ARCTIC MARINE SCIENCE CURRICULUM

BACKGROUND INFORMATION

TEACHER'S GUIDE

2001

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1.0 WHAT IS TEK?

An important component of this course is the incorporation of Traditional Ecological Knowledge (TEK). This section contains excerpts from the website hosted by Inuit Taparisat, and contains an important perspective on TEK (www.tapirisat.ca). Visit the website for additional information on TEK.

1.1 UNDERSTANDING INUIT KNOWLEDGE

> *"In our culture when a person grows wise and has knowledge we just call him or her a thinker and that means he or she is usually an elder. We don't bother with words like scientist and biologist and professor, because they do not represent what we mean by knowledge.*
>
> *In the north, the Inuit do not try to use knowledge to become more important than someone else. There are people here in my community who are really brilliant, but they do not boast about it or try to confuse people with words. One of the big differences between our knowledge and yours is that individuals do not try to use their knowledge like a profession.*
>
> *The idea of being an expert is very complicated, especially when being an expert is your business. No one has a monopoly on knowledge, and a good teacher is one whose knowledge is stable enough to let the knowledge of another continue to exist. That's why good teachers are very rare. My father is an expert but also a good teacher because he knows where there is room for doubt.*
>
> *We think it is important to recognize that it is the Inuit ourselves and not academic researchers or other non-Inuit who must take the lead in answering the question of what is Inuit environmental and ecological knowledge. We want the content and organization of our knowledge to be based on what we identify as important, and not on non-Inuit points of view or arguments about the meaning or validity of our knowledge. The issue is: who speaks for us and for our knowledge of the land and resources?*
>
> *Another important issue to Inuit is how our knowledge is referred to. The most common term or reference is probably "Traditional Ecological Knowledge" (TEK). Some Inuit think this term limits the meaning, content and potential use of our environmental and ecological knowledge.*
>
> *[Traditional] sounds the same as some type of handicraft that we make and then sell to tourists."*
>
> Source: *JP, Kuujjuaq.*

In a 1996 seminar held in Inuvik, called "Two Ways of Knowing: Indigenous Knowledge and Scientific Knowledge," it was noted that:

> *"There are many terms in use to describe the body of expertise and knowledge held in indigenous communities. Among these are indigenous knowledge, traditional ecological knowledge, indigenous science, ecological wisdom and many others. None is wholly adequate or satisfactory. [The seminar's chairperson observed] that 'indigenous knowledge' may imply that any indigenous person may have this expertise, when in fact personal experience and learning form elders are more important than ancestry. Because they are widely used terms, these recommendations use as synonyms the terms "indigenous knowledge" and "traditional ecological knowledge" and the acronym "TEK."*

Recently, the Inuit of Nunavut have recognized the many levels of attachment between Inuit culture, language and knowledge and now use the term Inuit Qaujimajatuqangit or IQ.

What do we as Inuit mean when we talk about our environmental and ecological knowledge? There are many ways to describe or define our knowledge. The key, however, is to make sure that the definitions are developed by Inuit and not by outsiders. ITC does not speak on behalf of regional Inuit organizations and research groups that are working with Inuit environmental and ecological knowledge on a day-to-day and project-by-project basis. However, we feel that these organizations, working directly as they do with the collection and use of our knowledge, would agree that it needs to be thought of as Inuit-specific. Knowledge learned from experience and elders is closely tied to our culture, language, and to the environment in which we live. It is important not to create stereotypes that assume that all indigenous peoples have the same type of knowledge. All knowledge must be respected but it must be allowed to remain rooted in a particular culture.

1.2 KNOWLEDGE AND CULTURE

Inuit knowledge (or traditional knowledge, or IQ), results from our age-old connection to our land and its living resources, and the inseparable relationship that exists between our land, resources and culture. Attachment to the land through personal histories, stories and place names is just as important as more functional attachments based on areas of good hunting, travel routes and specific knowledge about the physical environment and living resources.

Knowledge of the environment and ecosystems underlie all patterns of Inuit land use, but it is also through land use that Inuit are able to expand our knowledge. Our ecological and environmental knowledge is very detailed and cannot easily be divided into separate categories. The knowledge is based not just on information itself, but on meanings and ways of thinking about the environment that are part of our culture and dependent on the use of our language. We have very powerful ways of expressing our knowledge, and it is important for scientists to understand what this implies, just as we must become familiar with their language.

> *"What many southern scientists don't understand, even those who have worked here a long time, is how the knowledge Inuit have is really connected to our culture. They may not be exactly the same things, but they almost are. This fact will not keep us from being good researchers. What I am saying is that Inuit have always thought in a very ecological way about everything, not just about our resources."*

1.3 NEW DIRECTIONS FOR INUIT KNOWLEDGE

Inuit knowledge is living knowledge. It is knowledge that exists for those who attain it through experience, as well as through oral traditions, songs, and other cultural practices. It is important for outsiders to recognize that our knowledge includes more than information about the past.

> *"We are learning new things every day since we still travel, hunt and observe what is going on in our backyards all across the arctic. Our knowledge is not only about the past or the way we once lived. Our elders saw their surrounding world differently from the youth of today. What we want to do is make sure our youth have an opportunity to understand what our elders knew but to then take this information in new directions."*

Our knowledge includes both existing and new information. We respect the knowledge passed on to us by our elders, but our youth must be encouraged to explore other ways of learning. They will bring new skills and systems of knowledge to our culture and the northern environment, so it is important to broaden the definition of our knowledge to reflect this. In addition, the meanings and applications of our knowledge will change to reflect new political, economic, cultural and technological realities, which together will provide multiple challenges to Inuit and to the circumpolar countries within which we live.

2.0 WHAT IS CULTURALLY RESPONSIVE SCIENCE CURRICULUM?

INTRODUCTION

Your task is to help the students connect to the world around them in ways that prepare them for the responsibilities and opportunities they will face as adults. That means they need to know as much as possible about their own immediate world as well as the larger world in which they are situated, and the inter-relationship between the two. To achieve such a goal requires attention to the local culture in a holistic and integrative manner across the curriculum, rather than as an add-on component for a few hours a week after attending to the "real" curriculum. The baseline for the curriculum should be the local cultural community, with everything else being built upon and grounded in that reality.

Source: Teaching/Learning Across Cultures: Strategies for Success (Sharing Our Pathways Vol. 2, Issue 3 Summer 1997)

This course represents a unique blending of science and traditional knowledge that allows students to explore Arctic marine environments from both perspectives and to appreciate the interrelationships between the two. As a culturally responsive science curriculum, it attempts to integrate aboriginal and Western knowledge systems around science topics with goals of enhancing the cultural well-being and science skills and knowledge of students. It assumes that students come to school with a whole set of beliefs, skills and understandings formed from their experiences in the world and that the role of school is not to ignore or replace proper understanding, but to recognize and make connections to that understanding. It assumes that there are multiple ways of viewing, structuring and transmitting knowledge about the world-each with its own insights and limitations. It values both the rich knowledge of aboriginal cultures and of Western science and regards them as complementary to one another in mutually beneficial ways.

What are the characteristics of culturally responsive science curricula?

- It begins with topics of cultural significance and involves local experts.
- It links science instruction to locally identified topics and to science learning outcomes.
- It devotes substantial blocks of time and provides ample opportunity for students to develop a deeper understanding of culturally significant knowledge linked to science.
- It incorporates teaching practices that are both compatible with the cultural context, and focus on student understanding and use of knowledge and skills.
- It engages in ongoing authentic assessment that subtly guides instruction and taps deeper cultural and scientific understanding, reasoning and skill development tied to curriculum.

NOTE: THIS SECTION DRAWS ON THE WORK OF THE ALASKA SCIENCE CONSORTIUM AND THEIR DOCUMENT "CULTURALLY RESPONSIVE SCIENCE CURRICULUM", 2001.

What are some strengths of a culturally responsive science curriculum?

- It recognizes and validates what children currently know and builds upon that knowledge toward more disciplined and sophisticated understanding from both indigenous and Western perspectives.
- It taps the, often, unrecognized expertise of local people and links their contemporary observations to a vast historical database gained from living on the land.
- It provides for rich inquiry into different knowledge systems and fosters collaboration, mutual understanding and respect.
- It creates a strong connection between what student's experience in school and their lives out of school.
- It can address curriculum from multiple disciplines.

What are some difficulties associated with culturally responsive curriculum?

- Cultural knowledge may not be readily available to or understood by teachers.
- Cultural experts may be unfamiliar, uncomfortable or hesitant to work within the school setting.
- Standard science texts may be of little assistance in generating locally relevant activities.
- Administrative or community support for design and implementation may be lacking.
- It takes time and commitment.

*The **application of knowledge** is of paramount importance in aboriginal cultures and has traditionally been equated with the ability to survive… As Richard Glenn, a Inupiat geologist in Barrow said, an Elder has little use for all of the physics formulas that describe sea ice movement, but knows intimately which ice is safe to walk on or travel through, and what ice conditions to watch for in order to stay safe when out hunting. The same could be said for weather prediction, hunting and fishing practices, navigation and so forth.*

Source:
Handbook for Culturally Responsive Science Curriculum

2.1 COMPONENTS OF A CULTURALLY RESPONSIVE SCIENCE CURRICULUM

CULTURAL RELEVANCE EXAMINES TOPICS OF CULTURAL SIGNIFICANCE, INVOLVES CULTURAL EXPERTS, PROVIDES ADEQUATE OPPORTUNITY FOR REACHING DEEPER CULTURAL UNDERSTANDING, LINKS STUDENTS TO THEIR COMMUNITY, VALUES TRADITIONAL KNOWLEDGE AND ITS ROLE IN MODERN SOCIETY.	CURRICULUM BASED IDENTIFIES SPECIFIC STUDENT LEARNING OUTCOMES FOR SCIENCE (WHOSE FOUNDATIONS ARE FOUND IN A PAN-CANADIAN SCIENCE FRAMEWORK), PROVIDES A RANGE OF OPPORTUNITIES THAT LEAD STUDENTS TO A DEEPER UNDERSTANDING OF SCIENCE, VALUES SCIENCE WHILE ACKNOWLEDGING IT REPRESENTS ONLY ONE WAY OF VIEWING THE WORLD.
BEST PRACTICES INCORPORATES STRATEGIES WHICH ARE CULTURALLY APPROPRIATE AND STUDENT CENTRED, FOCUSES ON STUDENT UNDERSTANDING AND APPLICATION OF KNOWLEDGE, IDEAS AND INQUIRY PROCESS; GUIDES STUDENTS IN ACTIVE AND EXTENDED INQUIRY; AND SUPPORTS A CLASSROOM COMMUNITY WITH CO-OPERATION, SHARED RESPONSIBILITY AND RESPECT.	ASSESSMENT ENGAGES IN ONGOING ASSESSMENT OF STUDENT: UNDERSTANDING OF HIGHLY VALUED, WELL-STRUCTURED KNOWLEDGE; SKILL DEVELOPMENT AND REASONING; AND ABILITY TO APPLY KNOWLEDGE TO THE REAL WORLD. ALLOWS FOR DIVERSE DEMONSTRATIONS OF UNDERSTANDING AND SKILLS.

2.2 INTEGRATING TRADITIONAL KNOWLEDGE AND SCIENCE

Excerpts from: Culturally Responsive Science Curriculum, Alaska Science Consortium, 2001.

Perspectives
For many aboriginal educators, culturally responsive science curriculum has to do with:

- Their passion for making cultural knowledge, language and values a prominent part of the schooling system.

- With presenting science within the whole of cultural knowledge in a way that embodies that culture and with demonstrating that science standards can be met in the process.
- With finding the knowledge, strategies and support needed to carry out this work.

For those educators not so linked to the local culture, culturally responsive science curriculum has more to do with connecting what is known about Western science education to what local people know and value. It has to do with accessing cultural information, correlating that information with science skills and concepts, adjusting teaching strategies to make a place for such knowledge, and coming to value a new perspective. It, too, has to do with addressing science standards and finding the knowledge strategies, and support needed to carry out this work.

Implications

The creation of culturally responsive science curriculum has powerful implications for students for at least three reasons:

- A student might conceivably develop all of the common ground skills and understanding while working from and enhancing a traditional knowledge base;
- Acquisition of the common ground, regardless of route, is a significant accomplishment; and
- Exploration of a topic through multiple knowledge systems can only enrich perspective and create thoughtful dialogue.

One way of envisioning this merger would be for young children to consistently focus on traditional knowledge as a way of enhancing a cultural foundation and developing skills and knowledge common to both systems. As children get older, this traditional focus might continue with increased use and discussion of some of the tools and procedures of Western science and how they differ from traditional ways of knowing. By middle/high school, students could tackle more sophisticated science concepts/skills and develop more sophisticated cultural understanding while also becoming more able to apply them in the real world, and more able to analyze and compare the insights and limitations of each system. In this way, students could have a truly rich and relevant education without demeaning or subjugating either knowledge system.

The following diagram on the following page highlights the commonalities between Traditional Knowledge and Western Science.

Traditional Knowledge and Western Science – A Comparison of Two World Views

TRADITIONAL KNOWLEDGE

- holistic
- includes physical & metaphysical world linked to moral code
- emphasis on practical application of skills and knowledge
- trust for inherited wisdom
- respect for all things
- practical experimentation
- qualitative oral record
- local verification
- communication of metaphor & story connected to life, values, and proper behaviour
- integrated and applied to daily living and traditional subsistence practices

COMMON GROUND

Organizing Principles
- universe is unified
- body of knowledge stable but subject to modification

Habits of Mind
- honesty, inquisitiveness
- perseverance
- open-mindedness

Skills and Procedures
- empirical observation in natural settings
- pattern recognition
- verification through repetition
- inference and prediction

Knowledge
- plant and animal behaviour, cycles, habitat needs, interdependence;
- properties of objects and materials;
- position and motion of objects;
- cycles and changes in Earth and sky

WESTERN SCIENCE

- part to whole
- limited to evidence and explanation within physical world
- emphasis on understanding how
- skepticism
- tools expand scale of direct and indirect observation & measurement
- hypothesis falsification
- global verification
- quantitative written record
- communication of procedures, evidence and theory
- discipline-based
- micro and macro theory (e.g. cell biology & physiology, atomic theory, plate tectonics, etc.)
- mathematical models

2.3 INVOLVING CULTURAL EXPERTS

Excerpts from: Culturally Responsive Science Curriculum, Alaska Science Consortium, 2001.

Creating and implementing culturally responsive curriculum is a collaborative process involving local cultural experts as much as possible throughout the process. It involves an exchange of information and perspective in which the classroom teacher comes to understand what local knowledge is valued and held locally and by whom. It then involves the connection of these cultural experts and their knowledge to classroom practice.

Teachers who are teaching within their own community have the advantage of knowing who the cultural experts are and being familiar with local traditions, i.e. ways of showing respect, etc. However, creating linkages between the classroom and community members and doing it within the context of a science curriculum will still be a challenge. For those teachers not teaching in their home community the challenge is even greater. In either case, the cultural experts may feel unaccustomed to such inquiries; may have had bad experiences in the past; may feel that the teachers (and/or students) aren't truly listening; or may feel uncomfortable with the school or what is expected of them.

The interaction with cultural experts can be done with the teacher making contacts and gathering information, individual students gathering information, the cultural expert visiting the class, or the class accompanying the cultural expert on the land. Ideally, all of these interactions would happen at some point during the year.

It is important for students to learn how to gather traditional knowledge. This serves the dual purpose of creating stronger links between students and community members as well as documenting important knowledge that would otherwise be lost. Many organizations have already taken on the task of documenting traditional knowledge and this information may be available for classroom use. It may also be possible for students to collect traditional knowledge to add to this collection. If such activities are not already in place, the school can begin the process of collecting and recording this knowledge as part of a school and community resource.

The following list highlights some tips for involving cultural experts in the classroom:

First Step

- Identify organizations that may already be collecting traditional knowledge from local people
- Access existing information wherever possible
- Have students collect additional information to supplement existing collections or start a school traditional knowledge collection if none currently exists

Identifying Elders and Asking Them for Help

- Look for contacts through students in your classroom and teachers, teachers aides etc. on staff at the school
- Utilize local organizations such as Hunters and Trappers Associations, Hamlet Councils, etc. to identify contacts
- If you are not familiar with the local traditions, seek the help of someone who is; it is critical to approach the elder with a request to become involved with students in a respectful and culturally appropriate manner

Gathering and Recording Traditional Knowledge

- Students can work with tapes or documents already in existence (students may be able to make significant contributions through the summarizing or transcribing of tapes that have already been collected – a very time-consuming task)
- Can take the form of informal interviews, note taking, audio or video recording, sharing an experience (e.g. a hunting trip to the floe edge), demonstrations by the Elder (e.g. demonstrating how to skin a seal), or an Elder's Conference on a particular topic (e.g. climate change)

Elder Visits to the Classroom

- Ensure that when the elder arrives, he/she is properly greeted and introduced
- While you will suggest the topic you wish the elder to address, their information/stories, etc. may stray from what you perceive as the topic at hand; remember that traditional knowledge is usually situated within a context or a number of interrelated topics that must also be addressed; the elder will determine the approach he/she wishes to take (students may need to refrain from asking questions that interrupt the elder, and wait for an appropriate time to ask the questions)
- Think about how to make a smooth transition to help the Elder leave the class

Follow-Up ("Giving Back")

- It is important to share the products of the information, sharing back with the Elders and community members
- Student work (booklets, posters, collections, reports) can be shared with the Elders who shared their knowledge as well as with other community members
- People can be thanked publicly at a community event
- This "giving back" completes a cycle that will build knowledge and encourage all to participate again

2.4 CAUTIONS

History contains many examples of aboriginal people having negative experiences centred around good-faith sharing of traditional knowledge with outsiders. These can range from simple plagiarism to exploitation and thievery. Many times a negative feeling exists simply because the scientists who collected information have never returned to share their findings. The information was taken away and nothing was given back.

Be aware that this reluctance may exist as well as a concern over who "owns" the information and what will be done with it. This should be less of an issue if the information requests come from the youth in their own community, for use in local schools. However, when outsiders (often scientists) request access to this information, or information collected by a local organization, the question of ownership and use is an important one.

It is best to obtain guidance in the collection and use of traditional knowledge from local cultural organizations such as:

Inuvialuit Cultural Society
Dene Cultural Institute
Inuit Tapirisat

It is important to utilize existing resources that provide a solid grounding in the perspectives of aboriginal people in the Arctic. These may be locally developed (e.g. by your school division) or they may be the result of large-scale projects, such as Inuuquatigiit and Dene Kede. These documents contain a wealth of information on aboriginal perspectives of the Inuit and Dene respectively, and contain traditional knowledge that is relevant to the study of Arctic marine environments.

3.0 CULTURAL STANDARDS FOR EDUCATORS

The following section contains cultural standards for educators related to the development of culturally responsive schools. They serve to highlight the key components that educators must address. These standards were developed by the Assembly of Native Educator Associations in Alaska. Related standards for students, schools and communities can be found at the following website:

The Alaska Knowledge Network
http://www.ankn.uaf.edu

ALASKA STANDARDS FOR CULTURALLY RESPONSIVE SCHOOLS

Adopted February 3, 1998, Anchorage, Alaska

Cultural Standards for Educators

A. Culturally-responsive educators incorporate local ways of knowing and teaching in their work.

Educators who meet this cultural standard:

1. Recognize the validity and integrity of the traditional knowledge system;
2. Utilize Elders' expertise in multiple ways in their teaching;
3. Provide opportunities and time for students to learn in settings where local cultural knowledge and skills are naturally relevant;
4. Provide opportunities for students to learn through observation and hands-on demonstration of cultural knowledge and skills;
5. Adhere to the cultural and intellectual property rights that pertain to all aspects of the local knowledge they are addressing; and
6. Continually involve themselves in learning about the local culture.

B. Culturally-responsive educators use the local environment and community resources on a regular basis to link what they are teaching to the everyday lives of students.

Educators who meet this cultural standard:

1. Regularly engage students in appropriate projects and experiential learning activities in the surrounding environment;
2. Utilize traditional settings such as camps as learning environments for transmitting both cultural and academic knowledge and skills;
3. Provide integrated learning activities organized around themes of local significance and across subject areas;
4. Are knowledgeable in all the areas of local history and cultural tradition that may have bearing on their work as a teacher, including the appropriate times for certain knowledge to be taught; and
5. Seek to ground all teaching as a constructive process built on a local cultural foundation.

C. Culturally-responsive educators participate in community events and activities in an appropriate and supportive way.

Educators who meet this cultural standard:

1. Become active members of the community in which they teach and to make positive and culturally-appropriate contributions to the well being of that community;
2. Exercise professional responsibilities in the context of local cultural traditions and expectations;
3. Maintain a close working relationship with and make appropriate use of the cultural and professional expertise of their co-workers from the local community.

D. Culturally-responsive educators work closely with parents to achieve a high level of complementary educational expectations between home and school.

Educators who meet this cultural standard:

1. Promote extensive community and parental interaction and involvement in their children's education;
2. Involve Elders, parents and local leaders in all aspects of instructional planning and implementation;
3. Seek to continually learn about and build upon the cultural knowledge that students bring with them from their homes and community;
4. Seek to learn the local heritage language and promote its use in their teaching.

E. Culturally-responsive educators recognize the full educational potential of each student and provide the challenges necessary for them to achieve that potential.

Educators who meet this cultural standard:

1. Recognize cultural differences as positive attributes around which to build appropriate educational experiences;
2. Provide learning opportunities that help students recognize the integrity of the knowledge they bring with them and use that knowledge as a springboard to new understandings;
3. Reinforce the student's sense of cultural identity and place in the world;
4. Acquaint students with the world beyond their home community in ways that expand their horizons while strengthening their own identities;
5. Recognize the need for all people to understand the importance of learning about other cultures and appreciating what each has to offer.

4.0 BEST PRACTICES

4.1 BLENDING TRADITIONAL AND INQUIRY TEACHING PRACTICES

Teachers work hard to incorporate best practices of teaching, or ways to incorporate what we know about how students learn best into classroom practices. In working towards the goal of culturally responsive teaching, priorities now include teaching practices that best support science learning while enhancing the cultural well being of students. The following suggestions arise from a comparison of traditional and science inquiry based teaching practices.

TRADITIONAL TEACHING	INQUIRY TEACHING	COMPATIBLE STRATEGIES
• Elders, family, community and peer teach	• Teacher as a facilitator of learning; science as a social endeavour	• Community involvement, co-operative groups, peer tutoring; multiple teachers as facilitators of learning
• Learning connected to life, seasons, and environment	• Investigate fundamental science questions of interest to students	• Investigate fundamental science questions related to life, seasons and environment; investigate questions from multiple perspectives and disciplines
• Learn by watching, listening and doing, elder is expert	• Active and extended inquiry over time; use of print and electronic sources to help interpret or revise explanation	• Learn by active and extended inquiry; use multiple sources of expert knowledge including cultural expert
• Emphasize watching, listening and doing; Elder is expert	• Focus on student understanding and use of scientific knowledge, ideas and inquiry skills	• Integrate skill development, understanding and application of knowledge
• Knowledge shared through modelling, story telling and innovation	• Classroom communication and debate of understandings	• Diverse representations and communication of student ideas and work to classmates and community

Source: Grades 5 to 8 Science:
A Foundation for Implementation,
Manitoba Education and Training: 2000.

4.2 PHASES OF LEARNING

Source: Grades 5 to 8 Science:
A Foundation for Implementation,
Manitoba Education and Training: 2000.

When preparing instructional plans and goals, teachers should consider three learning phases:

1. Activating (preparing for learning)
2. Acquiring (integrating and processing learning)
3. Applying (consolidating learning)

These phases are not entirely linear, but are a useful way of thinking and planning.

Activating (Preparing for Learning)
One of the strongest indications of how well students will comprehend new information is their prior knowledge of the subject. Some educators observe that more student learning occurs during the activating phase than at any other time. In planning instruction, teachers develop learning activities and select strategies for activating students' prior knowledge. These learning activities provide information about the extent of students' prior knowledge of the topic to be studied, and about their knowledge of and proficiency in applying skills and strategies needed for learning in this topic area.

Prior knowledge activities include the following:

- Helping students relate new information, skills, and strategies to what they already know and can do
- Allowing teachers to correct misconceptions that might otherwise persist and make learning difficult for students
- Allowing teachers to augment and strengthen students' knowledge bases in cases where students do not possess adequate prior knowledge and experience to engage with new information and ideas
- Helping students recognize gaps in their knowledge
- Stimulating curiosity, and initiating the inquiry process that will direct learning

Acquiring (Integrating and Processing Learning)
In the second phase of learning, students absorb new information and integrate it with what they already know, adding to and revising their previous knowledge. Part of the teacher's role in this phase is to present this new information, or to help students access it from other sources. Because learning is an internal process, facilitating learning requires more of teachers than the simple presentation of information. In the acquiring phase, teachers instruct students in strategies that help them make meaning of information, integrate it with what they already know, and express their new understanding. In addition, teachers monitor these processes to ensure that learning is taking place, using a variety of instruments, tools, and strategies such as observations, interviews, and examination of student work.

Applying (Consolidating Learning)
New learning that is not reinforced is soon forgotten. Teachers need to move students beyond guided practice and into independent practice. The products and performances by which students demonstrate new learning are not simply required for assessment; they have an essential instructional purpose in providing students with opportunities to demonstrate and consolidate their new knowledge, skills and strategies, and attitudes. Students also need opportunities to reflect on what they have learned and to consider how new learning applies to new situations. By restructuring information or integrating what they have learned in one strand with other strands or subject areas, students strengthen and extend learning.

4.3 STRATEGIES FOR TAPPING INTO PRIOR KNOWLEDGE

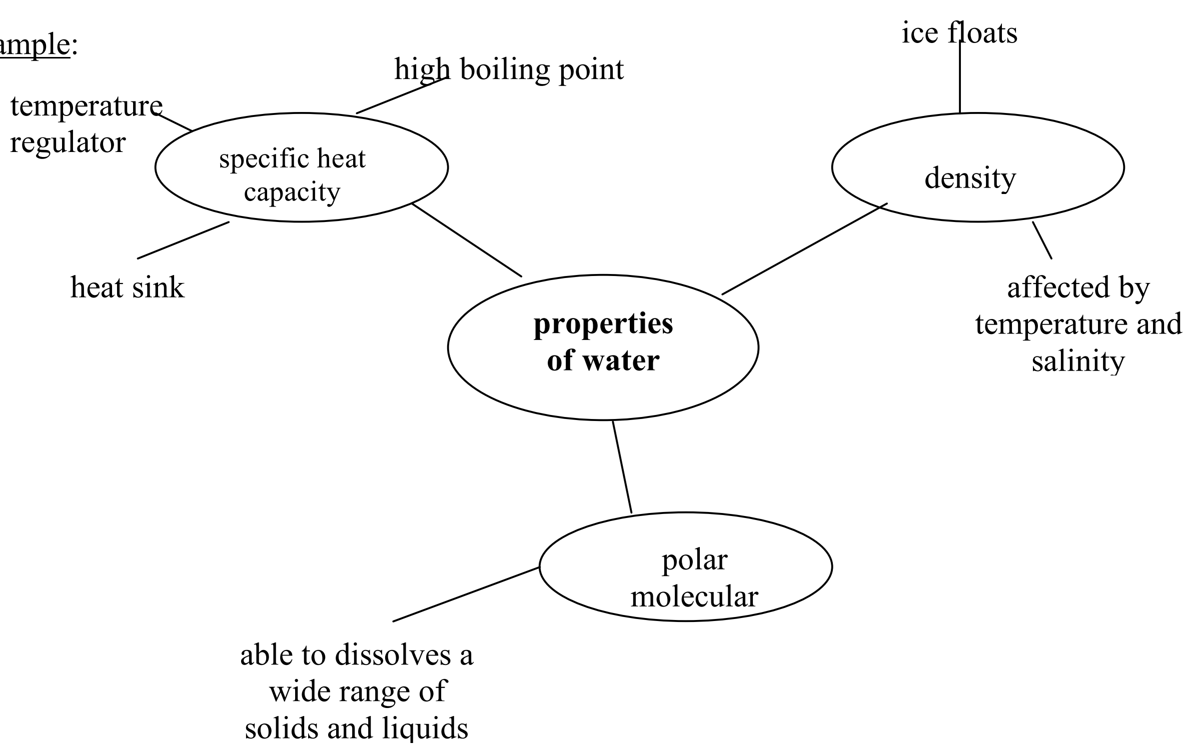
Adapted From: Senior Years Science Teachers' Handbook, Manitoba Education and Training: 1997.

This section describes several strategies that can be used to access prior knowledge.

Concept Map
A concept map helps students to identify key vocabulary for a topic and the relationships between terms within a topic.

1. Identify key vocabulary (can be done by the teacher or the students)
2. Identify big ideas and details
3. Arrange the words to show relationships or logical connections between the big ideas and details and use bubbles and lines to show these relationships

Example:



NOTE: No two maps are likely to look the same and there is no one "right" map. The goal is to have students make connections between concepts.

KWL
The KWL strategy asks students to identify what they *Know*, *Want to Know*, and what they *Learned* in the lesson or unit. It is one of the most widely recognized and frequently used prior knowledge strategies. Some variations include:

KWL-Plus Strategy adds an additional step where at the end of the unit or lesson each student builds a new concept map that incorporates both what they "knew" and what they learned. This concept map provides a valuable review sheet and summary.

The Knowledge Chart changes the W column to an N column, rephrased as "what you Need to Know". Students write down what they'll need to know to succeed in the lesson or unit. Students can check at the end to see if they learned what they needed to know. Another variation is to have the Know Now section broken down into "draw" and "list" components.

Anticipation Guide
In this strategy students state their initial reaction to a given statement, gain factual information about a topic, and re-evaluate their initial reaction to the given statement and explain any changes. This strategy is useful for probing controversial issues and/or areas where misconceptions may be present. *For example*: Scientists are positive that global warming is taking place.

A reaction to this statement would be followed by a lesson where students are exposed to text, videos, speakers, etc. that provide information on this topic. They then write another response and explain why their opinion was either strengthened or changed.

4.3 BUILDING A SCIENTIFIC VOCABULARY

To successfully learn scientific vocabulary, students need both multiple and varied exposures to the essential words of that discipline. However, to understand these words well, student must have both a definitional and contextual knowledge of that word. Suggested strategies are provided below.

Word Cycle
Refer to the appendix for a template. In this strategy, students begin by placing two words from the list provided into adjoining ovals and writing the connection between those words in the band that connects they ovals. They continue with this process until all of the terms have been used and the final connection is made.

Three-Point Approach
This approach goes beyond simply writing a definition of a term. Students are also asked to list a synonym or example and draw a picture or diagram. The following template is commonly used:

<table>
<tr><td rowspan="2">Definition:</td><td>WORD OR CONCEPT:</td><td rowspan="2">DIAGRAM</td></tr>
<tr><td>SYNONYM /EXAMPLE</td></tr>
</table>

Sort and Predict
In this strategy students work in small groups to sub-divide a list of approximately 20 foundation words from the unit into four categories, each category having at least three terms. The teacher can challenge the groups to create one category that is unique and original. Groups then share their results and describe their basis for categorization.

Compare and Contrast
Sometimes the essential words taught are very similar to each other. These are the terms students have to compare and contrast. Often students have experience in defining terms, but little experience in comparing and contrasting terms. The following headings provide a suggested outline.

How are ______________________________ and ________________________ alike?	

How are ______________________________ and ________________________ different?	

Write a statement to compare and contrast the two terms, concepts or events.

4.4 DEVELOPING SCIENTIFIC CONCEPTS USING GRAPHIC DISPLAYS

Science students must not only acquire knowledge, they must be able to recall and apply this knowledge correctly. Concept maps (already discussed) can help them do this. Another important tool is Concept Organizer Frames. These frames focus the students on different aspects of a concept allowing them to obtain a complete picture of the concept. Two frames have been provided in the Appendix, a Concept Overview and a Fact-Based Article Analysis.

5.0 ASSESSMENT

INTRODUCTION

With the merger of cultural knowledge and science, and with the shift in science education from science as only content to science as complex combinations of attitudes, inquiry skills, and conceptual understanding, come necessary shifts in assessment. If student growth and understanding of cultural knowledge is valued, then we must find ways to assess such knowledge and resist the temptation to merely treat cultural knowledge as a vehicle for science learning. If we truly value student abilities to: reason scientifically; apply science learning in real life situations; and understand the context and constraints under which science functions, then we must assess in all those areas as well. And finally, if we recognize that learning includes the process of exploration and the student's autonomous construction of meaning, then we must allow for diverse pathways and demonstrations of understanding.

5.1 CULTURALLY RELEVANT ASSESSMENT

There is an emerging body of research emerging on authentic assessment in science, but there is little research related to assessing cultural behaviour, knowledge and values. The following chart offers some promising (if somewhat tentative) practices related to culturally relevant assessment.

	Traditional Assessment	Inquiry Assessment	Compatible Assessment Strategies
DIAGNOSTIC	• Elder sets standards using cultural knowledge continuum and "need to know" as a guide • Elder watches and interacts with children in daily life and gauges individual readiness for specific tasks	• Teacher uses student learning outcomes as a guide to instructional priorities • Prior to instruction, teacher gauges student's background experiences, skills, attitudes and misconceptions	• Informal discussion of topic to be studied • Observational evidence from prior activities • Concept mapping

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F O R M A T I V E	• Elder observes children at work on task during daily life, offering continued modelling, encouragement and positive acknowledgements of individual progress • Elder provides additional tasks as student skills and knowledge develop and they appear ready for the next challenge • Skills and knowledge are not assessed in isolation from their purpose and application	• Teacher monitors student progress and adjusts learning activities to reach goals • Teacher provides helpful feedback to improve student's understanding • Assessments tap developing skills, attitudes and conceptual understanding	• Observations • Informal interviews • Journals and learning logs • Self-evaluation • Performance tasks
S U M M A T I V E	• Ultimate evaluation is whether or not child can apply their learning effectively in daily life (e.g. do they have adequate skills and understanding to successfully hunt seals, collect and preserve berries, etc.?)	• Teacher assesses student's ability to transfer skills and understandings to other tasks in other contexts	• Performance tasks • Self-evaluation • Portfolios • Creative performances and exhibitions

Source: Culturally Relevant Science Curriculum, Alaska Native Knowledge Network, 2000.

5.2 PRINCIPLES OF ASSESSMENT

The table of the following page summarizes the principles of good assessment.

1. AN INTEGRAL PART OF INSTRUCTION AND LEARNING Assessment . . . • Is meaningful to students • Leads to goal setting • Fosters transfer/integration with other curricular areas and application to daily life • Reflects instructional strategies used • Uses a wide variety of strategies and tools • Reflects a definite purpose	
2. Continuous and Ongoing Assessment . . . • Occurs through all instructional activities • Occurs systematically over a period of time • Demonstrates progress towards achievement of learning outcomes	6. Developmentally and Culturally Appropriate Assessment . . . • Is suited to students' developmental levels • Is sensitive to diverse social, cultural, and linguistic backgrounds • Is unbiased
3. Authentic and Meaningful Learning and Contexts Assessment . . . • Focuses on connecting prior knowledge and new knowledge (integration of information) • Focuses on authentic problem-solving contexts and tasks • Focuses on application of strategies for constructing meaning in new contexts	7. Focused on Students' Strengths Assessment . . . • Identifies what students can do and are learning to do • Identifies competencies in the development of knowledge, skills and strategies, and attitudes • Considers preferred learning approaches • Focuses on celebrations of progress and success • Provides for differentiation • Provides information to compare a student's performance with his or her other performances
4. Collaborative and Reflective Process Assessment . . . • Encourages meaningful student involvement and	8. Based on How Students Learn Assessment . . . • Uses sound educational practice based on current learning theory and brain research

reflection • Involves parents as partners • Reaches out to the community • Focuses on collaborative review of products and processes to draw conclusions • Involves a team approach	• Fosters development of metacognition • Considers multiple intelligences and learning approaches • Uses collaborative and cooperative strategies • Considers research on the role of memory in learning • Reflects current models of learning
5. Multidimensional—Incorporating a Variety of Tasks Assessment . . . • Uses a variety of authentic strategies, tasks, and tools • Is completed for a variety of purposes and audiences • Reflects instructional tasks	9. Offer Clear Performance Targets Assessment . . . • Encourages student involvement (setting criteria, measuring progress, working towards learning outcomes and standards) • Encourages application beyond the classroom • Provides a basis for goal setting • Provides students with a sense of achievement • Provides information that compares a student's performance to predetermined criteria or standards

Adapted From: Kindergarten to Grade 4 Mathematics: Classroom-Based Assessment, Manitoba Education and Training, 2000.

5.3 THE TEACHER'S ROLE IN ASSESSMENT

The ultimate goal of assessment is to develop independent, lifelong learners who regularly monitor and assess their own progress. In the classroom, teachers are the primary assessors of students. Teachers design assessment tools with two broad purposes:

1. To collect information that will inform classroom instruction and,
2. To monitor students' progress toward achieving year-end science learning outcomes.

Teachers also assist students in developing self-monitoring and self-assessment skills and strategies. To do this effectively, teachers must ensure that students are involved in setting learning goals, developing action plans, and using assessment processes to monitor their achievement of goals. Teachers also create opportunities to celebrate their progress and successes.

Teachers learn about student learning and progress by regularly and systematically observing students in action, and by interacting with students during instruction. Because students' knowledge and many of their skills, strategies, and attitudes are internal processes, teachers gather data and make judgments based on observing and assessing students' interactions, performances, and products or work samples. Teachers demonstrate that assessment is an essential part of learning. They model effective assessment strategies and include students in the development of assessment procedures, such as creating rubrics or checklists.

Assessment Purposes and Audiences
The quality of assessment largely determines the quality of evaluation. Evaluation is the process of making judgments and decisions based on the interpretation of evidence gathered through assessment. Valid judgments can be made only if accurate and complete assessment data are collected in a variety of contexts over time. Managing assessment that serves a multitude of purposes and audiences is a challenging task. Teachers must continually balance the assessment of their students' progress in the development of knowledge, skills, strategies, and attitudes with the purposes and audiences for the information collected.

Purposes of Ongoing Assessment
Ongoing assessment helps teachers decide:

- Whether students have mastered certain learning outcomes
- Whether they are making progress in attaining other learning outcomes
- Which learning outcomes need to be the focus of further instruction and assessment
- Whether instructional resources, activities, and strategies need to be adapted
- Which tools would be most appropriate for assessment
- Whether individual students need alternative learning experiences or further support

Formative Assessment
Formative assessment is data collected about the individual students and/or the whole group during classroom instruction. Formative assessment is designed to guide instruction and to improve student learning. This is done by:

- Identifying specific learning needs
- Providing feedback describing students' performance

The instruments used in formative assessment provide information or data that teachers, parents/guardians, and students may use to identify factors that facilitate or hinder student learning. Possible assessment strategies/tools that can be used for formative assessment include:

- Observations recorded on checklists or in teacher notes
- Performance tasks with scoring rubrics
- Diagnostic interviews
- Group/peer assessments
- Self-assessment

- Paper-and-pencil tasks
- Science notebooks

NOTE: The thrust of formative assessment is toward improving learning and instruction. Therefore, the information should not be used for assigning marks as the assessment often occurs before students have had full opportunities to learn content or develop skills.

Summative Assessment
Summative assessment (evaluation) is based on an interpretation of the assessment information collected. It helps determine the extent of each student's achievement of identified learning outcomes. Evaluation should be based on a variety of assessment information. Summative assessment is used primarily to:

- Measure student achievement
- Report to parent(s)/guardian(s), students, and other stakeholders
- Measure the effectiveness of instructional programming

5.4 PUTTING ASSESSMENT INTO PRACTICE

There are many different types of assessments that can be used in the science classrooms and many different tools that can be used to make that assessment. It is important to keep in mind the purpose of assessment and when that assessment is taking place when making decisions about the tools to use. The following table illustrates one way of approaching assessment decisions.

	WHEN ASSESSMENT TAKES PLACE	TYPE OF ASSESSMENT	POSSIBLE ASSESSMENT TOOLS
Formative **or** **Summative** **Assessment** (depending on stage of learning and purpose for assessment)	DURING THE Learning Experience	OBSERVATION • to assess scientific inquiry skills, design process skills, group skills	TOOLS rating scales, checklists, ANECDOTAL RECORDS
	Following the Learning Experience	Product/Work Sample • MAY BE ASSESSED BY SELF, PEERS, AND/OR TEACHER	RATING SCALES, CHECKLISTS, RUBRICS, ANECDOTAL COMMENTS
		QUIZZES/TESTS • may be restricted or extended response	restricted response: answer keys; extended response: CHECKLISTS, RATING SCALES
		REFLECTION • INCLUDES PEER OR SELF-ASSESSMENT OF THE PROCESS AND/OR PRODUCT, AND GENERAL REFLECTION ON LEARNING	rating scales, checklists, dialogue/interview
		PERFORMANCE TASKS • synthesize a broad range of knowledge and skills from	RATING SCALES, RUBRICS

		previous learning activities, focus may be on the performance and/or a product • result in a wide range of complex PERFORMANCES	

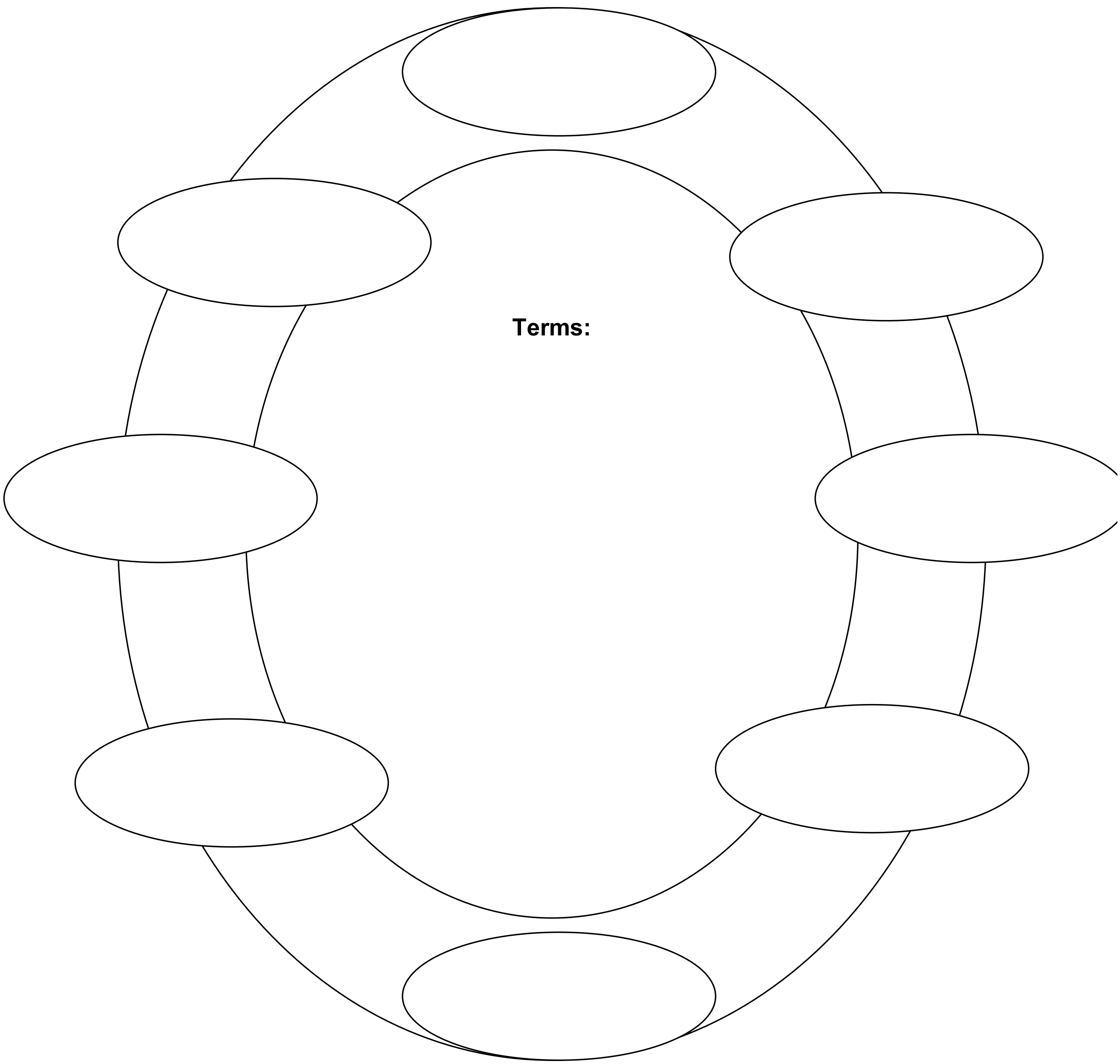
Source: Grades 5 to 8 Science:
A Foundation for Implementation
Manitoba Education and Training, 2000.

Appendices

APPENDIX 1: WORD CYCLE
APPENDIX 2: CONCEPT OVERVIEW
APPENDIX 3: FACT-BASED ARTICLE ANALYSIS

APPENDIX 1: WORD CYCLE

Select two words from the list provided in the diagram and identify the connection between them. Place the words in two adjoining ovals, with the relationship between the words written in the band that connects the ovals. Continue this process, adding connections to additional words, until the cycle is complete.



Adapted From: Senior Years Science Teachers' Handbook, Manitoba Education and Training,

APPENDIX 2: CONCEPT OVERVIEW

Key Word concept (written in a sentence):

Write an explanation or definition in your own words, i.e. paraphrase

Draw or find a figurative representation.

List facts (at least 5)

Create your own questions.

Create an analogy.

Adapted From: Senior Years Science Teachers' Handbook. Manitoba Education and Training, 1997.

APPENDIX 3: FACT-BASED ARTICLE ANALYSIS

Key concept (written in a sentence):

Write an article summary or definition in your own words. Do not list facts. Give an overview.

Draw a figurative representation.

List your questions (at least two).

What are the scientific facts? List at least five.

List at least 5 key terms.

Relevance today: This is important or not important because…

Adapted From: Senior Years Science Teachers' Handbook. Manitoba Education and Training. 1997.