem jar. With your group, determine the following:
 - (a) which things are biotic
 - (b) which things are abiotic
2. In your group, identify which biotic elements and which abiotic elements should be placed in the sealed jar.
3. Before creating your ecosystem, identify any precautions you should take when preparing your materials. For example, should the jar be cleaned with soap or just rinsed with water?
4. Organize your group to make sure that everyone has a role in preparing the sealed-jar ecosystem.
5. Assemble your ecosystem and seal it. Store it in a place where it can be observed easily.
6. Make a sketch or take a photograph of your sealed ecosystem to record its appearance at the beginning of this activity.

Analyzing and Interpreting

7. Discuss with your group the biotic and abiotic elements of your ecosystem and how you think they will interact over the next three weeks. Record these ideas and prepare a drawing of what you think the jar will look like after three weeks.
8. Create a chart that will allow you to record any changes you observe in the sealed-jar ecosystem over the next three weeks. Include a section in your chart to describe any observations of the types of interactions that can occur in an ecosystem.

Skill Builder

9. How does what you already know about ecosystems help you make reasonable predictions?

Forming Conclusions

10. For any changes you observe in the ecosystem, suggest reasons that might explain what is happening.

(2008, p. 29)

Where the curriculum has suggested an inquiry, where asking the right questions and investigation are the goal, the text has produced an answer-getting exercise that is prescribed to the last letter. There is no encouragement to go past responding to the questions given, and no reason to allow one's personal curiosity to guide a student's investigation. Moreover, the activity doesn't allow the student to see or explore perspectives other than what is suggested in the text.

3.1.2 Form and Function

- 2.2 design, construct, and use physical models to investigate the effects of various forces on structures (*e.g., the struts of a roof experience compression forces from shingles; the support cables of a suspension bridge are in tension; a twisted ruler has torsion forces; the pin that holds the two parts of a pair of scissors together has shear forces acting on it*)
- 2.3 investigate the factors that determine the ability of a structure to support a load (*e.g., the weight of the structure itself; the magnitude of the external loads it will need to support; the strength of the materials used to build it*)
- 2.4 use technological problem-solving skills (see page 16) to determine the most efficient way for a structure (*e.g., a chair, a shelf, a bridge*) to support a given load
- Sample problem:* Using the least amount of material (by mass), construct a bridge to support a specific load (*e.g., minimum of 4 kilograms*).
- 2.5 investigate methods used by engineers to ensure structural safety (*e.g., incorporating sensors in structures to detect unusual stresses and give early warning of failure; designing structures to carry much heavier loads than they will actually have to bear*)

Figure 11: Ontario Ministry of Education 2007, p. 125

The curriculum refers to the basic concepts in the “Form and Function” strand as “the interrelationship between the function or use of a natural or human-made object and the form that the object takes.” (Ontario Ministry of Education, 2007, p. 5) Specifically for Grade 7, the emphasis is on the physical construction of structures that suit their location and use.

“Humans build structures to meet specific needs. In doing so, they must consider many factors, including not only the functions the structures must perform but also the resources available to build them, the intended lifetime of the structures, and the impact of the structures on the environment. In Grade 7, students will continue to learn about the effects of forces that act on and within different structural forms. They will investigate how different structural forms support or withstand loads by designing, building, and testing structures, using increasingly sophisticated techniques. Other factors that affect a structure’s functioning, such as type of structure and centre of gravity, will also be explored.” (Ontario Ministry of Education, 2007, p. 126)

Clearly it is the intention of the authors of the curriculum that students do this through direct experimentation and investigation. The wording of the curriculum expectations – especially words like “design,” “construct” and “investigate” – and the suggestion of subjects for investigation indicates the move towards inquiry as the preferred teaching model.

Structural Components and Materials

When designing and constructing a structure, you need to know about structural components and materials. In this lab, you will experiment with components and materials to learn more about their properties.

Questions

1. What are the properties of some structural components?
2. What is the effect of using different materials when building structural components?

Materials & Equipment

- various types of paper
- masking tape
- scissors
- a roll of coins for testing

CAUTION: Handle sharp objects like scissors very carefully.

Procedure

Part 1 The Components

1. Look at some of the structural components in Figure 5.8 on page 132. Choose three to build using photocopy paper and tape.
2. Build your components using as little tape as possible in each case.
3. Determine how strong each component is by using your coins.
4. Record your findings on a chart like the one in Table 5.1.

Table 5.1 Results of Components Test

Name of Component	Sketch	Results

Part 2 The Materials

5. Choose one of the components you tested above.
6. Build the component three times using a different type of paper each time. Try to use the same amount of tape and paper for each one.
7. Determine how strong each sample is by using your coins.
8. Record your findings in a table.

Analyzing and Interpreting

9. What did you find out about components in Part 1? Compare your results with those of another group.
10. What did you find out about materials in Part 2? Compare your results with those of another group.
11. Which component resisted the forces the best?
12. Which material resisted the forces the best?

Skill Builder

13. Could any parts of this test be made fairer? Explain how.

Forming Conclusions

14. What are some of the properties of the structural components you tested? Where would this component be useful?
15. What are some properties of the materials you tested? Where would these materials be useful?

Figure 12: Investigating Science and Technology, p. 138

The “Inquiry Activity” for this section begins with much the same language as the curriculum, telling students that they “will experiment with components and materials to learn more about their properties”. (Investigating Science and Technology 7, 2008)

It goes on to pose two questions – what are the properties of structural components and the effects of using different materials when building the components?

However, this is where the similarities end. The activity leaves no choice of materials, specifies a procedure, asks specific, closed-ended analysis and interpretation questions and prescribes potential conclusions. The question is not whether students will learn some of the properties of and materials used in building components – there are students for whom this approach will work quite well. The real difficulty is whether the text is mirroring the curriculum, and therefore meets the requirements of the Trillium List, making it suitable for use in Ontario classrooms.

3.1.3 Heat in the Environment

D26 Inquiry Activity
Toolkit 2

SKILLS YOU WILL USE
Recording and engineering data
Analyzing systems

Curious Candle

Air contains a mixture of gases, including oxygen. How long can a candle burn inside a closed container? How does the size of the container affect the time for a burning candle to go out? In this activity, you will use several beakers to observe the effect of heating different volumes of air inside the beakers of different sizes.

Question
How long can a candle burn under beakers of different sizes?

CAUTION: Do not touch the hot beaker after the candle has gone out.

Materials & Equipment

- pie plate
- modelling clay
- small candle
- water
- matches
- clock or stopwatch
- beakers of different sizes
- oven mitts

Hypothesis
Suggest how the size of a beaker might affect the time a candle can burn inside it. Record your answer.

Procedure

1. Copy Table 11.2 into your notebook.
2. Place a small piece of modelling clay onto the centre of the pie plate.
3. Stand the candle upright in the modelling clay.
4. Fill the pie plate with water.
5. Your teacher will light the candle.
6. As you place the smallest beaker over the candle, start timing. Closely observe the spout of the beaker and record your observations.

7. When the candle goes out, record the time in minutes and seconds in your table.
8. Use an oven mitt to lift the beaker out of the pie plate. Do not let water drip on the candle.
9. Repeat steps 5–8, replacing the small beaker with the middle-sized beaker.
10. Repeat steps 5–8 using the largest beaker.

Figure 11.8 Set up for activity

	Size of Beaker (mL)	Time That the Candle Lasted (min and s)
smallest beaker		
middle-sized beaker		
largest beaker		

Analyzing and Interpreting

11. Compare the three results you recorded in your table. Record your comparison.
12. Why did you need to start this activity by adding water to the pie plate?

Skill Builder

13. Predict how long the candle flame would last under a beaker twice as large as the largest beaker you used in step 10.

Forming Conclusions

14. What effect does the size of the beaker have on how long the candle will burn?

Activity Notes

- In this activity, students use beakers and a candle to stimulate their thinking about air and the gases it contains. Birthday candles work well for this activity. Students mount the candle in a small piece of modelling clay on a pie plate.
- A small quantity of water is poured into the pie plate (the level of water should be sufficient so as to cover the “beak” on each beaker when it is inverted). The smallest beaker must be sufficiently tall to be able to cover the candle. When the beaker is inverted over the burning candle, the flame slowly extinguishes and water travels into the beaker.
- Light the candle and invert a beaker over the candle. Watch carefully, as the effect happens quickly: the air inside the beaker expands due to the heat transferred from the candle flame. The expanded air pushes out of the beaker through the beaker’s pouring spout — look carefully and you will see bubbles of (expanded) air pushing and bubbling into the water.
- Students may believe that the intake of water into the inverted beaker after the candle goes out is due to the reduced amount of oxygen (and lower air pressure) inside the inverted beaker. This is a common misconception. Some websites and teacher resource books incorrectly explain the activity that way. There is indeed lower air pressure inside the inverted beaker. But this was caused by the removal of air while the candle was burning. The next point tells what really happens.
- As soon as the candle flame goes out due to lack of oxygen, the air inside the beaker cools and contracts, producing lower air pressure inside the inverted beaker. The air surrounding the beaker has normal atmospheric pressure. Therefore, the air surrounding the beaker pushes down on the water in the pie plate, pushing water into the beaker. Additional resources regarding this topic are available at ScienceSource.ca.
- Ask students to draw Table 11.2 before beginning the activity. Teachers may also wish to ask students to draw and label one or more illustrations similar to Figure 11.8.

**Figure 13: Activity D26: Investigating Science and Technology 7
Teacher’s Resource, p. 320**

**Figure 13a: Activity D26: Heat in the Environment
Teacher’s Resource, p. 45**

The Heat in the Environment strand has more “Inquiry Activities” than the other three, yet only one directly corresponds to specific expectations in the curriculum. Activity D26, *Curious Candle*, as is mentioned in the teacher’s resource, is specifically associated with four expectations in the curriculum (see Figure 13, following page) – each one tasking the student with explaining the way heat is transmitted through solids, liquids and gases, and the effects heat has on all three forms of matter taught in Grade 7. Once again, this activity follows the “recipe” approach that the others quoted herein have used, with one exception. In the teacher’s resource, not only are students steered to get

specific answers rather than developing responses to their own questions, the teacher is given prompts to become the “Sage on the Stage”, giving them the inside information about the real reason water climbs into the beaker once the candle heats the air inside the container. The teacher becomes the font of hidden knowledge, rather than the student developing theories on her or his own, and learning through an exploration of the theory. In fact, the correct information mentioned in the teacher’s resource is not printed in the student version of the text. It is left at the teacher’s discretion whether the correct analysis and interpretation of the results of the experiment are transmitted to the student.

<p>2.2 investigate the effects of heating and cooling on the volume of a solid, a liquid, and a gas</p> <p>2.3 use technological problem-solving skills (see page 16) to identify ways to minimize heat loss</p> <p><i>Sample problem:</i> Use the materials provided to create a product (e.g., a model of a piece of winter clothing, a model of a wet suit, a model travel mug for a hot beverage or food item) that will minimize heat loss</p> <p>2.4 use scientific inquiry/experimentation skills (see page 12) to investigate heat transfer through conduction, convection, and radiation</p> <p><i>Sample problem (conduction):</i> After letting spoons made of different materials sit partially submerged in a container of hot water, measure the temperature of the parts sticking out of the water. What conclusions can you draw from your findings?</p>
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Figure 14: Ontario Science and Technology Curriculum 2007, p. 112

Moreover, the “Inquiry” takes on the aspects of a teacher’s demonstration done solely for its “wow” factor, than an opportunity to investigate a facet of the way heat works in the environment. Admittedly, I have used this demonstration myself, primarily for the effect it has on students as they watch the water climb the wall of the beaker. When used as a way to incite curiosity and encourage discovery of the reason the

elements behave in certain ways, it works as a catalyst to inquiry. When used as described in the teacher's resource, it only serves to reinforce the teacher as the keeper of the knowledge, and to discourage exploration of concepts based on the idea that they are beyond the students in the classroom.

3.1.4 *Pure Substances and Mixtures*

The strand entitled Pure Substances and Mixtures is, for all intents and purposes, an introduction to “*real*” chemistry, and could be excused as being the one strand most likely to be pre-scripted in its approach, due to the large amount of basic skill and knowledge accumulation needed. The curriculum however, does not reflect this idea.

The curriculum once again uses words like “investigate” “inquiry” “experimentation” and “communicate” as anchors to learning the concepts presented in the document, while giving suggestions for investigation. For example:

- How does changing the amount of solute or solvent affect the solution?
- What factors affect the amount of solute that can dissolve in a solvent?
- What factors affect the speed at which a solute dissolves?
(Ontario Ministry of Education, 2007, p. 133)

As well, there are suggestions for inquiry and exploration of issues in the other two sections of the strand:

- Pure substances that are harmful to people or the environment must be disposed of very carefully. That usually means burying them in special landfills or underground chambers that will keep them from getting back into the environment or, if possible, recycling them or converting them into a substance that is not harmful. If these solutions are not possible, then we have to reduce our use of the substance or not use it all.
- Mixtures that have harmful components must be treated in the same way. Lead-based paint is a mixture that has to be disposed of in special landfills because the lead in it is harmful. Latex paint, which has no

harmful components, does not require special treatment. Sometimes, harmful components can be separated from the rest of the mixture, leaving less material for special disposal. Sewage is an example. Solid materials can be removed and decomposed by bacteria, leaving water that can be returned to lakes and rivers. The leftover sludge can be buried or, if it does not contain toxic materials, converted into fertilizer.

- Nuclear power stations produce no air pollutants, but the used uranium fuel rods remain dangerously radioactive for thousands of years. What options have been proposed for disposing of this waste? How safe are they? How would these concerns affect your decision about whether to heat your home by using electricity that is provided by nuclear energy? (Ontario Ministry of Education, 2007, p. 133)

Each of these issues could form the basis for good, meaningful inquiry. Students would have the opportunity to form their own guiding questions, develop opinion and explore multiple viewpoints.

- 2.1 follow established safety procedures for handling chemicals and apparatus (*e.g., wash hands after handling chemicals, take note of universal warning symbols*)
- 2.2 use scientific inquiry/experimentation skills (see page 12) to investigate factors (*e.g., temperature, type of solute or solvent, particle size, stirring*) that affect the solubility of a substance and the rate at which substances dissolve
- 2.3 investigate processes (*e.g., filtration, distillation, settling, magnetism*) used for separating different mixtures
- Sample problem:* Use filtration and magnetism to separate a mixture of water, sand, and paperclips. Use filtration to separate marbles of different sizes. Use evaporation to separate dissolved salt from water.
- 2.4 use scientific inquiry/experimentation skills (see page 12) to investigate the properties of mixtures and solutions (*e.g., the amount of solute required to form a saturated solution; differences between pure substances and mixtures*)
- Sample guiding questions:* How does changing the amount of solute or solvent affect the solution? What factors affect the amount of solute that can dissolve in a solvent? What factors affect the speed at which a solute dissolves?
- 2.5 use appropriate science and technology vocabulary, including *mechanical mixture, solution, solute, insoluble, saturated, unsaturated, and dilute*, in oral and written communication
- 2.6 use a variety of forms (*e.g., oral, written, graphic, multimedia*) to communicate with different audiences and for a variety of purposes (*e.g., using appropriate mathematical conventions, make a scatter plot to show the relationship between solute, solvent, and temperature*)

C29 Inquiry Activity **Toolkit 2** **SKILLS YOU WILL USE**
 ■ Evaluating procedures
 ■ Drawing conclusions

Separating a Mixture of Nails, Salt, Sand, Oil, and Water

Question
 What methods are necessary to separate and retain all components of a mechanical mixture?

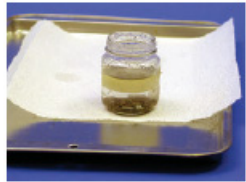


Figure 8.23 You will devise a method to separate this mixture of nails, salt, sand, oil, and water.

Materials & Equipment

- small jar with lid
- 5–10 small nails
- 5 mL table salt
- 5 mL fine sand
- 50 mL tap water
- 50 mL vegetable oil
- 2 small beakers
- bar magnet
- paper towel
- metal tray

Procedure

1. Work with a partner. Combine the nails, table salt, sand, water, and oil in the small jar.
2. Firmly secure the lid to the jar and shake the contents vigorously to dissolve and thoroughly mix the components of the mixture.
3. As a team, discuss and determine how to separate **and retain** all of the components of the mixture.

4. Discuss your procedure with your teacher, and get approval before you proceed with the method.

Analyzing and Interpreting

5. What component did you separate from the mixture first?
6. How did your choice in question 5 affect what you separated next?
7. How did you ensure that the maximum amount of each component of the mixture was retained?
8. Check with other students in your class. Did all students follow the same sequence to separate components from the mixture?
9. Use your understanding of the particle theory of matter to explain why your procedure worked to separate and retain the components of your mixture.
10. Wash your hands thoroughly after completing this investigation.

Skill Builder

11. How did you and your partner decide on the method you eventually used to complete this activity?

Forming Conclusions

12. What property of solutions was most useful to enable separation of the mixture?
13. What property of solids was most useful to enable separation of the mixture?

Figure 15: Investigating Science and Technology 7, p. 233

Once again, however, the “Inquiry Activity” serves only as an answer getting assignment, relying on the students to answer the questions that are posed in the activity and not to necessarily add their own.

In the accompanying Teacher’s Resource, under the heading “Assess the Activity” the teacher is encouraged to, as students work on this activity, “circulate around the room and listen for students’ use of scientific terminology. You may wish to check answers to the questions.” There is no mention as to whether the students are grasping the concepts presented, asking questions relating to the activity, or indeed curious about any

other part of the experiment and would like to explore it more. Simply put, if the answer that is predetermined is being found, then the student can move on in the text.

If the Inquiry Activities listed in the text do not actually meet the requirements for inquiry set out in the curriculum, where could they be found?

3.2 *Problem-Solving Activities*

By their definition in the text's teacher's resource overview, the problem-solving activities in *Investigating Science and Technology 7* "provide students with opportunities to solve practical problems that arise from human needs or wants. Usually, students build a device or system to solve a problem."

Redesign a Package

Recognize a Need

Most goods sold in Canada must be shipped long distances. The goods must arrive in perfect condition and often require a lot of label information. Most packaging ends up as waste in landfills or ecosystems. If it is not made of organic matter, decomposers cannot break it down.



Figure 2.12

Problem

How can you make a secure package that can be broken down by decomposers?

Materials & Equipment

- a plastic vase of flowers with water, or
- a pyramid of marbles, or
- 4 hard-boiled eggs (not in carton)
- packaging materials of your choice

Criteria for Success

Your model addresses the following issues:

- the package can be broken down by decomposers
- goods in the package are not damaged in transit
- labelling requirements (required customer information) are met
- the package is appealing to customers

Brainstorm Ideas

1. Research the packaging for any one of the items listed. Answer the following questions: How is the item protected? How is it transported? How is it sold? What happens to the packaging?
2. What is the impact of the packaging on the environment? Can decomposers break it down? How long will it take?
3. What packaging alternatives would be better for the environment?

Build a Model

4. Create a package that meets the criteria for success but at the same time reduces the amount of packaging that would end up as waste.

Test and Evaluate

5. Using your new package, transport your item along the hall and up or down the stairs to another floor at the other end of the school using a custodian's two-wheeled device to transport it. Did your package meet the criteria for success?

6. Share and compare your ideas and findings with your classmates' plans and findings. Did anyone have ideas exactly like yours? Similar to yours? Completely different from yours? How do your results compare with theirs?

Communicate

7. Prepare a poster, computer slide show presentation, or a packaging "fair" to display alternatives. Or present your findings to the class in a form suggested by your teacher.

Cleaning Up an Oil Spill



Figure 3.14 Oil spills destroy the insulating qualities of the leathers and fur of many shoreline birds and animals.

Recognize a Need

Oil is shipped long distances in large tankers. From time to time, these tankers run aground and spill their contents along a shoreline. People living nearby must move very quickly to clean up the oil before it damages local ecosystems.

Problem

How can you clean up an oil spill in an ecosystem?

Materials & Equipment

- a square or rectangular shallow container (minimum 1.2 L)
- 1 L of sand
- 4-5 small rocks
- 2 small plants
- water
- 2 tbsps (30 mL) motor oil
- materials of your choice for use in the clean-up

Criteria for Success

- Oil is completely cleaned out of the water and the other abiotic and biotic materials.

Brainstorm Ideas

1. Research the technologies used to clean up spills from oil tankers. How effective were these technologies?
2. What technologies could you use to clean up your model oil spill?

Build a Model

3. Create a miniature shoreline ecosystem in your container. Use the rocks to protect the sand. Add the water last, using just enough to create a model shoreline.

Test and Evaluate

4. Take 2 tbsp of the oil and add it to the water. Move the container from side to side to model gentle wave action.
5. Use the technology you researched to clean up biotic and abiotic elements in your mini-ecosystem.
6. Share and compare your ideas and findings with your classmates' plans and findings. Did anyone have ideas exactly like yours? Similar to yours? Completely different from yours? How do your results compare with theirs?

Communicate

7. Prepare a report or computer slide show presentation on the success of your clean-up operation. Or present your findings to the class in a form suggested by your teacher.

Newspaper Bookcase

Recognize a Need

You have been asked to design and build a bookcase using only newspaper and masking tape.

Problem

Can a bookcase be made from newspaper and masking tape that will support a textbook?

CAUTION: Handle sharp objects like scissors very carefully.

Materials & Equipment

- newspapers
- masking tape
- textbook
- scissors
- ruler

Criteria for Success

- The bookcase must stand up by itself.
- The bookcase must be constructed of newspaper and masking tape only.
- The bookcase must support at least one textbook for 1 min.
- The best bookcase must satisfy the first three criteria above and be built with the least amount of material.

Brainstorm Ideas

1. What shape should the bookcase have?
2. How big should the bookcase be?
3. What structural components should be incorporated into the design?

Build a Prototype

4. Draw sketches of a few different designs for your bookcase. Discuss the pros and cons of each design with your group.
5. Decide on the design you would like to build and check your design with your teacher.
6. Gather the materials you will need and build your bookcase.

Test and Evaluate

7. Place the books on the bookcase. Check the time to see if your bookcase meets the design criteria. Keep working until you have a design that works.
8. When you have a design that works, study it to decide how you can improve it. Could you use less material? Could you make it stronger? Could you make it more aesthetically pleasing?
9. Modify your design and build another model.

Communicate

10. Create a chart with a diagram of your finished bookcase. Highlight the structural components and the materials you used that made your design a good one.

Designing a Method to Separate a Mixture

Recognize a Need

Many industrial and manufacturing applications involve the need to separate components of a mixture of different substances. This may involve removing precious stones, minerals, or metals from rocky raw material, making cheese by separating clumped material called curd from raw milk, or some other application. In this activity, you will work with a team to design a method to separate the components of a mixture determined by your teacher.

Problem

How can you separate this mixture into each of its component parts?

Materials & Equipment

- as determined by the teacher

Criteria for Success

- A method of separation for each component part is approved by the teacher.
- The mixture is sorted into each component part.

Brainstorm Ideas

1. Classify each of the substances known to be in the mixture using the following criteria:
 - pure substances or mixtures
 - water soluble or water insoluble
 - magnetic or non-magnetic
 - large particle size or small particle size
2. Determine which separation methods will be allowed by your teacher.

Make a Drawing

3. Show on your flowchart when and how each substance is separated from the mixture.
4. Ask your teacher to approve your process.
5. Revise your process as necessary, and repeat steps 3 and 4 until your flowchart is approved by your teacher.

Test and Evaluate

6. Using the flowchart you prepared as your guide, conduct the separation as you have planned.
7. Be prepared to demonstrate your separation technique by modelling the procedure for your class. As much as is possible, use real examples and include the thinking process you used to design your technique.
8. When finished, clean up your work station and wash your hands thoroughly.

Communicate

9. Prepare a brief presentation (2 min) of your separation technique and deliver this to your class. Be sure that all team members contribute to the presentation.
10. Use simple examples to get your point across. Try to include extensions that would enable other students, groups, or industries to use your technique for other mixtures.

There are four “problem-solving” activities in the text – two in the chapter devoted to Interactions in the Environment, and one each in Form and Function and Pure Substances and Mixtures. There are no problem-solving activities in the Heat in the Environment strand section. This is difficult to understand, owing to the ongoing debate over climate change and global warming.

These activities would at first blush, seem to provide a perfect opportunity for the use of inquiry as an approach to further the understanding of science and technology in a Grade 7 classroom, based on the definition spelled out in the curriculum. However, the approach in the text is less inquiry and more research project in another guise. This is made clearer when examining each in detail.

3.2.1 A26 – Redesign a Package

This assignment has a clear objective – “How can you make a secure package that can be broken down by decomposers?” If left here to develop guiding questions, a series of success criteria and ways to determine bias, viewpoints and perspective, this assignment could become a rich inquiry assignment.

The assignment as proposed by the text continues:

Criteria for Success

Your model addresses the following issues:

- the package can be broken down by decomposers
- goods in the package are not damaged in transit
- labelling requirements (required customer information) are met
- the package is appealing to customers

Brainstorm Ideas

1. Research the packaging for any one of the items listed. Answer the following questions:

How is the item protected? How is it transported? How is it sold? What happens to the packaging?

2. What is the impact of the packaging on the environment? Can decomposers break it down? How long will it take?

3. What packaging alternatives would be better for the environment?

Build a Model

4. Create a package that meets the criteria for success but at the same time reduces the amount of packaging that would end up as waste.

Test and Evaluate

5. Using your new package, transport your item along the hall and up or down the stairs to another floor at the other end of the school using a custodian's two-wheeled device to transport it. Did your package meet the criteria for success?

6. Share and compare your ideas and findings with your classmates' plans and findings. Did anyone have ideas exactly like yours? Similar to yours? Completely different from yours? How do your results compare with theirs?

Communicate

7. Prepare a poster, computer slide show presentation, or a packaging "fair" to display alternatives. Or present your findings to the class in a form suggested by your teacher. (Investigating Science and Technology 7, 2008)

Although this assignment meets the requirements for a “lab” or a planned experiment quite well, the lack of suggested input by the student, the prescribed assessment criteria and the planned communication medium makes this activity more an answer-getting exercise than an inquiry. This is made more evident by the activity notes in the Teacher’s Resource.

- Before beginning this activity, start collecting a variety of different packaging materials. These materials should include examples of materials that can and cannot be broken down by decomposers. Alternatively, when you begin the activity, have the class make suggestions of different materials they could use.
- Read the entire activity with students to ensure they are aware of all the information they need to consider before beginning.
- Decide on the working groups and review strategies for effective group work.
- Make sure that students understand the Criteria for Success, and that these are what will be used to assess whether or not their design was successful. Explain that there are many ways that these criteria can be met, and that as long as their package does meet these criteria, they have been successful.
- Show students the three objects they can choose to package and discuss the challenges each one presents:
- vase of flowers: needs to be kept upright; don’t spill the water; protect the flowers
- pyramid of marbles: to build the pyramid, start with a 5 marble by 5 marble base and then build each level up so that it ends at a point; transport it so that the pyramid remains intact
- eggs: build container to carry the 4 eggs without cracking the shells.
(2008, p. 47)

The proposed format gives the teacher complete control over the process, criteria, materials and assessment. The student is not involved in the planning, questioning or determining the potential for success of their work, nor are the interests and curiosity of the student addressed.

There is no discussion of other viewpoints beyond the need to package materials and ship products. Could a student suggest that, by purchasing products made locally,

packaging to protect them in the ways suggested would be superfluous, and as a result do an inquiry into the savings, both for the environment and the retailer, inherent with local production? Is there room for a discussion and research about packaging that can immediately be reused for other purposes, such as margarine being shipped in Tupperware containers or running shoes in canvas shopping bags, as has been done by Converse? In either case, the assignment limits the student's options and potential for investigation, putting the teacher in complete control of the learning process.

3.2.2 A42 – *Cleaning Up an Oil Spill*

Under the heading *Recognizing the Need*, this problem-solving activity tries to develop a mind-set that could lead to understanding.

Oil is shipped long distances in large tankers. From time to time, these tankers run aground and spill their contents along a shoreline. People living nearby must move very quickly to clean up the oil before it damages local ecosystems. (2008, p. 72)

In the course of two sentences, the environmental impact of a man-made disaster, responsibility for its clean-up and the inevitability of it occurring in the first place are neatly put into place. There is no discussion about the safety of shipping oil by tanker through sensitive ecosystems, no debate over the responsibilities of the corporations for whom this practice is very profitable, simply a situation where there is a disaster to avert.

Criteria for Success

Oil is completely cleaned out of the water and the other abiotic and biotic materials.

Brainstorm Ideas

1. Research the technologies used to clean up spills from oil tankers. How effective were these technologies?
2. What technologies could you use to clean up your model oil spill?

Build a Model

3. Create a miniature shoreline ecosystem in your container. Use the rocks to protect the sand. Add the water last, using just enough to create a model shoreline.

Test and Evaluate

4. Take 2 tbsp of the oil and add it to the water. Move the container from side to side to model gentle wave action.
5. Use the technology you researched to clean up biotic and abiotic elements in your mini-ecosystem.
6. Share and compare your ideas and findings with your classmates' plans and findings. Did anyone have ideas exactly like yours? Similar to yours? Completely different from yours? How do your results compare with theirs?

Communicate

7. Prepare a report or computer slide show presentation on the success of your clean-up operation. Or present your findings to the class in a form suggested by your teacher.

Here, as in the first activity above, there is no room given for student input, only a procedure to follow. Moreover, student demonstration of understanding is limited to a single form, not allowing for the use of varying forms of communication media to report on findings.

The Teacher's resource makes specific suggestions for the assessment of this assignment.

As students work on this activity, look for evidence of their abilities to design a potential solution to a problem. In particular, look for evidence that shows they have clearly identified how they will clean the oil from the abiotic and biotic elements of their mini-ecosystem, and have designed an approach that allows them to do this. As they are testing their method of cleaning the spill, check to see if they are keeping a record of how well their method is actually cleaning the oil from the abiotic and biotic elements of the mini-ecosystem. (Investigating Science and Technology 7, Teacher's Resource, 2008)

The corresponding expectations in the curriculum are as follows:

Relating Science and Technology to Society and the Environment

1.1 assess the impact of selected technologies on the environment

Sample issue: The use of technologies such as cars and computers has many impacts on the environment. What are some of these impacts and how do they affect the ability of the environment to support life?

Developing Investigation and Communication Skills

2.3 use scientific inquiry/research skills (see page 15) to investigate occurrences (*e.g., a forest fire, a drought, an infestation of invasive species such as zebra mussels in a local lake or purple loosestrife in a wetland habitat*) that affect the balance within a local ecosystem.

Sample guiding questions: Should naturally caused fires in national parks be allowed to burn to their natural end? How do human activities and natural occurrences contribute to droughts? What happens in a drought? What is the impact of invasive species such as zebra mussels, spiny water fleas, round gobies, and sea lampreys on Ontario lakes, and what can be done to lessen the impact?

Understanding Basic Concepts

3.8 describe ways in which human activities and technologies alter balances and interactions in the environment (*e.g., clear-cutting a forest, overusing motorized water vehicles, managing wolf-killings in Yukon*) (Ontario Ministry of Education, 2007)

The suggestions for assessment of this assignment begin and end with the skills needs for the solving of the problem (which is granted, in consideration of the fact that it is a *problem-solving* activity), but disregard the clear intent of the curriculum to teach those skills in concert with allowing for student exploration of real-life issues and situations. The learning of the skills, taught in isolation, lack the richness that could have been achieved through a more investigative approach, using student participation in planning the assignment.

This one-dimensional approach to the expectations of the curriculum is also reflected in the suggested rubric offered in the Teacher`s Resource -

	Level 1	Level 2	Level 3	Level 4
Knowledge and Understanding				
Understanding of content <ul style="list-style-type: none"> Recognize a need The Problem 	Student demonstrates limited understanding of the task.	Student demonstrates some understanding of the task.	Student demonstrates considerable understanding of the task.	Student demonstrates thorough understanding of the task.
Thinking and Investigation				
Use of initiating and planning skills and strategies <ul style="list-style-type: none"> Brainstorm Ideas Build a Prototype 	Student uses initiating and planning skills and strategies with limited effectiveness.	Student uses initiating and planning skills and strategies with some effectiveness.	Student uses initiating and planning skills and strategies with considerable effectiveness.	Student uses initiating and planning skills and strategies with a high degree of effectiveness.
Use of critical/creative thinking processes, skills, and strategies <ul style="list-style-type: none"> Build a Prototype Test and Evaluate 	Student uses critical/ creative thinking processes, skills, and strategies with limited effectiveness.	Student uses critical/ creative thinking processes, skills, and strategies with some effectiveness.	Student uses critical/ creative thinking processes, skills, and strategies with considerable effectiveness.	Student uses critical/ creative thinking processes, skills, and strategies with a high degree of effectiveness.
Communication				
Expression and organization of ideas and information in oral, visual, and/or written forms	Student expresses and organizes ideas and information with limited effectiveness.	Student expresses and organizes ideas and information with some effectiveness.	Student expresses and organizes ideas and information with considerable effectiveness.	Student expresses and organizes ideas and information with a high degree of effectiveness.
Communication for different audiences and purposes in oral, visual, and/or written forms	Student communicates for different audiences and purposes with limited effectiveness.	Student communicates for different audiences and purposes with some effectiveness.	Student communicates for different audiences and purposes with considerable effectiveness.	Student communicates for different audiences and purposes with a high degree of effectiveness.
Application				
Transfer of knowledge and skills to unfamiliar contexts <ul style="list-style-type: none"> Build a Prototype Test and Evaluate 	Student transfers knowledge and skills to unfamiliar contexts with limited effectiveness.	Student transfers knowledge and skills to unfamiliar contexts with some effectiveness.	Student transfers knowledge and skills to unfamiliar contexts with considerable effectiveness.	Student transfers knowledge and skills to unfamiliar contexts with a high degree of effectiveness.

(2008, pp. LM-3)

This rubric is the recommended assessment tool for all of the problem-solving activities in Investigating Science and Technology 7, and mirrors the quantitative approach of assessment that is found throughout the book. There is no assessment of the student's understanding of the issues involved, nor any discussions student investigation or thinking, other than planning skills and testing of the prototype, both of which are prescribed in the assignment. Throughout this assignment, from planning to assessment, teacher control is paramount and student participation is limited to building the model to the teacher's template.

3.2.3 B33 – Newspaper Bookcase

In the Teacher's Resource teaching notes for this activity, it suggests, `` Some students may benefit from Skills Worksheet 6, Designing Experiments Skills: Asking Questions Related to Scientific Inquiry``. (Investigating Science and Technology 7, Teacher's Resource, 2008)

Designing Experiments Skills: Asking Questions Related to Scientific Inquiry

Asking questions is an essential part of science. Scientific questions can be answered by observations or evidence. This is an important difference from other types of questions.

Hints for Asking Questions Related to Scientific Inquiry

- ▶ Start by making a list of several questions related to the natural world.
- ▶ Review your list. If any questions cannot be answered by gathering evidence, delete them.
- ▶ If your questions are general, break them down into questions that can be investigated one at a time.
- ▶ Good questions that can be answered by scientific inquiry begin with:
 “What is the relationship between ...?”
 “What factors cause ...?”
 “What is the effect ...?”
- ▶ Your questions should identify a relationship or factor you can investigate.

Practise Your Questioning Skills

Directions: Read each statement below and indicate if it can be investigated scientifically or not. For statements that can be investigated, write a scientific question you would try to answer.

1. Animals at the top of the food chain eat plants and animals at the bottom of the food chain.
2. Eating too much junk food is bad for you.
3. Wayne Gretzky was the best hockey player ever.
4. When you hear thunder, lightning and rain are soon to follow.
5. Reducing energy consumption is a good thing.
6. Bears hibernate through the winter.
7. A red sunrise means the weather will change.
8. Sunlight is made of seven colours.
9. Structures made of concrete are more stable than structures made of wood.
10. Horoscopes correctly predict your future.

*Figure 16: Investigating Science and Technology 7
Teacher’s Resource, p. 32*

The primary purpose for this “worksheet”, as it is referred to in the Teacher’s Resource, is to help introduce and clarify the skills necessary to ask inquiry questions within science and technology. The opening paragraphs, referring to questioning within science to be somewhat different than normal questioning because they “can be answered by observations or evidence” is troubling, because it gives the impression that other forms of questioning aren’t subject to the same criteria. The curriculum recognizes that:

Trying to understand how the world works is what children do naturally, and it is what you need to take advantage of when teaching science [and technology]. Just remember: Avoid being the knowledge authority. Jeffery W. Bloom (Ontario Ministry of Education, 2007, p. 30)

The activity makes a procedural exercise out of something that is done naturally by students, limiting their natural abilities to try to make sense of their world.

Additionally, the “*Practise your Questioning Skills*” could, if used incorrectly, allow a misconception of what the development of questions within an inquiry requires. As an example, the sample statement – “Eating too much junk food is bad for you.” The prescribed assignment is to develop a “scientific question” that can be answered. The student could simply write – “What is the relationship between eating too much junk food and health?” This may suffice as a global question to begin further questioning, but delving deeper into the subject is not only not required, it isn’t even suggested. Questions such as “What is junk food?” “What is a healthy diet?” “What is health?” “What constitutes too much of something?” “Do we only mean physical health when we say something is ‘bad’ for you?” would not be explored by a student who is only mining for a “right answer”. The student is therefore being told not to explore the entire issue or topic, just to answer a question with the acceptable answer.

With this in mind, students are charged with assembling a newspaper bookcase, activity B33.

Criteria for Success

- The bookcase must stand up by itself.
- The bookcase must be constructed of newspaper and masking tape only.
- The bookcase must support at least one textbook for 1 min.
- The best bookcase must satisfy the first three criteria above and be built with the least amount of material.

Brainstorm Ideas

1. What shape should the bookcase have?
2. How big should the bookcase be?
3. What structural components should be incorporated into the design?

Build a Prototype

4. Draw sketches of a few different designs for your bookcase. Discuss the pros and cons of each design with your group.
5. Decide on the design you would like to build and check your design with your teacher.
6. Gather the materials you will need and build your bookcase.

Test and Evaluate

7. Place the books on the bookcase. Check the time to see if your bookcase meets the design criteria. Keep working until you have a design that works.
8. When you have a design that works, study it to decide how you can improve it. Could you use less material? Could you make it stronger? Could you make it more aesthetically pleasing?
9. Modify your design and build another model.

Communicate

10. Create a chart with a diagram of your finished bookcase. Highlight the structural components and the materials you used that made your design a good one.

Once again, what analytical questions that could be asked by the student to evaluate and critique their own work and that of others have already been asked by the teacher through the text, the power of assessment of the product has been put squarely into the hands of the teacher, as has all the criteria for success. In an inquiry, students would first determine what they believed a successful structure to be and would determine their own criteria to suit. This would not only engage students, but also enrich the task by letting students experience the decision making process from the perspective of a consumer, designer, producer and fabricator. The assignment only allows for the viewpoints of the “teacher”, by way of the text and the Teacher’s Resource, and the designer.

3.3 Decision-Making Analysis Activities

The Teacher’s Resource of Investigating Science and Technology 7 describes the Decision-Making Analysis activities in the text as follows: “Decision-Making Analysis activities have students explore the social, economic, environmental, political, ethical, and moral impacts of a real-world issue related to the unit being studied.” (Investigating Science and Technology 7, Teacher's Resource, 2008)

Based on this definition alone, it would seem that these activities would come closer to the definition of inquiry as given in the curriculum, especially in regard to the development and investigation of differing viewpoints.

There are ten Decision-Making Analysis activities in the Grade 7 text. They include:

- Interactions in the Environment - A36-Managing Forests and Forest Fires, A41-Taking out the E-Trash, A46-What Kind of Car Will You Be Driving?, A47-What Do You Want To Do Today?
- Structures: Form and Function - B45-Altering a Product Lifespan, B50-How Green Can We Be?
- Pure Substances and Mixtures - C44-Community Treatment of Water Waste, C45-Dealing with dangerous Disposal Practices
- Heat in the Environment - D47-Reduce, Re-Use, Recycle, Recover, D51-Cutting Energy Costs

The assignments are located at the end of the third and final chapter for each strand, and are designed, according to the Teacher's Resource to, "allow students to explore the social, economic, environmental, political, ethical, and moral impacts of a real-world issue. Students working together collect evidence and make a decision based on their research. The skills used in these activities directly link to the Scientific Inquiry/Research Skills continuum. Using these activities, students consolidate their knowledge and skills while relating to issues that affect their lives." (2008, p. 28 & 29)

It is assumed that these activities are left for the end of each unit because they are cumulative, needing the knowledge, skills and concepts taught in the entire section in order to successfully complete them. For this reason as well as that of brevity, I will concentrate on the final assignment for each unit. This should not prove to be problematic due to the similarity of format these activities share.

3.3.1 A47 – What Do You Want To Do Today?

A47 Decision-Making Analysis **ToolKit 4** **SKILLS YOU WILL USE**
• Asking questions
• Organizing information

What do you want to do today?

Issue
Human activities and technologies have an effect on the environment. Often there are choices available that will have a limited impact on the environment and can help protect ecosystems.

Background Information
Consumers are found in every ecosystem on Earth. In addition, human consumers are often found in malls and shopping centres in North America, as well as online.
Shopping for and buying items is an important part of the economy. Human consumption includes getting the weekly groceries, buying the latest fashion, getting a haircut, or going to a restaurant for a quick snack. Packaging, plastic bags, emissions from cars driving to the mall, throw-away dishes, and basements full of objects that are not used anymore are all results of these human activities.
The products we buy are made from resources that come from Earth. Energy is used to manufacture, package, and transport them to markets. More energy is used to light and power stores and malls. Considerable waste is generated after products have been used. What impact do these activities have on the environment? As we begin to understand about the environmental impact of our consumption, what are we willing to do to change that impact?

Analyze and Evaluate

1. Consider one of the activities listed below and how it affects the environment:
 - (a) visiting a fast food restaurant for a meal with your friends
 - (b) the family's grocery shopping
2. Use the chart below to analyze the impact of your chosen activity on the environment.

Benefit to you (+)	Cost to the environment (-)	Options

In this activity, benefits (+) are things that are good for you, the consumer. Costs (-) are things that are not good for the environment. In the Options column, list ways you could reduce the negative impact of the costs but still get the benefit of the activity.

3. Once you have filled in information on the activity you chose, find two classmates and compare the benefits, costs, and options you each listed.
4. Discuss with your small group any other questions, concerns, or related information you have about your activity. Record these on the back of your chart.
5. Work as a group to develop a creative way to share your findings with the rest of the class, (speech, computer slide show, editorial, or video report) or suggest ways to balance the benefits and costs of some common activities at an Environmental Action Fair. Your teacher will tell you the date by which you must be ready to present.

Figure 17: Investigating Science and Technology 7, p. 79

The issue given as the focus for this assignment is, “Human activities and technologies have an effect on the environment. Often there are choices available that will have a limited impact on the environment and can help protect ecosystems.”

This statement opens a door to many different potential investigations. However the text, in the *Background Information* of the assignment, identifies only one – shopping. The assignment states that consumers exist worldwide and on the Internet, and emphasizes their importance. “Shopping for and buying items is an important part of the economy.”

Human consumption includes getting the weekly groceries, buying the latest fashion, getting a haircut, or going to a restaurant for a quick snack. Packaging, plastic bags, emissions from cars driving to the mall, throw-away dishes and basements full of

objects that are not used anymore are all results of these human activities.” (2008, p. 79)

The introduction goes on to discuss the use of resources necessary to produce, transport and offer for sale everyday goods.

Based on the above, and on the skill and knowledge that the students have been taught over the unit, the assignment asks students to consider the impact of their activities, analyzing and evaluating their cost to the environment.

Analyze and Evaluate

1. Consider one of the activities listed below and how it affects the environment:

- (a) visiting a fast food restaurant for a meal with your friends
- (b) the family’s grocery shopping
- (c) going to the mall to pick up something new to wear or play with
- (d) another activity that you participate in that has an impact on the environment (check with your teacher to ensure it is applicable)

2. Use the chart below to analyze the impact of your chosen activity on the environment.

Benefit to you (+)	Cost to the environment (-)	Options

In this activity, benefits (+) are things that are good for you, the consumer. Costs (-) are things that are not good for the environment. In the Options column, list ways you could reduce the negative impact of the costs but still get the benefit of the activity.

- 3. Once you have filled in information on the activity you chose, find two classmates and compare the benefits, costs, and options you each listed.
- 4. Discuss with your small group any other questions, concerns, or related information you have about your activity. Record these on the back of your chart.
- 5. Work as a group to develop a creative way to share your findings with the rest of the class, (speech, computer slide show, editorial, or video report) or suggest ways to balance the benefits and costs of some common activities at an Environmental Action Fair.

Your teacher will tell you the date by which you must be ready to present.

Once again, the assignment doesn't allow for the student to choose specifically what he/she wishes to explore, giving three specific suggestions for investigation before offering an opportunity for choice almost as an afterthought, and then only if the teacher gives permission for the student to do so. Even if the student is considering choosing another subject for study, the mind-set has already made it clear that this assignment is to be about the given issue – being a consumer – and leaves little to choose from should an alternate issue be more applicable to an individual.

The assignment also assumes that students are homogeneously interested in being “consumers” or can afford to do so. Students from financially strapped households may not find themselves visiting a fast food restaurant often, nor would they have occasion to purchase new clothing or playthings on a regular basis. Finally, for some, this may be an issue that may emphasize the divisions between the “haves and have-nots” within a classroom. The text assumes that either the family or student has a discretionary income to purchase new things to, “wear or play with”, or that it is culturally acceptable for children to involve themselves in purchasing the family's food order.

Although these issues in themselves could lend themselves well to inquiry, the assignment can't, in its current form.

3.3.2 *B50 – How Green Can We Be?*

As has been the case in earlier assignments, the Teacher's Resource recommends a worksheet. In this instance it specifically refers to a page dedicated to data analysis, in particular to the interpretation of data.

The page in the text suggests that, once the applicable data is collected, interpretation of the data means looking for a pattern or a trend, and that one way of finding those patterns is through graphing the data.

Of course, this presupposes the data collected is quantitative rather than qualitative or a mixture of both, and that discovering trends and patterns will give the student the interpretive insight they are searching for. Nonetheless, it is an interesting choice for the assigned activity, as will be seen in the following.

Data Analysis: Interpreting Data

When you are doing a scientific inquiry, you make observations and measurements. These recorded values are called your *data*. Once your data are collected, you need to interpret them. Interpreting data means looking for a pattern or trend. One way to find patterns is by graphing your data. By analyzing your graph, you can determine if a pattern exists. Comparing your interpretation to something you already know will help you figure out if you have made a logical interpretation.

Hints for Interpreting Data

- ▶ Organize your data into a table or arrange your data in some type of order.
- ▶ Make a graph for your data.
- ▶ Review your graph for patterns or trends.
- ▶ Using your data, infer what you think may be happening and compare your inferences with what you already know or have researched.

Practise Your Interpreting Skills

One way to increase your interpreting skills is to think about the patterns shown on graphs instead of the data itself. Here's how: Sketch a graph to show each of the following patterns. You won't be able to put in actual data, but you can label the axes and give the graph a title. You will also be able to draw in a line to show what is happening.

1. The height of a corn plant increases with time.
2. The number of clean cars on the road is lowest in the winter months.
3. A volume of water set over a heat source will gradually decrease.
4. The number of cats found in an area increases just after the number of mice increases. The number of cats decreases after the number of mice decreases. This continues every year for ten years. (Hint: You may need two lines on the same graph.)
5. A student measured her height once a month for two years. Her height increased for four months, then remained the same.
6. The processing speed of computer chips is increasing far more quickly than anyone had predicted. This trend shows no sign of slowing down.
7. Using a bar graph, show a comparison between: (a) the approximate number of hours a week you spend on homework now and (b) the number of hours a week you predict you will be spending on homework next year.

***Figure 18: Understanding Science and Technology 7
Teacher's Resource, p. 39***

Student Text

Issue

Every school also makes an impact on the environment. Students and staff spend a lot of time at schools and need the school to be safe and comfortable. The issue is: what changes can be made at school to lessen its impact on the environment?

Background Information

Energy is used to heat, cool, and light a school. Many school activities generate waste products. In order to reduce the school's impact on the environment, some of these activities and some of the energy use can be changed.

Some changes can be made with little or no cost. For example, asking students to bring litter-less lunches, such as the lunch shown in Figure 6.25, costs no money but reduces the amount of waste produced at the school. Other changes, such as installing energy efficient windows or switching to solar-powered water heating, will cost money.

Consider these two viewpoints on this issue.

- Some people feel that it is enough to make inexpensive changes to lessen the impact on the environment. Changes in behaviours such as turning off the lights when not needed and keeping the building at a moderate temperature do not cost much money.
- Others feel that changes in behaviour are just the start. Changes in infrastructure, such as increased insulation and the use of low-wattage light bulbs, must be made in order to be more environmentally responsible.

Your task is to choose one side of the argument and research the issue. You will present your findings as either a debate or a class presentation. Your teacher will provide more details about how to present your information.

Analyze and Evaluate

Begin your research using the following resources.

1. Go to ScienceSource to begin your search for information.
2. Look in print materials, such as magazines, newspapers, and books, for information on reducing your impact on the environment.
3. Summarize the information you find in a short

Teacher's Resource

Activity Notes

- Assign students to groups.
- Have groups pick the side of the issue they are interested in. You may have to assign some groups to the side considered negative by most students, because students should see both sides of an issue.
- Encourage the students to research their topic at ScienceSource.ca, in magazines, in newspapers, etc.
- Some students with an Individualized Education Plan might need a step-by-step breakdown of how and when to do each part of the assignment. Or provide these students with some research.
- Review the students' points to ensure that they have solid arguments for or against changes in infrastructure.
- Have the students present their information as a debate or presentation.
- Some students may benefit from Skills Worksheet 11 Data Analysis: Interpreting Data.

Extend

- Suggest that students present their ideas to administrators and the school board. Tell the students about other students making changes in their school. For example, at William Lyon Mackenzie Collegiate Institute in Toronto, the idea of SWITCH, Solar and Wind Initiatives Towards Change, came about.

Assess the Activity

- As students work on this activity, circulate and answer questions or direct students to information where they can find the answers themselves.
- Have the other students judge the presentations or the debates. When judging a debate, they should not vote for the side they agree with, but for the best presentation by the debaters.
- Use Assessment Rubric LM 4 Decision-Making Activity. For the debate or presentation, use Assessment Rubrics LM 10 Debate or LM 11 Oral Presentation.

As in activity A47, *How Green Are We?* gives a “no-choice choice”. Although the stated issue leaves quite a lot of opportunity for multiple viewpoints and perspectives, it is limited by the Background Information section that limits the discussion of a school's impacts on the environment to whether or not investing on changing a schools

infrastructure is necessary, or if simply making behavioural changes that make a limited impact should suffice. Whether or not it was the intention of the text's writers, the format of the assignment removes opportunity for multiple viewpoints and negates them from the very beginning. This is exacerbated where; despite given the chance to choose which side of the argument student could argue in a presentation or debate, there is no stated option to take on a third option – perhaps that of a climate change denier, or from the standpoint of an owner of a energy company, etc. – nor is the teacher encouraged to suggest one, given instructions in the Teacher's Resource to, "Review the students' points to ensure that they have solid arguments for or against changes in infrastructure." Once again, the control rests with the teacher, not the student.

This is also the case in the suggested assessment activities for the teacher. "As students work on this activity, circulate and answer questions or direct students to information where they can find the answers themselves." (Investigating Science and Technology 7, Teacher's Resource, 2008)

The teacher is not only put in the position of being the knowledge "gate-keeper" but the suggestion to have the teacher direct the students to information in order for them to "find the answers themselves" is contradictory. Not only have the students not formulated their own guiding questions, the teacher leaving "bread crumbs" as it were, for the students to "discover the information for themselves" is counterintuitive. In addition, the first source of information suggested to the student is the text's own website *ScienceSource.ca*. There is little to no room for creativity in approach, different perspectives or personal curiosity. The teacher becomes the guide, the resource and the

assessor all in one, leaving the students out of the entire process, with the notable exception of doing the assignment itself.

3.3.3 C45 – Dealing with Dangerous Disposal Practices

At the end of text, a selection of “Toolkits” is made available to the student in order to, “... provide references to lab safety and other basic scientific skills that will help students. Students can check the toolkits when they need a refresher about these skills.” (Investigating Science and Technology 7, Teacher's Resource, 2008). The toolkit that is referred to in assignment C45-Dealing with Dangerous Disposal Practices is Toolkit 4, The Decision-Making Process for Social and Environmental Issues.

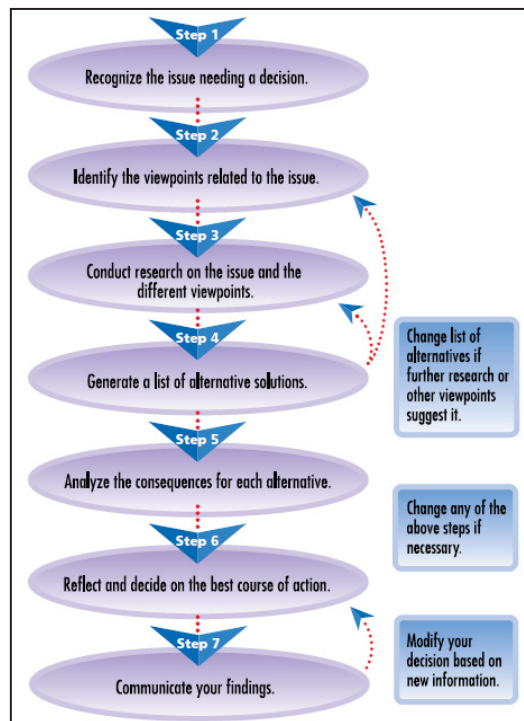


Figure 19: From Toolkit 4, Investigating Science and Technology 7, 2008

The toolkit takes a very formulaic approach the decision making process, offering a flow chart to follow. As a linear understanding of how a decision is made scientifically, it is quite sufficient. It doesn't start where inquiry should start – asking the questions necessary to determine what the issue is that needs to be recognized –however, it does put forward a tangible way to begin the proper analysis of guiding questions generated at the start of a inquiry – the “bones of an inquiry”, as it were.

The section continues to include how to choose a topic, information searching and researching techniques, how to better use the library and the Internet, and ways to record information that has been gathered. None of this information is exhaustive, but it does provide a well-organized primer for students about to engage in an information search.

The question remains, however – if the “toolkit” shows a potential for inquiry as is understood in the curriculum, could the assignment that it is associated with show us our first inquiry activity in the text? C45-Dealing with Dangerous Disposal Practices begins with an issue statement. “How can you determine whether or not a mixture of cellulose is hazardous waste or a soil conditioner that can benefit agriculture?” Despite the reference to the toolkit, this assignment becomes an answer-getting activity from the very start.

Student Text

Background Information

A by-product of paper production is a **slurry**, or mixture of cellulose, chemicals, heavy metals, and other unknown solutions. Paper manufacturers must be able to dispose of this mixture safely. Otherwise, it could be hazardous for the soil and the environment. Some environmental experts claim that the slurry is good for soils if it is applied under certain conditions in a limited amount.

Analyze and Evaluate

1. Use information from the Internet to learn about other uses of waste cellulose.
2. Identify alternatives to spreading cellulose on agricultural fields.
3. Try to determine the exact contents of the waste cellulose mixture.
4. Determine the potential benefits of spreading cellulose or other waste paper on agricultural fields.
5. Use the information you have developed to make a plan for the safe use and disposal of waste cellulose.
6. Prepare a list of precautions that must be exercised to ensure the safe and proper working of your plan.
7. Could you make an informed decision about safe disposal practices based on the information you collected? If so, how did you know your information was true and complete? If not, what steps could you take to ensure that the information you obtain is complete and reliable?
8. Share the results of your inquiry with the class as directed by your teacher.

Teacher's Resource

Activity Notes

- Mixtures of cellulose waste from the manufacture of paper are sometimes spread on agricultural land. Ultimately, the purpose is to dispose of the waste.

However, if the mixture is free from contaminants, the slurry that is put on the land can provide agricultural benefits.

- Students will need time (either at home, or using the library or computer lab) to gather information about this potential environmental risk.

Answers to Questions

1. Waste cellulose is used as a soil conditioner. In addition, it can be converted into corrugated paper and boxboard for packaging. Depending on quality, waste cellulose can be converted into fibres for textiles.
2. Cellulose can be recycled and remanufactured into many products that would otherwise use wood fibres, including low quality paper, boxboard, or formed wood products for combustion.
3. Waste cellulose will typically contain water, sodium, and calcium, and may contain heavy metals.
4. Cellulose is a soil conditioner that can break apart soil particles to hold more water and nutrients.
5. Students' plans should show where waste cellulose will be disposed of and safe methods of transportation to its final disposal site.
6. Precautions include:
 - safe handling and loading of cellulose at source
 - safe transportation of waste cellulose to disposal site
 - safe storage of waste cellulose, including evidence of attention to problems of leaching water
7. Students would have to list several reliable sources of information to ensure they have a good picture of the problem and potential solutions.

Extend

Students could extend their investigation by conducting research on a questionable disposal practice of local concern.

Assess the Activity

As students work on this activity, ask them whether the process is a dangerous disposal practice or a beneficial agricultural practice. Ask them to back up their decision with evidence.

If the ultimate goal, according to the curriculum, is to develop “the skills of scientific inquiry/research, (the) students must ask good questions to frame their research, interpret information, and detect bias”, this is not the route the assignment. Where other Decision-Making Analysis activities stressed research and a sense of exploration, this activity is simply an answer-finding activity where the teacher is again placed into the position of “sage on the stage”, assessing the work done by the student according to pre-determined outcomes. For example:

Question 1 – “Use information from the Internet to learn about other uses of waste cellulose.”

Response – “Waste cellulose is used as a soil conditioner. In addition, it can be converted into corrugated paper and boxboard for packaging. Depending on quality, waste cellulose can be converted into fibres for textiles.”

The teacher is not a learner in the room, as an inquiry approach would suggest, but the holder of the information. This assignment is not designed to “allow students to explore the social, economic, environmental, political, ethical, and moral impacts of a real-world issue”; it is designed to have the student search out information already obtained by the teacher, and for the teacher to assess whether the student has regurgitated it correctly.

3.3.4 *D51 – Cutting Energy Costs*

This activity is also tied to the same toolkit as the above, and is formatted in virtually the same way. The students are given an issue to establish the mind set, in this case – “How can our community reduce the financial and environmental costs of home energy use?”

In the background section, the student is introduced to concepts such as energy efficient “Green Building”, utilizing green roofs, improved windows, lighting and insulation. From here, the assignment as written in the student’s version of the text seemingly opens up the exploration of the subject to the curiosity of those who will do the investigation. This is also where the similarities between this assignment and that of the previous example begin to become clear.

Student Text

Activity

1. Select a method to reduce home energy use and/or reduce its effect on the environment from the list of homes provided. Or, choose your own method to research, after consulting your teacher.
 - a home that uses geothermal heating or a heat pump
 - a home that uses high levels of insulation in the attic and walls as well as energy-saving windows and a high-efficiency furnace
 - a home that uses solar energy to heat water
 - a home that includes a green roof
2. Research your topic. Begin your research at ScienceSource. Find out how the method you chose reduces energy use and/or reduces effects on the environment
3. Prepare a report in your own words that provides background information and images. Include a glossary (words and their meanings) of the new vocabulary you have learned in your research. Also, include a bibliography of websites (URLs and website names) or reference materials you have used in your research.

Analyze and Evaluate

4. Form a group with classmates who have chosen other methods. Share your report. The group should try to reach consensus (agreement) on one or two of the methods that are the best choices for your community. Be prepared to report your decisions to your class.
5. How did the class groups rate the methods? Design and complete a chart to summarize the results.
6. While the groups are reporting to the class, record some of the reasons why they chose these methods.
7. Why is more energy used in Canada for indoor heating compared to most other countries? Suggest several reasons.

Teacher's Resource

Activity Notes

- Students research methods to cut home energy costs and prepare a report including a glossary and bibliography. In the Analyze and Evaluate questions, students form a group to share their information and respond to questions about the possible class presentations.

Answers to Questions - Analyze and Evaluate

5. Students design a chart to summarize the decisions of the groups in the class.
6. Students individually record the reasons provided by each group for making its decision.
7. More energy is used per person in Canada for indoor heating compared to other countries (for example, Scandinavian countries) for several reasons. Students' answers will vary but may include the following:
 - Canada has a lot of single-family homes.
 - Energy in Canada is inexpensive compared to the rest of the world.
 - Canadians may not, as a whole, understand environmental issues or may not be prepared to address them.
 - Canada has a cold winter climate. This means that it is necessary to use large amounts of energy for indoor heating. However, because many Canadians live in large houses (rather than smaller homes or apartments as in many other countries) and because our homes and buildings do not use sufficient insulation, our per capita use of energy for indoor heating is much higher than in other northern countries.

Extend

Teachers could extend this activity by asking students to summarize the class discussions and prepare articles for a class newspaper/bulletin (to be sent home to parents). Consider inviting a reporter from a community newspaper to visit the class and write an article on the class activities.

Assess the Activity

As students work on this activity, teachers could give credit for class participation. Teachers can grade the reports of the individual students and the reporting back of each group to the class. Credit can be given for the chart produced in question 5, the note taking in question 6, and the answer to question 7.

There is little reason to repeat what was discussed when looking at the previous assignment; many of the same statements can be made about this activity. Clearly, it is not an indication of inquiry as defined by the curriculum, as is made even clearer by the suggestions under the *Assess the Activity* sub-heading.

The teacher is encouraged to use three specific questions for assessment – a graphing exercise to chart how the class rated the work done by the students, note taking on student reports, and the answers given for question 7 regarding Canadian energy use. Again, there is no discussion of questioning, analysis of the process or thinking on behalf of the students; the emphasis is put squarely on the student being able to access knowledge given in class at the right time for the right purposes according to the text.

3.4 *Design-a-Lab Activities*

By their description in the Teacher’s Resource overview, Design-a-Lab activities “are either scientific inquiry or problem-solving in nature. In general, these labs are more open-ended.” This in itself, in consideration of the topic demanded their inclusion here.

The Teacher’s Resource goes further in its definition of the Design-a-Lab activities –

In general, these labs give students minimal direction, asking them to go one step further than either the inquiry or problem-solving labs by designing the lab themselves, usually in a group. These labs are important in supporting co-operative learning. They give students the opportunity to demonstrate the range of skills they have learned in the Inquiry Activities. Similar to the Inquiry Activities, Design a Labs are directly linked to the Skills Continuum for Scientific Inquiry/Experimentation Skills, which are identified by the Skills You will Use box. (Investigating Science and Technology 7, Teacher's Resource, 2008)

Owing to the paragraph’s specific reference to the Skills Continuum for Scientific Inquiry/Experimentation Skills, this feature of the text could prove to be where the text comes in line with the curriculum in terms of the use of inquiry in a Science and Technology classroom. The activities are located in the mid-way point of each strand

they are included in, and are entered into after having performed at least to “Quick-Labs” and an “Inquiry Activity”.

The text contains only three Design-a-Lab activities -

- Interactions in the Environment – A30-Competition in Ecosystems
- Structures: Form and Function – B39-Surveying the Market
- Pure Substances and Mixtures – C22-Growing Crystals

There is no such activity for the Heat in the Environment strand. Although there is no reason given for its exclusion, it may be because there are safety considerations where most of the experiments with heat in the classroom are concerned. However, with only 75% of the stands including an assignment where students are encouraged “to go one step further than either the inquiry or problem-solving labs by designing the lab themselves”, the commitment to inquiry as a teaching tool by the authors must come into question.

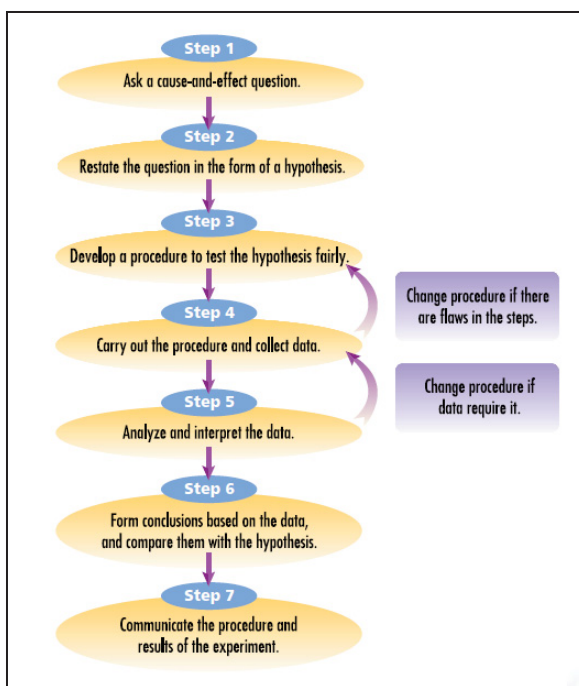
	Level 1	Level 2	Level 3	Level 4
Knowledge and Understanding				
Understanding of content • Initiating and Planning	Student demonstrates limited knowledge of content.	Student demonstrates some knowledge of content.	Student demonstrates considerable knowledge of content.	Student demonstrates thorough knowledge of content.
Thinking and Investigation				
Use of initiating and planning skills and strategies • Initiating and Planning	Student uses initiating and planning skills and strategies with limited effectiveness.	Student uses initiating and planning skills and strategies with some effectiveness.	Student uses initiating and planning skills and strategies with considerable effectiveness.	Student uses initiating and planning skills and strategies with a high degree of effectiveness.
Use of critical/creative thinking processes, skills, and strategies • Analyzing and Interpreting	Student uses critical/creative thinking processes, skills, and strategies with limited effectiveness.	Student uses critical/creative thinking processes, skills, and strategies with some effectiveness.	Student uses critical/creative thinking processes, skills, and strategies with considerable effectiveness.	Student uses critical/creative thinking processes, skills, and strategies with a high degree of effectiveness.
Communication				
Expression and organization of ideas and information in oral, visual, and/or written forms • Performing and Recording • Communication and Teamwork	Student expresses and organizes ideas and information with limited effectiveness.	Student expresses and organizes ideas and information with some effectiveness.	Student expresses and organizes ideas and information with considerable effectiveness.	Student expresses and organizes ideas and information with a high degree of effectiveness.
Use of conventions, vocabulary, and terminology of the discipline in oral, visual, and/or written forms • Performing and Recording	Student uses conventions, vocabulary, and terminology of the discipline with limited effectiveness.	Student uses conventions, vocabulary, and terminology of the discipline with some effectiveness.	Student uses conventions, vocabulary, and terminology of the discipline with considerable effectiveness.	Student uses conventions, vocabulary, and terminology of the discipline with a high degree of effectiveness.
Application				
Transfer of knowledge and skills to unfamiliar contexts • Analyzing and Interpreting	Student transfers knowledge and skills to unfamiliar contexts with limited effectiveness.	Student transfers knowledge and skills to unfamiliar contexts with some effectiveness.	Student transfers knowledge and skills to unfamiliar contexts with considerable effectiveness.	Student transfers knowledge and skills to unfamiliar contexts with a high degree of effectiveness.

**Figure 20: Investigating Science and Technology 7
Teacher's Resource, p.8**

Each Design-a-Lab's recommended assessment tool is a rubric provided in the Teacher's Resource. Rubrics are, by nature, general in their scope and leave much to the assessor in terms of how they are to be used. However, in consideration of the text assertion that this group of assignments are to be "either scientific inquiry or problem solving in their nature", there is little here to demonstrate an interest in developing questioning, the analysis of other viewpoints and perspectives or the use of alternative ways of showing understanding. Content, skills, basic communication and working with unfamiliar contexts dominate the tool, emphasizing the same concepts as were assessed in earlier activities.

Toolkit #2

Each of the Design-a-Lab activities refers to Toolkit #2, *The Inquiry Process of Science*, as a source of reference for specific skills students will need to complete the assignment. On the face of it, the toolkit does do a more than adequate job in defining the use of questions in a scientific investigation, and more importantly, what to do after you begin coming up with some of the answers.



The section does give some strong inquiry-related information, such as:

- Answers may lead to additional questions. New questions often lead to new hypotheses and experiments. Don't be afraid to ask questions, or to rethink the ones you've already asked.
- Science grows when scientists ask questions, answer them, and are willing to question those answers. Scientific knowledge is always growing and changing.

However, the toolkit is primarily a primer in conducting the scientific method in the form that the text uses. It does this quite well, and doesn't deal with the development of perspectives, viewpoints or the curiosity of the student carrying out the investigation to begin with.

3.4.1 A30 – Competition in Ecosystems

The stated goal for this assignment, according to the Teacher's Resource is "To have students design an experiment that shows how competition affects the number of plant populations in an ecosystem." The student's text varies slightly from this objective, asking, "How does competition affect the number of plant populations in an ecosystem?" The dissimilarity between the two sentences at first seems small, simple semantics, but when unpacking them, there is quite a difference between them. The student's sentence suggests a potentially open-ended exploration of plants in an environment, whereas the teacher's resource has a final product in mind from the start. This is not necessarily a negative, but it does speak to a lack of adherence to the curriculum's assertion of what inquiry is.

<i>Student Text</i>	<i>Teacher's Resource</i>
<p><i>Design and Conduct Your Investigation</i></p> <ol style="list-style-type: none"> 1. Make a hypothesis to test how the populations of three or more species of plants will be affected when they compete with each other in a small area. (A hypothesis is a possible answer to a question or a possible explanation of a situation.) 2. Decide what materials you will need to test your hypothesis. For example, you might consider the following questions: <ol style="list-style-type: none"> (a) How many populations will you experiment with? (b) Will you grow the plants from seeds or work with seedlings? (c) How many containers will you need? (d) How much soil will you need? 3. Plan your procedure. Ask yourself questions such as: <ol style="list-style-type: none"> (a) What evidence am I looking for to support my hypothesis? (b) What steps will I follow to collect the data I need? (c) Is the test I am designing fair? How do I know? (d) How will I record my results? For example, will I need a data chart? A graph? Both? Neither? (e) How long will I run my experiment? (f) How long do I have to complete my experiment? 4. Write up your procedure. Be sure to show it to your teacher before going any further. 5. Carry out your experiment. 6. Compare your results with your hypothesis. Did your results support it? If not, what possible reasons might there be? 7. Share and compare your experimental plan and findings with your classmates. Did anyone plan an experiment exactly like yours? Similar to yours? Completely different from yours? How do your results compare with theirs? 	<p><i>Activity Notes</i></p> <ul style="list-style-type: none"> • Students can discuss and write their procedures in the 40 minutes class time. Setting up the experiment and observations can be carried out at other times. • Before students begin planning their lab, have a discussion about how many people could effectively share one pizza. Ask what happens to each person's share as more people share the pizza. Ask students if they think the same idea— not enough “food” — could affect the growth of a group of plants. Explain to the class that they will be designing and carrying out an investigation to discover the effect of competition on plant growth. • Have students use Toolkit 2 as a reference when developing and carrying out their inquiry. You may need to provide students with some additional support at the following steps in designing their inquiry: rephrasing their questions as hypotheses that identify a reasonable and possible solution, and developing a fair procedure to test the hypotheses. • Emphasize to students the importance of reporting their data accurately and using that data to draw their conclusions. They may need a reminder to use their actual data and not to just assume data to prove their hypotheses. Data that does not support their original hypotheses can lead to students identifying a weakness in their design, and while this may upset them at this point, it will help them plan more effective inquiries in the future. <p><i>Answers to Questions</i></p> <ol style="list-style-type: none"> 7. Students should share their findings with the rest of the class and look for similarities and differences in the findings and conclusions. <p><i>Extend</i></p> <p>As an extension to this activity, ask students to come to a consensus on one general conclusion about how competition can affect the number of plant populations in an ecosystem.</p> <p><i>Assess the Activity</i></p> <p>Use applicable sections of Assessment Rubric LM 5</p>

There is no doubt that the assignment is more “open-ended” than the majority of activities I have explored in this thesis, and that there is a much closer resemblance to what is considered by the curriculum as being “inquiry.” There are questions suggested that would require the student to explore the subject on their own, and ultimately, to extend their learning through their own curiosity rather than by the suggestion of the

teacher. On the other hand, the suggested questions do tend to cover the majority of topics that could be developed by the student herself, and for most students without teacher encouragement to step out of the script provided by the text this would become another answer-getting exercise. Moreover, in consideration of the priorities set out by the rubric, the student answering the suggested questions without exploring further would be rewarded as well as a student who took the investigation beyond what was simply on the text's page.

The Teacher's Resource also demonstrates an agenda to stay with the accepted "formula" as set out by earlier activities and labs. In the activity notes, the teacher is encouraged to help students to follow the "steps of designing their inquiry", and to keep the student from straying too far from the scientific method being used. In other words, far from being an inquiry which this assignment could have easily been, given a few small changes, this Design-a-Lab is just as it sounds – a "lab" designed by students with a format to be followed and assessed by the teacher.

3.4.2 B39 – *Surveying the Market*

"Surveys." You may get them in the mail. Your school might send them home to gather information. You might be sent one by e-mail after visiting a retailer. Manufacturers often survey the general public to find out if a new product will sell.

Question: To develop a survey to collect information that would be useful to a manufacturer who is developing a product to meet a societal need." (2008, p. 159)

This is the opening paragraph of the Design-a-Lab activity entitled “Surveying the Market”. In this assignment student are expected to:

- Look over other surveys to see how they are written
- Choose a societal need to be surveyed, with the ultimate goal to help a manufacturer meet than need
- Design a survey form and draft questions
- Conduct the survey, compare results with others and use the information to develop a course of action

Student's Text

Design and Conduct Your Investigation

1. Look over examples of surveys to see how other people write them.
2. Work with a partner to think of a societal need, such as the need to increase home composting, the need to reduce the use of electricity, the need to prevent injury when using electronic devices, or something else that interests you.
3. Design a survey form that you could use to gather information about whether this need concerns your peers and what product they would require to meet this need.
4. Make a draft of your survey questions, paying attention to the following:
 - (a) Does your form protect people's privacy and encourage honest reflection?
 - (b) Will your questions provide data that you can analyze and graph?
 - (c) Is there a way for people to give you "comments"?
 - (d) Will people be able to complete the survey quickly and accurately?
 - (e) Will you leave the survey with people for them to complete on their own, or will you ask each individual the questions and record the answers yourself?
 - (f) Will you provide an incentive for people to respond to your survey?
 - (g) Can you use a method that does not involve pencil and paper to collect the information?
5. Design a one-page form in an attractive, easy to-use format. You may use a computer and word processing software.
6. Decide with your teacher who you will ask to fill out your survey. Conduct the research.
7. Examine your completed surveys. Decide on a method to organize your data so it can be analyzed.
8. Complete the data analysis.
9. Write a paragraph that summarizes your findings.
10. Based on your findings, what course of action would you follow in the development of your product?

Teacher's Resource

Activity Notes

- Read through the procedures and the purpose with the students and answer any questions.
- Provide students with a variety of surveys. Point out to students that when writing questions for their surveys, they need to think about how they will collect the data. If each question requires a written response instead of a tick mark, it may be time-consuming to consolidate the information. Have the students think very carefully about the purpose of the survey: to find out who uses composting, who would be willing to compost in an apartment or condominium if the waste had to be carried downstairs to a special room, who conserves water, who uses reusable grocery bags, etc.
- Have the students make a draft of the survey. Circulate around as the students write their surveys, reminding students to use the list of questions in step 4 to guide them.
- Collect and check over the surveys before allowing the students to conduct their research. Set up a time for students to conduct the research.
- Prompt the students who need help with organizing the data so that it can be analyzed. This might simply be asking the students about the different ways they could tally their data. However, some students with Individualized Education Plans might require a method to organize the data.
- Some students may benefit from Skills Worksheets 6 Designing Experiments Skills: Asking Questions Related to Scientific Inquiry, and 11 Data Analysis: Interpreting Data.

Answers to Questions

7. Answers will vary depending on the different questions asked during the survey. Students might choose to use different graphing models.
8. and 9. Student answers will depend on their survey.
10. Students will need to look at the data and decide what it tells them. For example, if people in apartments are not willing to go downstairs to discard compostables, then a product may need to be developed that allows composting on each floor of the building.

Extend

- If it is feasible to design any of the products the students have developed, allow time for them to do this.
- Have the students survey older people to find out which structures/products give them difficulty. Have the students use the information they have collected to design a better structure using ergonomics and universal design.

This is no doubt a useful exercise. The skills necessary to gather information about a specific subject and interpret it in the form of survey data is one-fifth of the Math curriculum in Grades 6 and 7. The fact that the text suggests that students do the survey on a subject of their choice does not make this activity an inquiry. There is no room for critical questioning, other than that which is suggested. There is no explicit discussion of differing perspectives and viewpoints, and more importantly, as an opportunity to demonstrate understanding, the assignment is one-dimensional. The question that must be asked is – with the potential for inquiry within the subject of “Structures” why was the concept of gathering and interpreting survey information used for a “Design-a-Lab?” It must be assumed that the authors had a specific reason for this choice, although it is not immediately obvious.

3.4.3 C22 – *Growing Crystals*

In a sidebar titled “Preparing for Differentiated Instruction”, the Teacher’s Resource states:

In this section, students need to understand that solubility is affected by four factors: temperature, type of solute or solvent, particle size, and stirring. Students may have little experience using the particle theory to explain dissolving. Teachers can augment this learning by using some of the different strategies listed in the teaching notes. Different ways to teach factors affecting solubility can be used both before and during the lesson depending on the needs of the students. (2008, pp. 29, Unit C)

The assignment in question, C22-Growing Crystals, no doubt addresses the above, and can be a very effective demonstration of the concepts in this unit. However, it is far from being inquiry, nor does it purport itself to be. The Teacher’s Resource, refers to the skills to be covered in this assignment as “inferring, designing an experiment,

measuring, communicating, observing, recording and organizing data”, without a discussion of questioning, discovering bias or discussing varying viewpoints or perspectives. Again, for what it is, the assignment is a good opportunity for students to have a “hands-on” experiment rather than get the information through a teacher’s lecture. The question that remains is, with so many opportunities for experiential learning in this text, why would the authors provide yet another such experience with an activity that was supposed to provide experiences that “are either scientific inquiry or problem-solving in nature?”

The activity clearly advises students at the outset that this activity will instruct them in two areas:

- Designing an experimental procedure
- Recording and organizing data

Neither skill is specifically inquiry or problem solving in nature.

<p><i>Student's Text</i> Crystals can be grown from solutions made from common solutes with water as the solvent. This is a slow process involving the growth, particle by particle, of a solute on a seed crystal suspended in a supersaturated solution. The resulting crystals are often quite beautiful in colour and demonstrate some of the characteristic shapes of the solute particles from which they are made.</p> <p><i>Question</i> How can you grow crystals from a solution?</p> <p><i>Design and Conduct Your Investigation</i></p> <ol style="list-style-type: none"> 1. Form a research team with a partner. 2. Decide what type of solute you will select from the following list: <ul style="list-style-type: none"> • sugar • copper sulfate • salt • Rochelle salt • Alum 3. Determine where you will conduct the investigation. 4. Decide on what apparatus will be needed for you to complete that activity. 5. Make a plan that clearly identifies how you will conduct your investigation, including how much time you intend to spend on the investigation to monitor progress each day. 6. Discuss your plan with your teacher. Once the plan has been approved, conduct the investigation. 7. 7. When your work is finished, be prepared to bring your crystal to class for comparison with others. 	<p><i>Teacher's Resource</i> <i>Activity Notes</i></p> <ul style="list-style-type: none"> • Students will work outside class to prepare a saturated solution using water and one of the solutes suggested in the list on page 224 of the student book. There is information at ScienceSource.ca to help students complete this task. • Students will start a seed crystal and attach it to fine nylon thread to suspend the seed crystal in the supersaturated solution. They will then cover the solution with material that allows water to escape but keeps dust and dirt out. <p><i>Answers to Questions</i></p> <ol style="list-style-type: none"> 3. Critical factor: must be able to leave set-up undisturbed for about two weeks. 4. Students will need a Mason jar with a lid that can be used to cover and shake the solution, and then replaced with a piece of fabric (to allow evaporation). They will need thin nylon thread or fishing line to suspend the seed crystal. 5. Small crystals will appear in the bottom of the jar upon saturation. Students will then transfer the solution to another container, retain a seed crystal, clean the jar, and replace the solution in the jar. They will attach a seed crystal to the thread and suspend it from the top of the jar. After covering the jar with cloth, students wait for the crystal to grow, which could take at least two weeks.
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This, as in other assignments like it, is an engaging and thought-provoking experiment, allowing for rich discussion. It belongs in the text as an experiment the students will talk about for days or weeks after, comparing outcomes and observations. But for all its positives, this assignment does not meet the criteria set out by the province and the writers of the curriculum as inquiry, as has been the case with each assignment that has been explored here. It would seem that we are left with two questions:

1. If there is a requirement for texts in the Province of Ontario to reflect the curriculum, both in content and in spirit, why does this text not seem to have a single identifiable inquiry activity; and
2. If it is true that the text does not reflect the curriculum, the prime qualification for approval of text books in Ontario, why has *Investigating Science and Technology 7* been put on the Trillium List?

Chapter Four: Bernstein and the Pedagogic Device

In this chapter the theories of Basil Bernstein regarding the discourses between education stakeholders and their potential effect on the materials used in the classroom in general, and to *Investigating Science and Technology 7* in particular, will be explored. These theories will be used to understand the differences in approach between the curriculum and the text activities.

One possible answer to these questions may lie in the discourses that dominate the production of texts for schools in Ontario. Bernstein's theory of class discourse and the pedagogic device can be used to shed light on the subject.

Basil Bernstein was very unusual, in that he spent his entire academic life on the same project: a theory on how the structure of social relationships influences the structure of communication, and how the structure of communication shapes people's consciousness and identity – through the curriculum. The research itself is also quite unusual in that, while the theory was supported by empirical work, the theory always went before empirical work. He provides a well-developed set of concepts and criteria for understanding curriculum (and for doing research), and his work has been particularly influential in developing countries.

Bernstein's early work was highly controversial, owing to criticism of his sociolinguistic analysis of differences in language by social class as constituting a "deficit model" based on socioeconomics and cultural differences. It has nonetheless, been regarded since as exploring the relationships between labour classes, families, schools and the effect they have on the learning process.

Bernstein's later work, beginning in 1977, began investigating the connection between power and class relations to the educational process. It is here that Bernstein's work connects with this thesis through his theory of the Pedagogic Device.

4.1 Pedagogic Device

The Ontario educational system, in contrast to many jurisdictions in North America, has the enviable position of having a prescribed curriculum and an informal pedagogy. This allows not only for teacher autonomy in the way the information should be presented to the student, but also for the forms of differentiated instruction, activities and materials the teacher sees necessary to use to explore the concepts presented based on her/his professional judgment. This has resulted in an educational system that can be at times quicker to apply changes in approach when justified; at others, reluctant to adopt new ideas when not deemed warranted.

This organizational structure, coupled with teacher shortages in the 1990s, changed the dynamics of the system. Bernstein, when discussing the same process that occurred in Britain in the 1970s, stated that the teacher shortage there "shifted the power relations from the selective power of management to that of teachers. At the same time full employment moved the focus of schools to issues of social relations (multiculturalism, youth cultures) and leisure." (Bernstein, 1996) However, just as in Britain, the Harris Government's efforts to centralize monitoring and funding, and decentralize local institutions and management (notably Bill 160, the Education Quality Improvement Act passed in 1997, and 2000's Bill 74, the Education Accountability Act) left teachers and the schools that deliver the curriculum with reduced significance and an

orientation toward practical and policy interests. This conflict between the State, its Ministries and representatives (with whom resides the Regulatory Discourse – the ongoing moral discussion that creates order, relations and identity (Bernstein, 1996, p. 30)) and the teachers, school boards and others who deliver the curriculum (the members of the Instructional Discourse, who form pedagogy and create specialized skills and the relationships to each other (Ibid, p.30)) is the basis for the Pedagogical Device.

The Instructional Discourse is embedded in that of the Regulatory, the regulative being the dominant of the two. Bernstein uses the graphic below to more clearly identify this relationship:

<u>Instructional Discourse</u>	<u>ID</u>
Regulative Discourse	RD

The instructional discourse, embedded in the regulatory, forming a single discourse out of the two.

Both discourses develop modes of re-contextualizing the unmediated discourses they must address into “mediated, virtual or imaginary discourses” (Bernstein, 1996, p. 33) in order to accommodate ideology, and therefore they no longer remain the same discourse. These two areas of re-contextualization are referred to by Bernstein as the Official Re-contextualizing Field (or ORF, dominated by the state and its agents) and the Pedagogic Re-contextualizing Fields (PRF; teachers in schools and colleges, department of education, school boards, etc.). To illustrate the roles of the ORF and PRF, Bernstein uses the example of an example from his own education:

When I was in school I spent three years in a large room with wooden benches and with side benches with saws and hammers and chisels. After three years I had a pile of wood chippings as high as the bench itself. But what was I doing? Well, what I was doing in this: outside pedagogy, there was carpentry, but inside pedagogy there was woodwork. In other words,

here was a transformation of a real discourse called carpentry into an imaginary discourse called woodwork.” (Bernstein, 1996, p. 33)

The fields serve their purpose in creating the foundation for the autonomy of education. The PRF has had some autonomy and influence over pedagogic discourse and practices, but when the ORF is the only participant, there is no autonomy.

Bernstein defined pedagogy as the form or mode of transmission of education. More simply, *how* the selection of knowledge is taught. It is here where the connection of his theories on the Pedagogical Device to the gulf between curriculum and its associated texts, in this case, *Investigating Science and Technology 7*, can begin. If the ORF, being the result of the dominant Regulatory Discourse, has re-contextualized the priorities of the Science and Technology curriculum in a certain way, and if, by the time that information enters the curriculum through the textbook, it no longer resembles the curriculum in spirit and approach, is the resulting change a result of the PRF, or a third, as yet unknown discourse?

This conflict between the guiding discourses of education is illustrated in many of the activities that have been analyzed in this thesis, most notably in two activities from the Interactions in the Environment strand (A-42 – Cleaning up and Oil Spill) and a Design-a-Lab assignment (A47 – What Do You Want To Do Today?)

4.1.1 A42 – Cleaning Up an Oil Spill

The science and technology curriculum introduces the “Interactions in the Environment” strand by exploring the concept of environmental stewardship, “In the study of this topic, they (the students) will analyze some of these impacts and their consequences, while reflecting upon their personal responsibility to protect the

environment.” (Ontario Ministry of Education, 2007, p. 121) To do so, the curriculum identifies the three “Big Ideas” that are to be explored in the study of the subject -

- assess the impacts of human activities and technologies on the environment, and evaluate ways of controlling these impacts;
- investigate interactions within the environment, and identify factors that affect the balance between different components of an ecosystem;
- demonstrate an understanding of interactions between and among biotic and abiotic elements in the environment.
(Ontario Ministry of Education, 2007, p. 121)

To this end, the curriculum suggests many potential issues for study, including:

- The use of technologies such as cars and computers has many impacts on the environment. What are some of these impacts and how do they affect the ability of the environment to support life?
- analyze the costs and benefits of selected strategies for protecting the environment
- Many people recycle because it makes them feel that they are doing something good for the environment. But the focus on recycling takes the emphasis away from strategies like reducing or reusing.
- Integrated Pest Management (IPM) is a pest management strategy that uses a variety of methods to prevent or control pest problems. But some of the methods can be as much of a problem as the pests themselves.
- Some groups consider widening highways to reduce traffic congestion to be preferable to improving public transit systems. In some cases, however, highway expansion increases the problems that already existed, and other unexpected problems also arise.
- Controlling the water flow in natural systems has a domino effect on the environmental integrity of the water system.
(Ontario Ministry of Education, 2007, p. 123)

The sample issues do not carry with them judgements or clear bias; although it would be impossible to suggest that they are completely free of “agenda.” Nonetheless, coupled with the “Big Ideas” above and the already stated commitment to scientific inquiry, it seems clear that the curriculum’s major thrust would be to encourage the open

and thoughtful exploration of the subject, considering as many viewpoints and perspectives possible.

The text, however, has seemingly assumed a perspective at the outset in the Cleaning up an Oil Spill Problem-Solving activity. No where are we left an opportunity to discuss the environmental, social, even ethical issues surrounding the shipment of crude oil by ocean-going tanker, just that oil spills occur, they will happen from time-to-time, and local residents are ultimately the ones responsible for the clean-up.

The Official Re-contextualization Field (ORF) reconstructs the concept of environmental stewardship in the curriculum as being a preventative act, and that of the Pedagogical Re-contextualization Field (PRF) as being reactionary. At first glance this may seem no more than semantics, both concepts seemingly related, but the gap is yawning when considering potential for damage.

4.1.2 A-47 – What Do You Want to Do Today?

This assignment relates to the same curriculum expectations as that of the previous activity. As a Decision-Making activity, however, it should differ in its approach from the problem-solving assignment above. Decision-Making activities, according to the Teacher’s Resource, “allow students to explore the social, economic, environmental, political, ethical, and moral impacts of a real-world issue. Students working together collect evidence and make a decision based on their research.” The suggested issues that were applicable to the discussion of A42 – Cleaning up an Oil Spill are also pertinent here, as are the expectations: “By the end of Grade 7, students will: (1.1) assess the impact of selected technologies on the environment; (1.2) analyze the

costs and benefits of selected strategies for protecting the environment.” (Ontario Ministry of Education, 2007, p. 123)

In this activity, the text assumes that students in Grade 7 are specifically, consumers. They are asked, presumably in order to relate the substance of the assignment to the stereotypical pre-teen, to investigate the impact of human activities on the environment by considering the effects of:

- a) visiting a fast food restaurant for a meal with your friends
 - b) the family’s grocery shopping
 - c) going to the mall to pick up something new to wear or play with
 - d) another activity that you participate in that has an impact on the environment (check with your teacher to ensure it is applicable)
- (Investigating Science and Technology 7, 2008, p. 79)

The ORF re-contextualizes the student as an environmental steward, proactively involved in the protection of the environment, as was stated above. The text, through what could only be the PRF, according to Bernstein’s theory, places the student in the context of a consumer, and makes clear that “Shopping for and buying items is an important part of the economy. Human consumption includes getting the weekly groceries, buying the latest fashion, getting a haircut, or going to a restaurant for a quick snack.” (Investigating Science and Technology 7, 2008, p. 79)

This separation through the discourses set out by the curriculum and that specified by the text are all but diametrically opposed – the curriculum assuming the student to be part of the environment and environmental stewardship; the text suggesting the student to be only affected by it as an outsider.

This struggle between the two discourses and the associated re-contextualization fields continues throughout the text. Although the origin of the ORF is clear, there

remains a question as to whether the origin of the PRF is indeed from the pedagogic/classroom teacher perspective. I will explore this later in this chapter.

4.2 *Two Diverging School Cultures*

Bernstein postulated that schools transmit one of two different types of culture (Bernstein, *Sources of Consensus and Disaffection in Education*, 1975), as illustrated in the table below:

<i>Type of culture ...</i>	Instrumental	Expressive
<i>Type of activities ...</i>	Concerned with the transmission of formal school knowledge: learners are intended to acquire knowledge and specific vocational skills	Concerned with the transmission of values and norms: learners are intended to develop particular kinds of conduct and character
<i>Effect of the culture ...</i>	Potentially divisive: produce patterns of success and failure. Learners are ranked.	Potential for creating consensus by uniting learners.

Table 1: Bernstein, *Sources of Consensus and Disaffection in Education*, 1975

According to the Ontario Science and technology Curriculum, 2007, there is a definite leaning toward the column on the far right. Students are not just in the classroom to absorb knowledge, but to develop the ability to inquire, analyze and question.

One of the primary objectives of elementary science and technology curricula has always been, and must continue to be, development of curiosity and wonder. Students come to school with a natural curiosity. They also bring with them individual interests and abilities as well as diverse personal and cultural experiences, all of which have an impact on their prior knowledge about science, technology, the environment, and the world in which they live. Effective instructional approaches and learning activities draw on students' prior knowledge, capture their interest, and encourage meaningful practice both inside and outside the classroom. (Ontario Ministry of Education, 2007, p. 29)

It would not be a great leap, having illustrated the Ministry of Education's stated "primary objectives" of the curriculum, that the Regulative Discourse, and in turn the

ORF, could be placed in the “Expressive” column, the text in the “Instrumental”. In the previous section the activities I unpacked showed a gap between a curricula that encouraged a proactive environmental stewardship with a reactionary leaning towards consumerism in the text. The curriculum’s approach is therefore unifying, considering the need for our species to live within the environment we have been placed into. The text’s more consumerist approach becomes a point of division amongst students based on culture, social strata and more strikingly, economics. For one, claiming citizenship require your presence, for the other a need to contribute to an economy.

There are other instances throughout the text, as will be discussed below.

4.2.1 D26 – Curious Candle

This is of the more clearly defined examples of how Bernstein’s theory regarding the divergence of school culture is demonstrated. This Inquiry Activity itself is associated with the curriculum expectations surrounding the concepts of heat transmission through convection, conduction and radiation. To do this students perform an experiment where they place a small “birthday” candle in the centre of an aluminium pie plate that is partially filled with water. When the candle is lit, a beaker is place over it, creating a sealed environment in which the candle invariably is extinguished.

From the start, this is not an inquiry activity. It requires the students to observe what happened, and then answer prepared questions from the text. The students, should they wish to be successful, not only have to provide answers that resemble those that are included in the Teacher’s Resource, the teacher is also encouraged to “As students work on this activity ... provide marks for participation, cooperation, and completing (the

assigned table)”. Yet, there is no rubric or other device given to define what participation and cooperation consist of, thus leaving it up to the teacher in the room. These skills are not mentioned in the preamble to the assignment, only “recording and organizing data, analyzing patterns, observing, inferring, predicting, communicating” are cited. (Investigating Science and Technology 7, Teacher's Resource, 2008).

Teaching the specific skills and raking students based on how they regurgitate the facts and operate the experiment is the goal of the assignment, not the transmission of values or the development of the character of those in the classroom.

4.2.2 B39 – *Surveying the Market*

The stated purpose of this Design-a-Lab assignment is “To have students develop a survey to collect information useful to a manufacturer developing a product to meet a societal need”. (Investigating Science and Technology 7, 2008, p. 159) This is the start and end to the assignment’s stated interest in developing a solution to a nee of society. From here the assignment becomes a simple mathematics exercise in data management, with the students surveying one another, graphing the data, etc. There is no discussion of the necessity of the subject itself, not even research into what society is showing a need for. The actual reasoning for the product studied or the validity of its need is not even mentioned in the Assessment section of the Teacher’s Resource for the assignment.

As students work on this activity, observe the types of questions they formulate. Are the questions clear and do they include all the aspects asked for in step 4? Assess the students’ final surveys for clarity and ease of use. When students are finished their surveys, assess their ability to communicate the findings of the survey and display their data. This is a good opportunity to link the math curriculum into science. (Investigating Science and Technology 7, Teacher's Resource, 2008)

The skills involved with data collection and management are indeed important, as is this one and only attempt found in the text where there is clear instruction to link curricula. However, the purpose of the assignment indicated that there was to be an element of social conscious shown in it, where it was simply an opportunity to hone skills. That, in itself, is not necessarily a negative, but it is consistent with the text's lack of attention to teaching concepts other than straight skills and "knowledge".

The text has been demonstrated as a tool for "Instrumental" school culture, whereas the curriculum has shown to be "Expressive" in its approach, according to the theory put forward by Bernstein.

It is not clear, however, if the Pedagogical Discourse should be assumed to belong in the "Instrumental" column, simply because it is the other "voice in the conversation". Assuming that, at this juncture, would be a premature but understandable conclusion.

4.3 Types of School: Modalities of Control

The same considerations can be made when looking at change within schools. Bernstein appreciated the difference between the "positional" classification that lock students into a location to be found in schools transmitting a "stratified" modality, and the lack of "fixed attributes" that characterizes a "differentiated" approach.

Type of school ...	Stratified	Differentiated
Nature of ritual ...	Strong ritual: adult imposed	Less ritual: pupil imposed
Units of organisation are ...	Fixed,(e.g. pupils are grouped according to age, gender, ability)	Not Fixed, e.g. mixed ability, mixed gender groups.
Membership of units are ...	Fixed (e.g. pupil can't change age, gender etc)	Not fixed (e.g. pupil is seen as having potential to develop)
Boundaries between subjects are ...	Strong	Weak
Relationships are ...	Positional (e.g. strong boundaries between hierarchies like subject heads, teachers, learners)	Personalised (e.g. hierarchies are blurred by personal relationships which can be achieved)
School Rituals celebrate ...	Domination	Participation
Reward and Punishment are ...	Public (form of control is dominance)	Less public (form of control is personalised and therapeutic)
Roles of teachers and pupils are ...	Clear, 'given'	Ambiguous; have to be negotiated

Table 2: Bernstein, Basil, 'Ritual in Education' 1971

With the exception of the shaded rows, aspects of school organization that the curriculum has no control over, it would seem that the Regulatory Discourse, as it is presented within the curriculum, could be also considered "Differentiated" in its approach.

The inherent features of Inquiry, as defined by the curriculum, lend themselves to differentiation:

- An opportunity for students to develop their own guiding questions for research, based on that student's interest and curiosity.
- A set of questions to help in the interpretation of findings in an experiment or research project, as well as those to determine whether the findings are biased.

- A mechanism, preferably student developed, to bring the viewpoints or perspectives of the various stakeholders into account when unpacking an issue or situation.

The approach is pupil-imposed (students develop their own basis for inquiry based on their interests), therefore making the learning personalized and participatory. Moreover, the roles of the teacher and student become blurred, the teacher in fact becoming another learner in the room rather than the “gatekeeper” to the knowledge contained in the assignment.

Activity D26 – Curious Candle has already been pointed out as being an example of the text not providing information to the student, yet releasing it to the teacher (In the case of the candle experiment, no reference is made in the student’s text regarding the reason for water being pulled into the beaker after the candle is extinguished. The Teacher’s Resource not only explains it, but discusses the possible misconceptions that are present both in the minds of the students as well as in other texts). This puts the teacher into a clearly dominant position, the “sage on the stage”, and the student into a situation of being reliant on the teacher rather than their own thinking and investigation for their learning.

4.3.1 C29 – *Separating a Mixture of Nails, Salt, Sand, Oil and Water*

Presented as an “Inquiry Activity”, C29 – Separating a Mixture of Nails, Salt, Sand, Oil and Water, is a simple answer-getting assignment. In the previous chapter, it was considered as a potential inquiry assignment as per the given definition. However, it

also is an example where the text demonstrates a “stratified” approach to the working in the classroom, positioning all of the power within the teacher and away from the student.

The assignment begins with a straight-forward question – “What methods are necessary to separate and retain all components of a mechanical mixture?”, and continues with an explanation of the steps that must be completed by the student.

1. Work with a partner. Combine the nails, table salt, sand, water, and oil in the small jar.
2. Firmly secure the lid to the jar and shake the contents vigorously to dissolve and thoroughly mix the components of the mixture.
3. As a team, discuss and determine how to separate **and retain** all of the components of the mixture.
4. Discuss your procedure with your teacher, and get approval before you proceed with the method.

Since one of the primary goals of the curriculum is the safe investigation of science and technology in the classroom, the necessity for the student to clear their ideas through the teacher may avoid a potentially dangerous situation in the class, yet it may also inadvertently limit the choices made by the student, or allow the teacher to impose, unwittingly or otherwise, their ideas on how to perform the experiment.

The assignment suggests an opportunity for discovery of the ways that can be used to separate various elements from a mixture, allowing for the imagination of the student to guide the exploration. However, the rest of the activity is a simple question and answer format.

<i>Student Text</i>	<i>Teacher's Resource</i>
<p><i>Analyzing and Interpreting</i></p> <ol style="list-style-type: none"> 5. What component did you separate from the mixture first? 6. How did your choice in question 5 affect what you separated next? 7. How did you ensure that the maximum amount of each component of the mixture was retained? 8. Check with other students in your class. Did all students follow the same sequence to separate components from the mixture? 9. Use your understanding of the particle theory of matter to explain why your procedure worked to separate and retain the components of your mixture. 10. Wash your hands thoroughly after completing this investigation. <p><i>Skill Builder</i></p> <ol style="list-style-type: none"> 11. How did you and your partner decide on the method you eventually used to complete this activity? <p><i>Forming Conclusions</i></p> <ol style="list-style-type: none"> 12. What property of solutions was most useful to enable separation of the mixture? 13. What property of solids was most useful to enable separation of the mixture? 	<p><i>Analyzing and Interpreting</i></p> <ol style="list-style-type: none"> 5. A magnet could be used to remove the nails first. 6. By removing the nails, you do not have to worry about the next step, which is to pour off the less dense vegetable oil from the sand and water mixture. 7. Students should try to prevent any spillage at all times. During the separation of oil and water, it is important to use care to lose the minimum amount of water. A gravy separator can be used for this purpose. When filtering sand, ensure that all sand leaves the water mixture by using a stirring apparatus. 8. Most students will use a magnet first, but students' sequences will vary. 9. Particles are lost when they become attached to particles of other substances. A procedure that minimizes the interaction of one type of particle with another is important. For example, it is possible to filter the mixture of water, sand, and oil, but some of the oil will remain stuck to the filter and you will lose some oil. <p><i>Skill Builder</i></p> <ol style="list-style-type: none"> 10. Students should choose a method that matches the materials and apparatus that they have available to them. <p><i>Forming Conclusions</i></p> <ol style="list-style-type: none"> 11. Solubility is the property of solutions that is most useful to use when separating a mixture. Completely insoluble substances can be removed during the first part of a separation. Later on, substances can be removed by differential solubility. 13. Magnetism can be a very useful property to separate solids. Large amounts of similar substances can be removed quickly with almost no loss.

There is no option given for other potential techniques for separating the mixture, nor is there a suggestion for students to research other ideas. They are simply expected to follow the formula that is set in the Teacher's Resource. Additionally, the "Assess the Activity" section of the assignment in the Teacher's Resource stresses the aspects of the student's work that are to be considered for student success. "As students work on this activity, circulate around the room and listen for students' use of scientific terminology.

You may wish to check answers to the questions.” (Investigating Science and Technology 7, Teacher's Resource, 2008, p. 22)

No thought is given to the reasoning given for the techniques used, reactions to “success” or “failure” and, more importantly, no mention of the possibility that, through their exploration, the student may indeed discover a more effective or innovative way of separating the given mixture. The teacher has the answer, and it’s the role of the student to find that answer in particular.

4.3.2 B50 – *How Green Can We Be?*

When examining this assignment using the definition of inquiry (previous chapter) B50 – *How Green Can We Be?* was found to have “little to no room for creativity in approach, different perspectives or personal curiosity. The teacher becomes the guide, the resource and the assessor all in one, leaving the students out of the entire process, with the notable exception of doing the assignment itself.” To unpack this assignment again from this perspective in order to determine its modality of control would be redundant.

STSE and Basic Concepts Expectations	Assessment Opportunities
<p>3.5 describe the processes (<i>e.g., evaporation, sifting, filtration, distillation, magnetism</i>) used to separate mixtures or solutions into their components, and identify some industrial applications of these processes</p>	<ul style="list-style-type: none"> • Check and Reflect, p. 234: 1–8 • Chapter 8.0 Review, p. 236: 10, 12 • Unit C Review, pp. 268–271: 31, 32, 51 • Chapter 8.0 Quiz: 2, 15, 16–21, 22, 24 • Unit C Test: 6, 14, 27

Figure 21: Investigating Science and Technology 7, Teacher's Resource, p.18

3.5 describe the processes (*e.g., evaporation, sifting, filtration, distillation, magnetism*) used to separate mixtures or solutions into their components, and identify some industrial applications of these processes (*e.g., use of cheesecloth to separate seeds and skins from juice and pulp to make fruit jellies; use of evaporation in maple syrup production; use of different sizes of sieves to separate wheat grains in white bread production; use of strainers in industries to separate slurry into solids and liquids*)

Figure 22: Ontario Science and Technology Curriculum 2007, p. 130

However, these findings may be a reflection of the curriculum, which itself may be found to be “Stratified” in its orientation. The Teacher’s Resource identifies expectation 3.5 of the Pure Substances and Mixtures strand of the Science and Technology Curriculum as the target for this activity, although the suggested activities in the curriculum are not included in the Resource itself. The curriculum, on the other hand, includes many ideas for exploring the model. The curriculum proposes ideas for exploring the concepts contained in the strand, as well as how they are applied in real-world situations, but doesn’t suggest specific uses. In other words, the curriculum doesn’t

specify an answer to any of the questions it poses, whereas the text, through the Teacher's Resource expects certain responses.

B50 – *How Green Can We Be?* has been clearly found to be “stratified” the curriculum, “differentiated.” However, does this specifically aid to illustrate the gulf between the regulatory and pedagogic discourses? As has been suggested earlier, the regulatory discourse could only be located with the Ministry, and therefore the authors of the curriculum. There is not enough evidence however, to explicitly connect the “stratified” modality of control to the pedagogic discourse.

4.4 Class Shaping Communication

Bernstein's most controversial theory revolved around his argument that the language of working class children is *context specific*: it is locked into specific relationships in particular social situations, and it is predictable. Because it is *context specific*, Bernstein calls it a “Restricted Code”. This is contrasted with ‘middle class’ language, in which meaning is more abstract and *universalistic*, which he calls the “Elaborated Code”. (Bernstein, *Open Schools, Open Society?*, 1971)

When Bernstein presented this position, he was referring to the actual language used by those from each socioeconomic class. Yet, could we also not also apply the *intentional meaning and purpose* of language used in a particular text to the same test?

<i>Social Class is ...</i>	Working Class	Middle Class
<i>Spoken language is ...</i>	Context bound	Less context bound
<i>Meanings are ...</i>	Particularistic	Universalistic
<i>Principles are ...</i>	Explicit	Implicit
<i>The Code is</i>	Restricted	Elaborated

Table 3: Bernstein, “Open Schools, Open Society?” 1971

The curriculum suggests a more universalistic approach, less bound by context and more personal investigation of the subject. Inquiry is, by its very nature, implicit rather than explicit, as well as non-restrictive in its approach.

However, as illustrated in C29 – Separating a Mixture of Nails, Salt, Sand, Oil and Water and B50-How Green Can We Be? the text uses language as a tool to establish the position of both the teacher and the student in the classroom and elsewhere, as well as the method with which information is transmitted. In other words, rather than the language (or code) of the student determining social class, the text assumes the code and social class in its approach, positioning the student and teacher in the classroom. This dynamic is illustrated elsewhere in the text as well.

4.4.1 A16 – Ecosystem in a Jar

As in the two assignments mentioned above, A16-Ecosystem in a Jar follows a formulaic, “scientific method” approach to the exploration of a model ecosystem. What makes it subject to Bernstein’s theory of code and social class is the differences in the stated intent of the assignment and its practical outcome. The curriculum suggests an open investigation, as was discussed in the previous chapter. The suggested activities

outlined an approach that would be based on the student's curiosity and interests, and driven by the guiding questions that the student would ask.

The assignment as laid out in both the student edition and Teacher's Resource, however, is specifically designed to establish a system of demonstrating understanding for the student as well as a method for communication between the student and the teacher.

<p><i>Student Text</i> <i>Procedure</i></p> <ol style="list-style-type: none"> 1. Look at the things your teacher has brought in as possible items to go into the ecosystem jar. With your group, determine the following: <ol style="list-style-type: none"> (a) which things are biotic (b) which things are abiotic 2. In your group, identify which biotic elements and which abiotic elements should be placed in the sealed jar. 3. Before creating your ecosystem, identify any precautions you should take when preparing your materials. For example, should the jar be cleaned with soap or just rinsed with water? 4. Organize your group to make sure that everyone has a role in preparing the sealed-jar ecosystem. 5. Assemble your ecosystem and seal it. Store it in a place where it can be observed easily. 6. Make a sketch or take a photograph of your sealed ecosystem to record its appearance at the beginning of this activity. <p><i>Analyzing and Interpreting</i></p> <ol style="list-style-type: none"> 7. Discuss with your group the biotic and abiotic elements of your ecosystem and how you think they will interact over the next three weeks. Record these ideas and prepare a drawing of what you think the jar will look like after three weeks. 8. Create a chart that will allow you to record any changes you observe in the sealed-jar ecosystem over the next three weeks. Include a section in your chart to describe any observations of the types of interactions that can occur in an ecosystem. <p><i>Skill Builder</i></p> <ol style="list-style-type: none"> 9. How does what you already know about ecosystems help you make reasonable predictions? <p><i>Forming Conclusions</i></p> <ol style="list-style-type: none"> 10. For any changes you observe in the ecosystem, suggest reasons that might explain what is happening. 	<p><i>Teacher’s Resource</i> <i>Activity Notes</i></p> <ul style="list-style-type: none"> • Review Toolkit 2: The Inquiry Process of Science. • As a class, read the procedure steps through and ensure that all students understand what steps they need to cover to set up their model ecosystem. • Help students identify the different biotic elements that are available for them to use. You may substitute or provide additional biotic elements for the model ecosystems. • Discuss with students how they will go about determining what they will place in their model ecosystem to ensure the biotic elements have a good chance of surviving. • Help students organize into groups. Reinforce that everyone in the group will share equally in the task by reviewing rules and/or expectations for effective group work. You may wish to use Assessment Rubric LM 6 Working Cooperatively to help record and assess students’ work in groups. • Observe students carefully as they assemble their ecosystems. • Discuss with students how often they should observe and record their ecosystems. While there is no hard and fast rule, every other or every third day should provide sufficient observations. • Tell students to keep their diagrams and charts in their notebooks as they will be needed later in the unit. • You may wish to have students read and complete Skill Worksheet 5: Predicting before proceeding to the Analyzing and Interpreting section. <p><i>Answers to Questions</i></p> <ol style="list-style-type: none"> 7. Ensure students record their predictions as well as their drawings of what they think their jars will look like in their notes. (Toolkit 6 provides information on drawing diagrams.) Students may suggest that the plants will use sunlight to produce oxygen, and that the animals in the jar will breathe in the oxygen and produce carbon dioxide, which will then be used by plants. Students may also suggest that snails may eat the plants for food. 8. Provide students with headings they can use in their charts. Suggest that they have a column for explanations to record answers for #10 under Forming Conclusions, and a column for new predictions to record predictions based on their observations that they didn’t make previously. Encourage students to be as accurate as possible when making and recording their observations. 9. Have students share their predictions with the class and explain why they think their predictions will occur. Encourage them to use information and terms they have encountered so far in the unit as well as any information from their own personal experience. Students should use what they learned about basic needs to explain how they think the biotic elements in the jars will get their food and oxygen. They should also be able to explain the importance of the plants in the jars as producers of this food and oxygen as well as providing necessary habitat. 10. Students can record their reasons in their charts. If students begin to notice that the plants are looking unhealthy, they may suggest that the jar is not getting enough sunlight and move the jar. If they notice that the water is getting cloudy, they may suggest that there are not enough decomposers in the jar to remove the waste produced by the animals.
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The teacher is encouraged to instruct students as to how to investigate report and communicate their learning. This could be considered “*skill building*”, instructing the student in the accepted forms of scientific investigation. However, it could also be said that the assignment’s primary goal is to establish the “correct language” of school.

This is in contradiction to the spirit of the curriculum, exemplified by the quotes used to introduce the section entitled “Instructional Approaches”:

Trying to understand how the world works is what children do naturally and it is what you need to take advantage of when teaching science [and technology]. Just remember: Avoid being the knowledge authority. ... Instead, cultivate a sense of excitement for exploring and inquiring about our world and for generating and testing possible explanations.” (Jeffrey W. Bloom, *Creating a Classroom Community of Young Scientists*, 2nd ed. (2006), p. 4 as quoted in Ontario Science and Technology Curriculum, 2008.

The assignment as it is presented in the text expects the teacher to transmit the “proper” method of doing science; the curriculum encourages engagement in scientific learning. The text closes the relationship between the student and teacher, and positions them in a hierarchical structure; a suggestion not made in the text.

This, as has been illustrated throughout this thesis, has been an overriding theme throughout the text – the teacher maintains control over the modes of communication, investigation as well as the basic knowledge – and releases it to the student only when necessary. The text therefore may be written in a “middle class” code, but the intention of what is written is “restricted” in outcome, and positions the students in what could be considered, according to Bernstein, as “working class.”

Chapter Five: Conclusion

It is overwhelmingly clear that there is a considerable disconnect between the curriculum and the text, if not in terms of content, then of intent. As illustrated in Chapter Two, the 2007 curriculum stresses the need for student-driven inquiry, as well as the importance of the development of essential skills beyond basic knowledge. Yet, as shown in Chapter Three, the textbook remains grounded in direct instruction. Chapter Four discussed the dynamics of educational discourse, and its potential to divide those who set policy and those who execute it. What remains, is the cause of the disconnect.

Bernstein framed his view of educational discourse through the lens of class and hierarchy. He theorized that there were only two forces, diametrically opposed, whose influence determined policy and its implementation: the regulative discourse, in the form of decisions made at the Ministry and School Board level in Ontario, and the pedagogical discourse of those who deliver the curriculum in the classroom. Although this may explain many disputes and inefficiencies, it does not seem to be applicable in the case presented in this thesis.

If the curriculum is any indication however, the regulative and pedagogical discourses seem to have a tacit agreement on the approach to be taken in presenting the curriculum. The curriculum quotes the Science Coordinators' and Consultants' Association of Ontario, the Science Teachers' Association of Ontario, as well as many individual teachers who have written extensively on the subject, both on content and on teaching strategies. This leaves only one possible explanation – there may be a third dominant discourse, one that “bosses” the regulatory and pedagogical. This discourse would not only espouse the views of the corporate culture in which the text was written,

but also the values of that culture – consumerism, capitalism and entrepreneurialism – while ignoring others, limiting the scope of the learner.

This third, dominant discourse is the neo-liberal corporate discourse.

Primarily, the goal of the publisher is to make money and to maximize profit; this is granted and understood. Some regard must be given to a publisher's need to produce a text that is marketable to both teachers and school boards; texts that go too far forward in their approach may be harder to market. Moreover, the text is a good, basic reference that offers some enlightening activities to practice some primary skills.

Yet the vast differences that exist between the texts produced by the publishers and the curricula that they are supposedly based on, cannot simply be chalked up to “a difference in approach.” Throughout the text, the student is encouraged to solve complex problems, many specifically caused by human endeavor (oil spills, separation of toxic chemicals, development of more efficient vehicles, climate change) without questioning the necessity for what caused the problem in the first place.

In their treatise on the effect of neo-liberalism on curriculum reform in the U.K. and the Philippines, Camicia and Franklin (2011) examined the political economy of curriculum reform related to sometimes competing and sometimes overlapping visions of the global community.

Education has been a tool for perpetuating national myths that construct and maintain imagined consensus in, on the surface, the name of national unity. Postcolonial theorists mine below this surface to show how such intents to gain consensus, name, classify and sort serve to perpetuate relations of domination and subjugation. (Camicia & Franklin, 2011)

In the case of *Investigating Science and Technology 7*, a case could be made suggesting that the stereotypes presented in the book perpetuate the “consumer ideal”,

and that the lack of real inquiry as suggested by curriculum limits the student's ability to explore all potential sides of the issue being discussed. In other words, don't ask whether it was scientifically ethical to endanger the environment by transporting crude oil by super tanker, let's just look at how to clean up the spills as best we can. Steinberg (1999) suggested that discourses do not carry the same weight because they are embedded in a larger political economy that favours one discourse over another. Dominant discourses create and maintain a kind of gravitational pull on marginal discourses, a pull that seeks standardization, assimilation and efficiency.

The text's dominant discourse suggests it has all the answers, but it is also the only source of questions.

This is not to say that the neo-liberal perspective should not be presented in the classroom. On the contrary, it should be one of many explored by engaged, inquiring students.

Students like "G" who, despite what the text told him decided to explore an alternative explanation to a scientific phenomenon. "G" was given an opportunity to explore, he took it, and gave strong evidence for his findings. To tell him he was wrong simply because the book told him he was would fly in the face of science, and of good teaching.

"G" was thinking; inquiry in action. That is the point.

References

- Bernstein, B. (1971). Open Schools, Open Society? In B.R. (eds), *School and society: A sociological reader*. Cambridge, Massachusetts: MIT Press, pp. 66-69.
- Bernstein, B. (1996). *Pedagogy symbolic control and identity: Theory, reasearch, critique*. Bristol, PA: Taylor & Francis.
- Bernstein, B. (1996). *Pedagogy, symbolic control and identity*. Lanham, Maryland: Rowman & Littlefield.
- Bernstein, B. (1975). *Sources of consensus and disaffection in education*. London: Routledge.
- Camicia, S. & Franklin, B. (2011). What type of global community and citizenship? Tangled discourses of neoliberalism and critical democracy in curriculum and its reform. *Globalisation, Societies and Education*, pp. 311-322.
- Feinberg, J. (2013). Retrieved May 2, 2013, from Wordle: <http://www.wordle.net/>
- Harste, J. (1994). Literacy as curricular conversations about knowledge, inquiry, and morality. In M. R. R.B. Ruddell, *Theoretical Models and Processes of Reading*. Newark DE: International Reading Association, pp. 1230-31.
- Harste, J. (2001). What education as inquiry is and isn't. In B.C. Sibel Boran, *Critiquing Whole Language and Classroom Inquiry*, NTSC, pp. 3, 4.
- Investigating Science and Technology 7*. (2008). Toronto: Pearson Education Canada.
- Investigating Science and Technology 7, Teacher's Resource*. (2008). Pearson Education Canada.
- Moore, P. (2003). *Ontario Votes 2003, Indepth Feature*. Retrieved April 21, 2013 from CBC.ca: http://www.cbc.ca/ontariovotes2003/features/ed_platforms_052903.html
- Ontario Ministry of Education and Training (1998). *The Ontario Curriculum, Grade 1-8, Science and Technology*. Toronto: Queen's Printer for Ontario.
- Ontario Ministry of Education. (2013, February 2). *Curriculum Council*. Retrieved April 21, 2013 from Ontario Ministry of Education: <http://www.edu.gov.on.ca/curriculumcouncil/>

Ontario Ministry of Education (2008). *Guidelines for Approval of Textbooks*. Retrieved April 21, 2013 from Ontario Ministry of Education:

http://resources.curriculum.org/occ/trillium/Textbook_Guide_English_2008.pdf

Ontario Ministry of Education (2007). *The Ontario Curriculum Grades 1-8 - Science and Technology*. Toronto: Queen's Printer for Ontario.

Queen's Printer for Ontario (2012, September 9). *Education Facts*. Retrieved from Ontario

Ministry of Education: <http://www.edu.gov.on.ca/eng/educationFacts.html>

Steinberg, M. (1999). The talk and back talk of collective action: A dialogic analysis of repertoires of discourse among nineteenth-century English cotton spinners. *The American Journal of Sociology*, 736-780.