

**Aboriginal Perspectives into the Teaching and Learning of Science Education:
Beginning the Conversations in Southern Saskatchewan**

Background to the Guideline	3
Background of Aboriginal Perspectives	4
Contacting Elders and Establishing Protocols	6
Overview of the Guideline.....	8
Collaborative Inquiry Committee Themes.....	9
Spirituality.....	9
Science	15
Interconnectedness.....	20
Good pedagogy	23
Medicine Wheel.....	27
Introduction to the Medicine Wheel	27
Diagram One: the Inner Circle.....	29
Diagram Two: The Second Layer.....	32
Diagram Three: The Third Layer.....	34
Diagram Four: The Fourth Layer.....	36
Approaching from the East: Reaching the Spirit	39
Approaching from the South: Reaching the Heart.....	42
Approaching from the North: Reaching the Mind.....	47
Conclusion: Full Circle.....	50
Bibliography for Further Resources on (Saskatchewan) Aboriginal Perspectives	51
Bibliography of Aboriginal Science and Aboriginal Science Education-related items....	59
References.....	65
Appendix: Collaborative Inquiry Committee Participants	67

Background to the Guideline

This guideline emerged from a research project aimed at fostering collaboration among a diverse group of Aboriginal and non-Aboriginal educators and Elders. The purpose of this group was to begin the conversations to envision, discuss, and clarify a philosophy and framework for Aboriginal science teaching and learning in Southern Saskatchewan, Canada. The research committee, called the Collaborative Inquiry Committee, consisted of Elders, teachers of Aboriginal heritage, the director of the Royal Saskatchewan Museum, the science consultant from the Saskatchewan Science Centre, Aboriginal consultants from the Regina Catholic and Public School Boards, and university faculty from First Nations University and the University of Regina. The funding for this research came from a grant awarded jointly in 2005 by the Aboriginal Education Research Network and Saskatchewan Learning. The Collaborative Inquiry Committee met five times during the first half of 2005, and the conversations that emerged from those meetings formed the basis of this guideline. The Collaborative Inquiry Committee did not intend to generate science content, but to share Southern Saskatchewan Aboriginal perspectives, including an interpretation of a Medicine Wheel, so that teachers could more deeply engage with existing materials and develop the knowledge base and confidence to generate resources that included Aboriginal perspectives appropriate to the teaching and learning of science and the needs of Saskatchewan students. This small group of people came together to initiate conversations that is hoped will continue across the province. It is hoped that each community will come together and write for its own community's needs in this area. Communities in Saskatchewan may have similar views as those expressed in this document. This represents a first, small, but much needed step.

Although we acknowledge the broader use, and worldwide populations described by the term Aboriginal, in this guideline the term Aboriginal refers to First Nations and Métis peoples of Canada. The first section of this guideline outlines perspectives the Collaborative Inquiry Committee believes is important for teachers to understand when engaging ALL Saskatchewan students in learning and thinking about science and related knowledge. The second section focuses on how these specific Aboriginal perspectives may be practically integrated into the new Saskatchewan Middle Years science curriculum.

This guideline has two goals. The first is to offer ways for teachers at all comfort levels to integrate Aboriginal perspectives into science education. It is our hope that teachers will continue to learn, grow and explore ways they can continually integrate Aboriginal philosophical bases into their classes so they can extend the philosophy of science and good pedagogy, and recognize Aboriginal knowledge as part of a Canadian legacy. The second goal for this guideline is to work with and alongside formal Saskatchewan educational documents such as the renewed Middle Years science curriculum. This curriculum incorporates the renewed *Common Essential Learnings*, and the *School^{Plus}* initiative. As this guideline was intended to be integrated into the new Middle Years science curriculum, it is hoped that teachers will be able to compare teaching resources or units presented in that (and other) curriculum to this guideline and reflect on the extent to

which Aboriginal pedagogy and process are being incorporated. It is hoped that this guideline and its presentation of concepts such as the Medicine Wheel will not be seen in any way as a definitive presentation of Aboriginal knowledge but will inspire and encourage teachers to work with Elders and to seek out reliable published materials to further their own and their students' understanding of this valuable intellectual resource. This guide provides suggestions about protocols, procedures and questions that may extend the teacher's capacity to incorporate Aboriginal perspectives and practices into the teaching and learning of science.

The need to integrate Aboriginal perspectives into the science curriculum in Saskatchewan is clear and immediate. Aboriginal populations are large and growing in the prairie provinces of Canada, and particularly in Saskatchewan. Currently the proportion of people in Saskatchewan with Aboriginal ancestry is about 14%. This number is expected to grow to about 20% by 2017 (Government of Canada, 2003). The changes in the Aboriginal populations of major urban centers is even more striking. The percentage of Aboriginal people living in Regina has risen from 4.0% in 1981 to 8.3% in 2001; in Saskatoon the Aboriginal population has risen from 2.7% in 1981 to 9.4% in 2001; and in Prince Albert, the population has changed from 8.3% in 1981 to an extraordinary 30.5% in 2001 (Peters, 2005; Government of Canada, 2003). The school-age portion of the Aboriginal population of Saskatchewan is also greater than that in the population in general: nearly 25% of the Aboriginal population of Saskatchewan is aged 14 and under; by comparison, about 20% of the general population of Saskatchewan is aged 14 and under. The educational attainment for the current generation of Aboriginal youth is extraordinarily low, as the 1996 Census highlighted that 78% of Aboriginal youth between the ages of 15 and 24 have less than a grade twelve diploma. This educational attainment severely limits workforce participation, as the unemployment rate for Aboriginal youth in Canada, based on this Census is 44%. Only 2% of Aboriginal has a technical or Vocational certificate or Diploma, and only 0.3% of Aboriginal youth have a university degree (Federation of Saskatchewan Indian Nations, 2002).

Due to these striking demographics, the Collaborative Inquiry Committee recognized the importance for educators to expand their understandings of science to include the philosophies and knowledge of Aboriginal populations. Elders Betty McKenna and Ken Goodwill tell us the journey to integrate Aboriginal perspectives into Western science and Western education systems will be an ongoing, cyclical process with no beginning and no end. In order for Aboriginal knowledge to be included, all Saskatchewan peoples (the descendants of immigrants, and the Aboriginal peoples) must work together towards understanding and honouring Saskatchewan's Indigenous people and worldviews. It is a collective responsibility.

Background of Aboriginal Perspectives

Many Saskatchewan Aboriginal teachings are held as oral traditions. Using written media such as this guideline to communicate philosophies, knowledge and histories is not the traditional way. However, the Collaborative Inquiry Committee decided to use written form, in order to make these ideas accessible to people throughout Saskatchewan

through a variety of media. The use of this written form is consistent with contemporary Aboriginal thought (Cruikshank, 1992). Graveline (1998) suggests that ‘paper stories’ are now being used as means of cultural preservation. Contemporary Aboriginal teachings include both written and oral forms however, the habits of thought or traditions associated with oral philosophies are common in both forms. Habits such as stories and story telling remain a common way to share knowledge and skill with the next generation in all Aboriginal communities.

The strength of Saskatchewan’s oral cultures lies in their flexibility. Oral traditions adapt stories: the Elder adapts the story to suit the various situations and the needs of the learners. The learner is at the center of any interactions in Saskatchewan’s oral cultures. The teller continually attempts to be open to what the learner knows and needs, and endeavours to be responsive to those needs. Part of this responsiveness lies in the flexibility in how the story is told. The underlying philosophy does not change, but the carrier of that philosophy, the story, may change dramatically depending on the needs of the learner. With this flexibility, however, comes the responsibility of understanding the central concepts associated with the philosophies being taught and ensuring that they are represented accurately. Only Elders who hold and share the stories can guide teachers and learners in using traditional teaching stories appropriately. This document encourages and reminds teachers to seek out and learn from these Elders as teachers incorporate Aboriginal knowledge in their classrooms.

This guideline should be viewed as a starting point from which teachers can explore Aboriginal philosophies and work to understand how they may interact with the philosophies of contemporary EuroAmerican or Western science education. To come to understand the philosophical perspectives of many Saskatchewan Aboriginal peoples, the developers of this guideline strongly urge teachers to engage with Elders, and the Aboriginal communities, and to work to develop mutually respectful relationships.

A Note

Alfred (1999) provides a warning, “if we don’t get a sense of who we really are from the old teachings, then all this traditional stuff is just going to become watered down in a couple of generations” (p.10). This warning confirms concerns expressed in the deliberations of the Collaborative Inquiry Committee and provides an overarching goal for this guideline. In Canada, and Saskatchewan, as in many other places, Western worldviews have assumed a position of such dominance that attempts to understand Aboriginal worldviews have been made only on Western terms. Thinkers and educators have usually compared specific instances of Aboriginal knowledge to ideas or concepts in Western knowledge and then, having, often erroneously, decided that they are the same, have gone on to teach them in Western ways and language only. The Collaborative Inquiry Committee is clear that Aboriginal knowledge must be understood on its own terms. This document seeks to bring many Saskatchewan Aboriginal perspectives forward in the voices of those who shared this traditional knowledge with us, and of those who asked the questions in order to encourage greater discussion and clarification. Nothing that is presented in this document is to be understood as definitive. The

document is a beginning. It is a place to find questions that must then be addressed to Elders, communities, and academics knowledgeable in the Aboriginal ways and contemporary science pedagogies. It is a place in which we can begin to imagine a more inclusive and respectful science education.

To develop a deeper understanding and appreciation for Aboriginal perspectives, it is imperative to reach out to the Elders, the experts, who hold this Indigenous knowledge. These people have been taught by their Elders from early childhood and have developed certain gifts. It must be remembered, too, that people cannot expect any one Elder to be able to help in all matters. Not all Elders hold the same knowledge. Therefore, it is important to ask the Elders what knowledge they specialize in. It is important to remember that while all who have lived a considerable time have valuable wisdom to share with us, not all who have lived long lives are Elders. Elders are those who have spent lifetimes learning specific bodies of knowledge, in a variety of ways, and who are recognized by their communities as such.

It is also essential to learn how to incorporate Elders and their knowledge into the educational system. Their experiences and knowledge are based on an oral tradition. Although the knowledge of some Elders has been included in books, Elder knowledge cannot be solely found in books. The Elders are the keepers of knowledge. It is their job to protect that knowledge and relay that knowledge in appropriate situations. It is knowledge to be shared, if and when it is appropriate. But one must ask to be taught in ways that are respectful and appropriate to the traditions from which that Elder comes.

Contacting Elders and Establishing Protocols

Regardless of how far along you are on your journey toward an understanding of Aboriginal perspectives and building relationships, it is important to know that resources are available. Contact and develop a relationship with an Elder or Elders in your area. Elders can be contacted through school boards in various towns and cities in Saskatchewan.

Estevan Public School Division
130 King St.
P.O. Box 1600
Estevan, SK S4A 2T4
Phone: (306) 634-4777
Fax: (306) 634-6768

Saskatoon Public School Division
310-21st St. East
Saskatoon, SK S7K 1M7
<http://spsd.sk.ca/>
Phone: (306) 683-8200
Fax: (306) 683-8207

Moose Jaw Public Schools
1075 9th Ave. N.W.
Moose Jaw, SK S6H 1V7
Phone: (306) 693-4631
Fax: (306) 693-4686

Swift Current Public Schools
Elmwood Education Centre
Mr. K. McIntyre, Acting Director
Phone: (306) 778-4600
Fax: (306) 773-8011

Northern Lights School Division #113
La Ronge Central Office
Bag Service 6500
La Ronge, SK S0J 1L0
E-mail: centraloffice@nlsd113.net
Phone: (306) 425-3302
Fax: (306) 425-3377

Regina Public Schools
1600-4th Ave.
Regina, SK S4R 8C8
<http://rbe.sk.ca/>
Phone: (306) 791-8200

- Equity consultant
- Aboriginal policy consultant
- Elders' Council

When interacting with Elders there are Protocols (procedures) that must be understood and followed. These are ways of demonstrating respect. Every society has its codes of respect and of courtesy. If you are not sure what the correct procedures in your community are, ask the Elder what he/she needs. Protocol in Saskatchewan almost always involves tobacco. The tobacco that you need to purchase is pouch (rolling) tobacco, and can generally be purchased where cigarettes are sold. Tobacco is very important to Saskatchewan Aboriginal people and must be presented to the Elder when seeking advice and/or information. This offering must be given before one begins on his/her learning journey with that Elder. The tobacco is used by the Elder to pray to the Creator and the ancestors to help you to learn the information and teachings you are seeking. It is not a form of payment for services, but an offering to be used in ceremonies. This is always done at the beginning of the meeting, not at the end. Every time you meet with an Elder you must present tobacco. The amount of tobacco expected varies from one Elder to another and it may not have to be the full pouch. Ask the Elder for her/his protocol and if need be, discuss your financial situation regarding the giving of tobacco.

Ceremonial prayer cloth may also be requested. This, too, should be presented at the beginning of a meeting with an Elder along with the tobacco. Prayer cloth is a one-meter piece of broadcloth of a certain colour. If you are not sure what colour is required, ask the Elder prior to visiting him or her. It is not considered improper to ask about any

aspect of Protocol. Once you are aware of the colour required, you can purchase cotton broadcloth to be used as prayer cloth at any store that sells fabric.

The most important point to understand when working with Elders is to know that it is okay to ask questions and make mistakes. We all make them. But after you learn that you have made a mistake, it is your responsibility to change for the next time and/or event.

It is important for women to note that if they are on their moon time (menstrual cycle) they will need to let the Elder know before taking part in traditional ceremonies and Protocols. Women on their moon time may affect the ceremony and make it difficult for the Elder to do his or her work.

It is also important to remember that the Elder must live in this physical world too. She or he needs support for daily needs. This may take different forms; honoraria, gifts, work, are all forms of support which the learner may offer the Elder. Again, it is not wrong to ask the Elder what he or she needs.

Overview of the Guideline

This guideline consists of two major parts. The first section introduces the four themes that emerged from the work and discussions of the Collaborative Inquiry Committee. These themes include spirituality, science, interconnectedness, and good pedagogy. Included in the discussion of the themes are subsections on how various perspectives and philosophies of contemporary science education pedagogy and Saskatchewan Aboriginal understandings are interconnected and how they differ. This offers possibilities for the emergence of new perspectives and practices in the teaching and learning in science education in all Saskatchewan schools. It is hoped that teachers employ this guide alongside other curriculum documents to re-envision science education.

The second section of this guideline presents a version of a Medicine Wheel. The Medicine Wheel is presented here as a tool for teachers to specifically explore what concepts are important in many prairie Aboriginal perspectives and how these can be integrated into the teaching and learning of science education to create balance and to highlight interconnection. The particular version of the Medicine Wheel presented here is based on discussions held by the Collaborative Inquiry Committee, with influences from the work of Diane Hill (1999) and Lillian Dyck (1998). There are many variations on the Medicine Wheel framework (Graveline, 1998). In Aboriginal ways of thinking, no one variation is considered superior; some versions are more appropriate to the historical understandings of certain people, and are more helpful for those peoples.

The conclusion of this guideline provides a bibliography of further readings of Aboriginal perspectives and Aboriginal Science.

A Disclaimer

This guideline provides a review of dominant Western science and science education that is not intended to dismiss science, for it cannot be denied that science plays an important role in lives of all people. However, the guideline begins to explore the limits of dominant Western science and to offer insights into how dominant Western science and science education currently works, and how it could work for healthy, inclusive democratic societies. This is presented so that we may begin to break down barriers and assumptions about the universality and ‘truthfulness’ of Western science as we have learned and taught it for generations in Western schools. Only when we can begin to question power relations will we be able to see how Aboriginal knowledge is an important part of the vast human heritage of understanding of the natural and social universe of which we are a part.

Collaborative Inquiry Committee Themes

Spirituality

The Collaborative Inquiry Committee suggests that the Saskatchewan curriculum move in the direction of using Saskatchewan Aboriginal worldviews to extend all Saskatchewan students exploration of science. To be inclusive and to honour Saskatchewan’s Indigenous people and their ways, spirituality and Aboriginal worldviews needs to be incorporated into Saskatchewan science classrooms.

Throughout the Collaborative Inquiry Committee meetings, the Elders said that it is through physical, mental, emotional and spiritual connections we are able to relate to the earth, our Mother. The two Elders, involved in this research, Elder Betty McKenna and Elder Ken Goodwill, agreed, stating:

...In our view of the world around, the cosmos I suppose, is that everything is sacred and everything in creation is sacred and powerful.
(Elder Ken Goodwill)

and

... We’re all born spiritual. ...we have a path, a spiritual path, that’s laid out for us and we grow within that. We each have a choice though to step off that path whenever we choose and not grown within it. Because the important thing about growth is that we grow physically, we grow mentally, we grow spiritually, and emotionally.
(Elder Betty McKenna)

The Saskatchewan Learning Common Essential Learnings (CEL) renewal draft document of Personal Social Development (PSD), says of spirituality:

The central aim of spiritual development is the cultivation of inner strength and the development of an outward focus of care, compassion, and respect. ...

Spiritual development refers to the exploration of a larger and more general framework of ideas, questions, and experiences related to the search for meaning and purpose – ones that recognize and nourish the human spirit in positive and respectful ways. (Saskatchewan Education, 2004, “Background”)

In the discussions of the Collaborative Inquiry Committee, views of Aboriginal spirituality and views of coming to understand what science would look like from an Aboriginal perspective could not be separated. From an Aboriginal perspective, science and spirituality, as with everything, are so closely interconnected that they cannot be viewed separately. Gregory Cajete (2000) suggests divisions do not exist between science and spirituality and states, “every act, element, plant, animal and natural process is considered to have a moving spirit with which humans continually communicate.” (p. 69)

Understandings of spirituality are fundamentally interconnected with understanding of Aboriginal science. To teach Aboriginal perspectives one cannot exclude spirituality. According to many Saskatchewan Aboriginal worldviews, spirituality is something one is born with and will die with. This varies with how religion is understood. Throughout the Collaborative Inquiry Committee discussions religion was discussed through a lens of a human endeavour of trying to understand and to teach about spiritual matters. However, the Elders spoke of spirituality being a gift given to people by the Creator. In this way of understanding, a person cannot replace his/her spirit because it is innate and never ending. However, a person can change her or his religion.

In many Saskatchewan Aboriginal perspectives, the idea of spirituality means there is a spirit in everything of the planet. Therefore, the spirit is shared with ‘all of our relations’, implying that all of Creation has a spirit, not just human life, and not just animal and plant life. Alfred (1999) comments on North American perspectives when he states, “native ideas centre on the imperative of respectful, balanced coexistence among all human, animal and spirit beings, together with the earth.” (p. 42). Elder Betty McKenna agrees and adds that we must include the universe and the cosmos in our understanding of the spirit.

...[our] water, our fire, our air, ...[our] rock - we're connected to all of those...

[we are] 75% water, ...we [must] breathe in and out ... we contain all those little bits and pieces that's out there. We have calcium, we have salt, we have iron, we have copper, zinc and potassium. ...[We] go from the universe right down to Mother Earth and that's us.

(Elder Betty McKenna)

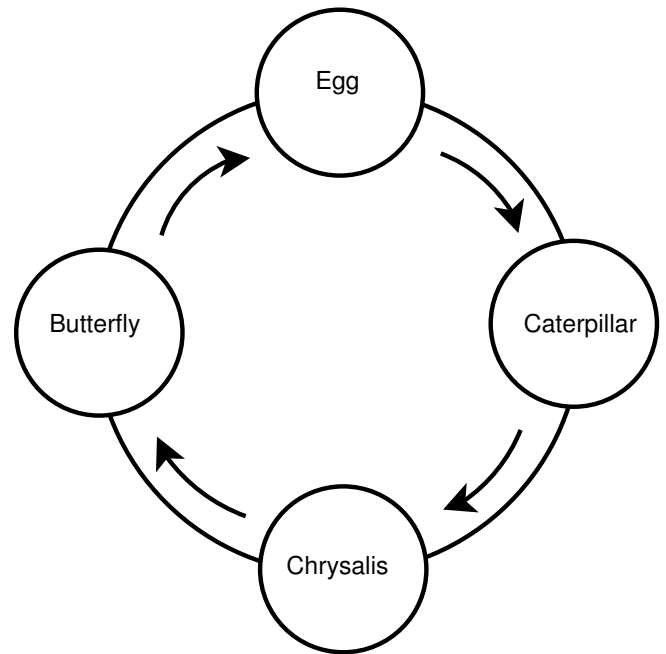
Aboriginal writers such as Deerchild (2003), Amadahy (2003) and Cajete (2000) further support this by clarifying that Aboriginal philosophies are not confined to the Mother Earth, but extend into the universe as everything has a spirit and is therefore,

interconnected. In this way, one part of Creation cannot survive without the other. As Deerchild (2003) explains:

“...the Earth is our original mother. All life comes from the Earth. She feeds us, clothes us and shelters us, in turn, we give her the highest respect. She is where we are born and where our bodies return when we die. This Mother Earth principle has survived [in Aboriginal worldviews], and there remains a deep respect and connect to the Earth. Many philosophies, values and ceremonies continue to revolve around this principle.” (p. 101)

Aboriginal learning needs to be understood as cyclical.

Western science highlights that nature is alive through cycles. These cycles continually repeat themselves; for example, the egg, caterpillar, chrysalis, and butterfly. Elder Betty McKenna uses this example to help gain understanding about the stages of how people learn. Some people are at the stage with a topic where they like the egg; they are processing and growing internally. Other people are at the stage of the caterpillar, moving around devouring and growing before your eyes, while others are at the stage of internal transformation. These people may seem visually quiet as they work to understand the workings of life around them. Other people are like the butterfly, free with a particular knowledge base and are able to be flexible, and flutter with the situation and be adaptable. In this way the educational process is viewed holistically. The Medicine Wheel also provides a philosophy for holistic education.



The teachings of the Medicine Wheel offer a model for inclusion of all students. This holistic educational philosophy is geared toward teaching the whole child. Holistic teaching from the Medicine Wheel begins with the individual and expands there from to include an Aboriginal view of human development: mental, spiritual, emotional and physical (Saskatchewan Education, 1991).

The notion of the Medicine Wheel is entwined with that of the Four Directions. According to Ernestine Buswa of the Ojibwe Cultural Foundation (Grigas, 1993),

Native Aboriginal people of North and South America have always used this age old symbol. This basic symbol is expressed in various different ways throughout the Americas, like the Four Grandfathers, the Four Seasons, and the Four Races. Like a mirror that can be used to see things that are not normally seen, the

Medicine Wheel helps us to see and understand things that we can't readily vision or understand because they are ... ideas or thoughts that are not physical objects that we can see or touch (p. 71).

Each nation, and even each Aboriginal individual, may have varying associations: different colours, different animals, etc., but general idea is the same throughout the Native people of North America and in particular throughout Southern Saskatchewan. The philosophy of the Medicine Wheel will be expanded upon later in this document.

Can teachers incorporate Spirituality in the (Science) Curriculum?

The incorporation of Aboriginal perspectives across subject areas, including science, in Saskatchewan schools is compulsory, not optional. *The Saskatchewan Education Aboriginal Education Provincial Advisory Committee Action Plan 2000-2005* notes, "school division/school personal and parents understand that the school's responsibility with respect to spirituality, in general, and Aboriginal spirituality in particular, is to increase awareness" (Saskatchewan Education, 2000, p. 9). It further recommends that, "schools and Aboriginal peoples [will] create and maintain successful partnerships" (Saskatchewan Education, 2000, p. 9). Such partnerships develop between communities who have common understanding of histories, traditions and languages. This has to be reciprocal; it cannot be Aboriginal people who have knowledge of histories, traditions and the language of non-Aboriginal peoples. For successful relationships, non-Aboriginal people need to acquire this knowledge as well.

Formalised Saskatchewan education policies and documents support this position. For example, the Saskatchewan *School^{Plus}* document acknowledges that, "Aboriginal peoples see their spirituality as inextricably part of their culture" (Tymchak, 2001, p. 105). Tymchak (2001) further suggests,

"What we need is a school culture and discourse that recognizes and respects differences, rather than one that erases them and thereby evacuates education of all spiritual significance" (p. 106).

Another document, the *Common Essential Learnings* draft document developed by Saskatchewan Education (2004) states,

"Spiritual development is one of the goals of education in Saskatchewan. It is incorporated into the Core Curriculum within Personal and Social Development (PSD), across subject areas, and through qualities and elements of school routines, relationships and ceremonies. The central aim of spiritual development is the cultivation of inner strength and the development of an outward focus of care, compassion, and respect." (p. Background)

This document, written by the provincial body that governs formal education continues to make a clear distinction between a student's spiritual development and religious education. The Common Essential Learning draft document states, "religious education

focuses upon the particular beliefs and practices of specific, institutionalized religions and is not part of PSD [Personal and Social Development]. Spiritual development refers to the exploration of a larger and more general framework of ideas, questions, and experiences related to the search for meaning and purpose – ones that recognize and nourish the human spirit in positive and respectful ways” (Saskatchewan Learning, 2004, n. p.). The document continues, “...the needs of the spirit are recognized as part of the development of whole persons” (Saskatchewan Learning, 2004, Background).

The provincial curriculum writer and developer for the Saskatchewan science curriculum also adds his supports to the formalised movement to include Aboriginal spirituality in science classrooms in Saskatchewan.

To me it came out loud and clear from Ken and Betty that spirituality is at its essence, about day-to-day living. ... I think it's pretty easy for teachers to get that, and with the new Common Essential Learning of Personal and Social Development being more focused on spirituality, I think that makes a very strong connection. ... spirituality is in the Common Essential Learnings first, and then automatically can be in all the curriculum documents.
(Dean Elliott)

Some suggestions for teaching

1. Have yourself and your students begin by simply sitting next to a tree or elsewhere on Mother Earth's ground. You can feel Mother Earth's energy and tranquility transfer to your body. This experience can be used simply as a relaxation technique or it can be the beginning of connecting and understanding her elements – the rocks, Mother Earth, the plants and the animals.
2. Rocks can also be used in the classroom when you are using a Talking Circle. Note that in the Saskatchewan prairie cultural Talking Circles, the rock is passed in a clockwise direction and the person holding the rock is the only one talking. Everyone else must be actively listening. This rock not only identifies the speaker and helps develop a respect for the speaker, but it also helps others develop active listening skills (See page 23 for more information about Talking Circles).
3. When examining the human body and the heart in a science classroom, one may investigate how the heart beats when it the body is resting, when it is physically active or when it is experiencing an illness. There is a belief that the vibrations in the heart's walls send us messages, telling a story. The musical instrument the drum, used in traditional ceremonies, signifies the heartbeat of Mother Earth, from which we all come. It is the belief that this heartbeat also has many different rhythms. The drum is used at ceremonies and powwows.
4. Upon examining the body's composition, you will find that we contain all of the elements of Mother Earth. We contain minerals, water, fire [energy] and air. We can look at what parts of the body make up air, water and minerals and how these interact to

support a healthy lifestyle. We can look at how when one part of the body's needs are out of sync, it can directly effect entire body. For example, when a person is lacking iron in their system, they may feel lethargic. A blood test may discover this. We are composed of all of the minerals that the planet is made of. This interconnection is so strong that the Earth provides all the minerals we need to become healthy if we are lacking. In the case of iron, in Saskatchewan this can be gathered through plants such as beet leaves, spinach and dandelion leaves, to name a few.

5. Visiting Claybank in Saskatchewan provides you an opportunity to see a Sacred Circle, which some call the Medicine Wheel. Visiting this site with an Elder may help your students come to understand Aboriginal knowledge. An Elder may help you explore with the students questions such as: How did the rocks get there? What meaning do they have? What kinds of teachings were taught in the Medicine Wheel using the symbol of the circle? How does wheel connect us to Mother Earth and the cosmos? Before you visit the wheel, go to an Elder with tobacco and ask for help in beginning to understand this knowledge. Ask the Elder to help explain to your class the meanings and significance of the wheel and relate it to everyday life in simple terms for the students and yourself to understand.

6. The many uses of plants as medicine are a good place to start many scientific investigations from Aboriginal and Western perspectives. For example:

Yarrow for making tea can be used for stomach aches. Rose osier can be used an antibiotic soap for wounds. Berries such as strawberries, Saskatoon berries, and rosehip are full of vitamins and nutrients and can be used for healing. Ask an Elder to help you find these plants and explain how and why they were used in everyday life.

You and your students can ask how each plant is special. All plants are special, but some have purposes that aid humans. What purpose(s) did each plant have? Where did they learn their information about these plants? When is it appropriate to talk about these plants and when is it appropriate to use them?"

7. The rhythm of the seasons is also taught using the idea of a Circle, or the Medicine Wheel. Each season has its own knowledge and gifts. One best learns the gifts of the season each at its particular time, where it is found on the wheel of the seasons or on the wheel of life. For example, talking about berry picking in January in Saskatchewan does not make sense. For this province, to learn about this activity would be out of sync with Mother Earth's rhythm of life. Explore with the students the rhythm of life. Explore the rhythm of their lives, from the everyday, to the annual to the larger picture.

No problem can be solved from the same consciousness that created it.

Albert Einstein.

Science

Science is the art and process of explaining the world around us. Science education, then, is the pedagogy associated with the teaching and learning of these explanations of the world. Science is usually understood as a single voice around singular concepts, but this is far from the reality of what science is. There are multiple understandings of science and the concepts that make up science. The most common understandings of dominant Western science are built from Newtonian images of the universe where everything is separated into parts that allows for us to engage in ways to ‘objectively’ perceive and predict in the world. This philosophy, originating from a certain time and place, has influenced all aspects of dominant Western thought and lifestyle, and is still predominant in the theory and practice of dominant science education.

This is not the only current understanding of contemporary science: innovative images and metaphors are emerging from a ‘new’ understanding of science offering other ways of understanding the world around us. Quantum and chaos theories offer changes in how we have come to make sense of concepts such as time, space, matter, objects, and cause and effect, and have had a dramatic impact on how we view science. This understanding of Western science shows us that there is not *the* answer, to *the* objective reality, but *many* perspectives to make sense of what is continually changing. Within these many perspectives, Western science offers *one* picture, a constantly changing picture, of how the world might be understood. It is a picture based upon what one culture, the dominant culture, believes to be the best understanding that can be currently found.

The idea that science is culturally derived and dependent on the worldview and/or paradigms of the society in which it was developed has significant opportunities for contemporary science education. The teaching and learning of modern scientific concepts and discoveries are important to people living in Western societies, but the story of science they present is often narrow and distorted.

The challenge for many science teachers is to present science knowledge, knowing that it is only *one* way, a strong, but culturally defined way, of making sense of the world. Science education depends on the perspective of those who teach it. It can leave out the sacredness of life while claiming to be *the* authority and *the* truth about life. Students can explore Western science as a valuable, credible, usable perspective on the world, but one that has limits. By acknowledging the limits, and the cultural biases of Western science, students can understand that other ways of knowing how and why the world works.

Similarities between Contemporary Science Education and many Saskatchewan Aboriginal philosophies

Quantum physics and chaos theories highlight that our world is constantly changing. The assumptions of Newtonian physics: that things can be taken apart and put back together without any significant loss, is in question (Wheatley, 1994). Rather than focusing on ‘things’, quantum physics and chaos theory are more in line with many Aboriginal philosophies that emphasize relationships. Many Saskatchewan Aboriginal

philosophies maintain that ‘things’ do not exist independently of each other, but are best understood through their connections. This common movement towards holism and in understanding systems as systems, rather than as discrete parts, offers possibilities for exciting new ways of teaching and learning science.

The principles of chaos theories show us that systems are constantly changing and evolving and as such, are outside the predictability of science. They exhibit random patterns not fixed ‘realities’. This parallels the beliefs of many Saskatchewan Aboriginal peoples. Cajete (2000) describes both Native science and chaos theory as showing all things are irrevocably interrelated to the degree that even small things can have influences in ways that are unpredictable and may lead to change.

Differences between Contemporary Science Education and many Saskatchewan Aboriginal philosophies

Saskatchewan Aboriginal cultures teach ‘science’, the interconnectedness of the cosmos, through stories and lived participation in the natural world. To help them to develop a deeper understanding of the world, many Aboriginal teachings encourage students to participate in nature and experience concepts associated with logic, and rational empiricism, as well as those that enable students to be open to sensations, perceptions, imaginations symbols, emotions and spirits (Cajete, 2000).

Hands-on or participatory (constructivist) forms of dominant Western science education also ask teachers to create opportunities for students to explore their understandings of the world. They encourage the development or modification of ideas to reflect the current understandings and beliefs of the scientific community (Hodson, 2001). The goal of constructivist approaches to science education is to encourage students to more fully understand, through hands-on experiences that engage the curiosity and mind of the learner, the concepts and ideas of the contemporary scientific community. In this way, the learning of science must be understandable and reasonable to the student, while at the same time providing possible new ways to think critically, problem solve and communicate their scientific literacy.

Promoting scientific literacy, through understanding rather than memorization, is central to the interactive, constructivist methods of learning science. Learners are asked to think, reflect and articulate their ideas. The teacher provides learning opportunities and asks questions rather than lectures. Exploring students’ beliefs is central to this process. However, not all beliefs are equal: if the goal is to enhance scientific literacy, then only those views that mirror the knowledge, values, understandings and codes of practice of the scientific community are accepted as scientifically “correct.” Hodson (2001) argues that students undergo a process of being enculturated into the knowledge, values, beliefs and practices of the scientific community.

To many Saskatchewan Aboriginal cultures experiential learning, indeed science learning in general, is not about the movement towards knowing a concept that is currently accepted by the scientific community, but rather it emphasizes process as a way of

teaching habits of mind, not outcomes. Truth to these Saskatchewan Aboriginal cultures is not a fixed point to be found, but an ever-changing point of balance where a person engages in a process of coming to know. Cajete (2000) states, “Native science at its highest levels of expression is a system of pathways for reaching this perpetual moving truth or ‘spirit’” (p.19). As in chaos theory, this implies that an individual or group has the ability to influence the relationships around them by their own visions and actions. The cosmos is not static; it is alive with moving relationships that can change through ‘the butterfly effect’. The ability of one action to influence something else implies that a rain dance, properly done with the mind and spirit, can bring physical, social and spiritual change. The spirit in all things is interconnected and open to all things, through continual and creative participation and respect. The concept that everything has a spirit is central to understandings of many Aboriginal views of truth and the world. To teach from these Saskatchewan Aboriginal perspectives, means teaching and learning about the sacredness of everything and how interconnectedness and patterns offer insights into a person’s ability to generate change.

Knowledge in many Saskatchewan Aboriginal cultures does not just come from mental processing. A version of the Medicine Wheel highlighted in the next section addresses four ways of knowing in Saskatchewan Aboriginal cultures and how these ways of knowing could be integrated into the teaching and learning of science. Briefly, these other ways of knowing include the physical or experiential, acknowledging the emotional dimensions of life, and the intuition or spirit-derived forms of knowing. In Western cultures the spirit-derived source of knowing may be least understood. In Saskatchewan Aboriginal cultures, education is used to help individuals gain knowledge about their purpose or calling in life; knowledge derived from spiritual guidance helps in this process. Spiritual guidance also provides knowledge about the natural world and aids in the process of coming to know. Ceremonies evolved as techniques for coming to know, so too did visions. This learning process involves a reciprocal relationship with the spirits that requires a person to be open and to follow the person’s intuition. In this approach to learning, students use their intuition about the images, perspectives and symbols around them to integrate knowledge, and work at creating understandings of the evolving relationships around them. Traditional stories are an important part of understanding relationships by enhancing the journey of coming to know.

The Medicine Wheel offered in this guideline provides insight into how a teacher might be able to explore each of the four ways of learning when teaching Middle Years science.

Some suggestions for teaching

1. Re-imagining science education in Saskatchewan that is respectful and inclusive is more than just exploring process. It involves being dedicated to integrating Aboriginal perspectives and knowledge. Students must understand that knowledge from Western science is subjective, changing and partial, not complete or objective, neutral and bias free. Teachers need to explore with their students the beliefs and assumptions that are embedded in science and science education. These beliefs hold positions of power within our societies. When we do this we privilege these concepts. Western science has shown

itself to be useful knowledge. But it is not the only possibly useful way of knowing the natural world. Nor is it the 'right' way of knowing. Certain ways of understanding the world have become common in Western culture, not because they may be 'the answer', but because they were the only ideas allowed to be heard and allowed to be explored. This was because they are aligned with the way the people in power made sense of the world at that time. Whose voices have been historically left out of science? Ask the students to name scientists...how many are woman? Black? Aboriginal? Asian? Etc. What is the age group of the scientists they name? What does this say about the images of science we are presenting to students? Ask the students to draw a scientist...what gender do they 'naturally' choose? Does this mean that only white men can really do science, or that they were the only ones who were historically given the opportunity? What might science look like through the lens of other people, influenced by other gender and cultural perspectives? Explore these ideas yourself, and the with your students.

2. Visit the First Nations Gallery at the Royal Saskatchewan Museum in Regina (<http://www.royalsaskmuseum.ca/>). Before you go to the museum tell your students stories about the museum. Ask them about what a museum is. What do we think about something that is in a museum? It is important to ensure that your students don't think that the knowledge represented in the Gallery is 'dead' knowledge. If they hear about the Elders and communities who helped to put together the museum display and about their hopes and dreams for it, then they will begin to understand that this is living and useful knowledge. It is very important to the people whose heritage it directly represents and it is important to us all because it is our heritage too. Ask your students to observe carefully and try to determine the scientific knowledge that the Aboriginal persons must have possessed to live successfully in their world in the past. Have them pay special attention to the displays that show how this knowledge remains useful today. When they return to their classrooms ask them to tell each other stories about how they might use the science knowledge they saw. Use this as an introduction to a project activity where students research Aboriginal scientific knowledge.

3. Visit Wanuskewin Heritage Park in Saskatoon. Activities at this park may be like those at the First Nations Gallery. Wanuskewin Park has the wonderful advantage of being outside. As your students experience it help them to imagine the lives of those who treasured it in the past. What must it have been like to live there? What knowledge would you need to live there? Most importantly, this is a spiritual place as well as a social and scientific one. Help them to connect with its beauty and peace. Story telling that helps them to do this must be careful not to degenerate into 'ghost' stories.

4. Visit the Native Studies 10 Evergreen Curriculum. This curriculum contains resources that can be adapted for use in science classrooms at all grades.

5. *The Keepers Series: of Life, of Plants, of Animals* are extremely useful resources. They may be adapted for use at all grade levels. *Green Teacher* magazine (www.greenteacher.com) may also provide useful resources.

6. There are many special monuments and sacred places of the Aboriginal people in Saskatchewan. *Monuments in Stone* (Brace, 2005) describes many of them. If one or more of them is near your community, ask the community and the Elders to teach you about them. When you and the Elder are sure that you are knowledgeable and ready, ask him or her to help you plan and carry out a field trip as well as the pre-trip and post-trip activities.

Interconnectedness

A difference between what is generally agreed upon in dominant Western science, and therefore dominant Western science education, and many Saskatchewan Aboriginal perspectives is the classification of the planet around us. In Aboriginal perspectives all things are interconnected and have individual gifts and a spirit. All is therefore dependent on each other and unfold into a web where the self is a reflection of the whole and is also integrated into the world as a whole. In this classification system trees, rocks, mosses, wind, indeed, everything has spirit and are sacred.

You know, we tell our people, you know when you have problems, you're in a dilemma, go out sit on the ground. Go lean against a tree. There's an energy transfer. It settles you down, relaxes you, and if you want to pray, if you want to talk to that tree, you want to talk to mother earth.

(Elder Ken Goodwill)

The hugest unknown resource is the wind, and the weather, and ground itself. It's just like children are so out of sync with the rhythm of life. You know you go out and the geese are coming back, you know you're picking up that energy, you're starting to feel that, a whole different feeling.

(Elder Ken Goodwill)

We have animals and snakes and bugs that poison and bite. Why do we have those...is that one time into the world came this whole big thing called poison and it was going to destroy the whole world and all of the little things came forward and took a little piece of it, so nothing would have all of it. That's why we have little bugs and snakes and things that bite because they all took a piece of it. So when everyone takes, when we say it's too huge or too big, it looks like it will destroy the world, everybody pitches in and takes a little piece.

(Elder Betty McKenna)

I was told the year I was born that the moose were very plentiful. My parents said they ate moose that year, not as much fish as they would any other year. Lots of berries, it was a good year for berries, and you know, we are what we eat. And being created, we are created from those parents who eat those foods. I have a little grandson. He's a year old. And I've watched my daughter eat. My grandson is ah made up of ah cheese whiz and Kraft dinner I think, certainly not moose and blueberries. But I don't know how his relationship with Mother Earth is going to be.

(Elder Betty McKenna)

This Aboriginal understanding of the world varies from the classifications of science. For example, the socially agreed upon scientific knowledge still categorizes the world into biotic (living) and abiotic (nonliving) systems based upon specific criteria that involves gas exchange, reproduction etc. Within these categories judgments of worth are

seemingly omitted as the world is assumed to be equally and neutrally classified. The teaching of these categories is conducted as if they were separated or removed from their derived cultural backgrounds. This is different from Southern Saskatchewan Aboriginal thought where the cultural philosophies underpin all understandings. Dominant Western thought tends to teach science as if it operates in a cultural vacuum, but Western cultural hierarchical notions of what is worthy of respect or protection, and what is not, are consciously and subconsciously taught alongside science. As dominant Western science education and science teachers rarely address the assumed values associated with what is worthy of respect and/or sacred and what is not, science students are taught about the interconnectedness of life from a technical point of view, but not from a reverence point of view. Some fractions of contemporary science and science education argue that this technical approach to understanding the world is part of the reason why Western lifestyles are so destructive to the planet.

Even though dominant forms of scientific thought, and dominant forms of science education, may categorize the world this way, not all scientists, or science teachers, agree with this classification. There is a growing minority of scientists and science educators who argue that the cost of promoting this version of understanding to future generations is destructive. If science is a continually changing, but currently agreed story that we use to make sense of the world around us, then the limitations of how we categorize the world and the consequences of those limitations need to be explored. Rather than assuming these categories as 'correct', as science teachers, we could introduce the historical and cultural backgrounds of scientific thought and explore with our students the benefits and limitations of these thoughts. We could introduce, through a variety of methods, Saskatchewan Aboriginal philosophical understandings and discuss how this knowledge provides another way of making sense of the world.

Similarities between Contemporary Science Education and many Saskatchewan Aboriginal philosophies

The current groundswell at the local, provincial, national and international level to address issues relating to ecological sustainability and climate change is a point of contact between dominant and marginalised science perspectives, and Aboriginal perspectives. Even though there are diverse viewpoints and beliefs within and amongst these perspectives, there is a common goal of teaching the reverence of interconnectedness of everything on the planet. A common understanding is that all people should maintain and sustain a healthy, functioning ecosystems and that supports and protects all species. All things provide humans with life-support services while nourishing us aesthetically and spiritually. Furthermore, everything on the planet must have its own right to exist without the threat of human destruction. This understanding of the interconnectedness of the planet, to various degrees, will be included within the new Middle Years curriculum. Its inclusion offers teachers the possibility to encourage students to understand the interdependence of all aspects of the planet and to reflect and act on the repercussions that their actions and decisions may have both now and in the future on the local and global environment.

Differences between Contemporary Science Education and many Saskatchewan Aboriginal philosophies

Dominant Western science is based within the philosophies of dominant Western culture. Those who have grown up within this culture perceive it not as a *culture* but as *normal*, so the teaching of dominant science philosophies may also seem normal. However *normal* science philosophies and practices may seem to some people, they are also perceived as *different* to those who might have been raised with different cultural understandings. The ability of teachers to introduce multiple understandings of how people make sense of the interconnectedness of the planet allows for all students to explore and discuss the cultural aspect of science that is usually missing in the teaching of science. This inclusion of other ways of making sense of the planet's interconnectedness also allows for both the teacher and the students to investigate what it might mean for the spirit to be included in everything. The incorporation of the spirit can be taught multiple ways, but its inclusion is mandated by formal Saskatchewan education documents, as the section on Spirituality highlights.

The concept of spirituality for Aboriginal cultures is similar to that of many of the worlds' cultures, in that the spiritual infuses the person's entire existence and underpins how one relates to the world. Saskatchewan Aboriginal cultures acknowledge that a spiritual person cannot make sense of anything in isolation from their spiritual path, which is why the philosophy of interconnectedness cannot be taught without acknowledgment of the spirit. The philosophy of interconnectedness promotes the ongoing process of encouraging the individual to move towards experiencing connection to themselves, their family, their communities, societies, and to the earth.

Some suggestions for teaching

Consider how you as a teacher promote this connection. Here are a few examples that might help you:

- How might you introduce the idea that everything has a spirit?
- Is there an Elder who can speak to your class and how might you develop a unit around this?
- Reflect on what your personal beliefs on this philosophy are and how might this influence your teaching and learning of it?
- Explore through listening (or some engaged media) to what your students respect and why? What do they believe society respects and why? How do they think they have come to know this information? What impacts on the planet do they think this philosophy might have over the long term as compared to the Aboriginal philosophy? What future do they want for their children?
- Ask the students to be involved in ethical conversation about 'simple' lab experiments you do that involve plants or animals (should classes be doing lessons that to any degree harm plants? What does collecting pond organisms to look under a microscope and then washed down the drain really teach your students about respect and sacredness?)

- In what ways can you listen to your students about their concerns for the planet and help them find ways to connect to their communities and do something about making a difference?
- What ways do they want to explore learning about respecting the sacredness of world around them and how does this relate to their own spiritual path?
- Can you take the students outside and have them explore the wonders of the world around them?
- Within the confines of the school, can you take the students to an all-concrete place and an all-natural place and ask the students to describe the difference? If we don't respect the natural places, and only have the concrete, what would they think about living in a world like that?

Good pedagogy

As it is a legal requirement of Canada to attend formal education to a certain age, most people living in Canada have had contact with the formal education system. Even though experiences with education systems are as varied as there are people, most people have stereotypical assumptions of what contemporary education looks like based on their own experiences that occurred many years previously. These experiences can be dramatically different from the realities of education today as pedagogical theory and practice, like any other thought, has continued to grow and evolve. Student teachers taught at Faculty of Education today are exploring pedagogies that are dramatically different from approaches that were taught years ago. How a teacher has learnt to engage with students is complex, but the pedagogical philosophies taught at the time a teacher undertook their educational degree impacts what teaching methods an educator may use in a classroom.

Similarities between Contemporary Science Education and many Saskatchewan Aboriginal philosophies

Many Saskatchewan Aboriginal perspectives of how learning is facilitated are similar to contemporary theories of student-centered, engaged (science) pedagogy. Both seek to activate students' innate enthusiasm for learning and discovery, and treat the child's knowledge with respect and compassion. In contemporary science pedagogical concepts such as constructivism, students reflect on their prior knowledge and experiences to cooperatively and collaboratively negotiate personal meaning in self-directed and peer-taught ways. Extending further, contract-based learning approaches encourage students to collaboratively work with the teacher to decide what their learning needs are, what goals they would like to formulate, and what content they would like to learn, and how they, and others, might know they are being successful at achieving their goals. In this way, the student owns what is relevant and meaningful to the learner, with the teacher acting as a mentor and facilitator. A further commonality is that learning is viewed as a lifelong process, where the task is not necessarily to instill all the needed information at one time, but to inspire curiosity, and a desire, and skills to further learning.

As with many Saskatchewan Aboriginal cultures, contemporary pedagogy acknowledges that people learn in different ways and at different times. There are many commonalities

in what Saskatchewan Aboriginal cultures have long since used as teaching approaches and what is considered today good pedagogy in Western science education. There are also points of departure that can allow for the habits of mind, important to Aboriginal philosophies, to be introduced to enrich the teaching and learning of science for all students in Canada.

Differences between Contemporary Science Education and many Saskatchewan Aboriginal philosophies

Saskatchewan Aboriginal cultures emphasize whole person learning that include the spirit forms of knowing, emotional or feelings aspects of learning, physical or task orientated experiences, and mental or informal forms of knowing. In the next section we explain an interpretation of the Medicine Wheel that may be a useful guide to explore how a resource or unit can be compared to the Medicine Wheel in order to see what is missing and what could be added to start to teach and learn from the four directions.

A point of departure from the dominant understanding of contemporary Western cultures is many Saskatchewan Aboriginal cultures instilling of certain habits of mind about listening and talking. Proper conduct around speaking and listening has built communities that value and understand what talking too often, too long means and maybe more importantly, what it means to sit and actively listen. Talking circles and Talking sticks are essential to the teaching and learning of listening and hearing where all people take responsibility for maintaining focus on what each speaker is sharing, and for processing their own emotions and thoughts about what is said. Graveline (1998) reminds us that speaking is a privilege and that words are powerful, and sacred, and should be treated as such.

The use of Talking Circles and Talking Sticks in a classroom can help both the teacher and student build communities that can honour Aboriginal philosophies while also strengthening science pedagogy by encouraging students to talk about what they know and believe about science concepts or impacts. Listening to the voices and understandings of students about any concept will allow the teacher to make sense of the students' prior knowledge. Gaining insight into how students' make sense of the topics they are learning will provide guidance for what activities or information needs to follow for the students to more deeply engage in the concept that is being presented. Talking Circles provide formal structures and protocols for students to speak and be listened to. The protocols have historically been put in place to generate places of respect and trust. The use of Talking Circles and Talking Sticks in science education can be a great asset when seeking to listen to student voices.

Some suggestions for teaching

Talking Circles

Talking Circles are both a philosophy and a method. They are congruent with the values and beliefs of many Saskatchewan Aboriginal cultures because they emphasize disciplined listening and valuing of every person and his or her contributions to the common effort to understand or to solve a problem. A Talking Circle can take many forms and follow many protocols in differing First Nations, and indigenous peoples worldwide. In this report and the accompanying Guideline we will provide an explanation and some general protocols which are close in practice and spirit to many of the versions of the Circle which are found in the prairies of Canada and the United States.

Talking Circles are a philosophy that emphasizes the social construction of knowledge and community. They are born of the consciousness of the Spirit that pervades most Aboriginal philosophies. All that exists in Creation is sacred. Sacred in this usage means precious, worthy of respect, essential to the existence of all. Respect for others and for their contributions is at the heart of the philosophy of the Talking Circle. Talking Circles are an expression of the understanding that all beings, all Creation is related. No part can exist without the others; no part is hurt without the others also being hurt. This principle is central to Aboriginal knowledge and life, and so to Aboriginal educational philosophy and practice.

Practically, the Talking Circle is a procedure where a group of persons sit in a circle and talk about an idea, an issue or a problem. When someone is talking everyone else listens. Each person is attentive and receptive to the speaker. A person does not simply remain silent while waiting for a chance to talk as so often happens in discussions. No one may be interrupted when talking in the circle. One person may begin the circle, and usually an Elder will provide a prayer and give advice to guide the participants, but no one is the leader of a circle. Everyone knows his or her responsibility to take part by talking or practicing attentive silence, to follow the protocols, to be respectful to all present, to carefully consider the issue or idea under discussion and to use their own knowledge and gifts to help achieve the purpose of the circle, which is the nourishment and maintenance of all in their society.

To understand more about the use of Talking Circles and Talking Sticks we have included an excerpt from the Saskatchewan Native Studies 10 document (<http://www.sasked.gov.sk.ca/docs/native10/>) that has reprinted information from Four Worlds Development Project (1988):

Talking circles may also be useful to:

- Introduce new ideas/concepts
- Teach the significance of the circle for various Aboriginal cultures
- Promote respect for the opinions and ideas of others

- Develop a trusting environment where students feel free to express thoughts, ideas, and feelings
- Develop listening and speaking skills in a safe, affirming environment
- Respond to literature, other media, or important issues.

Guidelines for Talking Circles:

The group sits in a circle and each person has a turn to contribute. An object (stone, stick or other) can be used to signify whose turn it is to speak. The teacher facilitates by ensuring that guidelines are followed.

- Direct comments to the question or issue, not to comments that another participant has made.
- Avoid responding either negatively or positively to participants' comments.
- Silence is an acceptable response. There must be no negative consequences, however subtle, for passing.
- Show respect for others by listening when they speak.
- Explain that self-putdowns or putdowns of others are unacceptable.
- Ensure that everyone has a turn to speak.

The facilitator should model respectful listening and speaking by participating in the talking circle. The facilitator might also consider the size of the group. Small groups are preferable when students are uncomfortable speaking in a large group or when time constraints are an issue.

Medicine Wheel

Although there are many Saskatchewan Aboriginal perspectives, one thing that may be agreed upon is that a goal of education is to connect the learner to the cosmos. It is therefore appropriate to begin with a model of the learner from an Saskatchewan Aboriginal perspective.

Introduction to the Medicine Wheel

The Medicine Wheel is a recurring symbol in Saskatchewan Aboriginal thought, particularly for the Southern Saskatchewan First Nations peoples. The Medicine Wheel depicts the four directions of east, south, west, and north. These directions are presented in this order as they follow the rising and setting of the sun, showing the patterns and interconnections of cycles. As described in the previous sections, interconnectedness in Aboriginal philosophies is key; therefore each of these directions cannot be considered separately from the others. If we reflect on the cycle of a day and the cycles of the year, the Medicine Wheel starts in the east where the sun rises and in the spring where life begins anew. East is the direction of beginnings. This direction is associated with young children, with initial learnings and the laying of the foundations for understanding the world. The next direction is south. In the south, you can feel the sun at its fullest; it is the season of summer where the growth of life is at its peak. It is the direction that is associated with young adulthood, where life is being explored and tested. West is the direction of the sunset and autumn. It is a time for harvesting what has been planted, and participating in community. It is a time where adults act to strengthen and protect the life of community. Next direction in this continuing cycle that has no end, is north. North represents nighttime or the season of winter. This is a time of stillness and reflection where the earth gets a chance to regenerate. It is also the time of old age, a time where those recognized as Elders pass along their wisdom to the next generations. This direction, as signified by the life process of aging, is not something to be avoided, but respected for the accumulation and continuation of knowledge and wisdom.

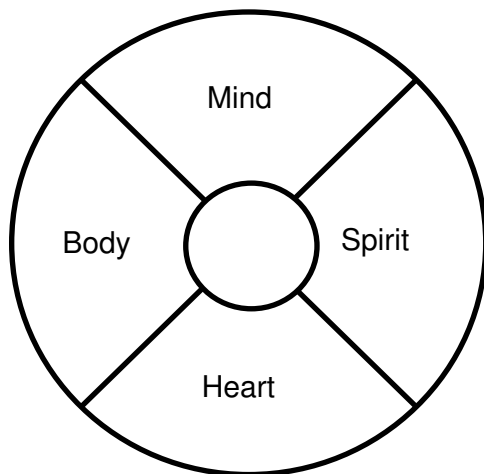
Grigas (1993) and many others (Bear & Bear 1980; Graveline 1998) discuss various associations with each of the directions of the Medicine Wheel. **East** is associated with morning; sunrise; the season of spring; birth and rebirth; light, joy, and spontaneity; the eagle; the colour yellow; the Asian race; and the sacred medicine of tobacco. **South** is associated with mid-day; noon; the season of summer; youth and vigor; preparing for the future; the mouse; the colour red; the Native American race; and the sacred medicine of cedar. **West** is associated with the afternoon and evening; sunset; the season of fall; adulthood; acceptance of ourselves as we are; the bear; the colour black; the Black race; and the sacred medicine of sage. Finally, **North** is associated with night time; midnight; the season of winter; old age; wisdom; the buffalo; the colour white; the Caucasian race; and the sacred medicine of sweetgrass.

The Medicine Wheel provides an opportunity to reflect on the interconnectedness of the land, (east, south, west and north), a 24-hour period (sunrise, noon, sunset, night), the seasons (spring, summer, autumn and winter) and the cycles of learning. The Medicine

Wheel depicts lifelong learning where the learner is acknowledged to consist of four parts, spirit, emotion, body, and mind.

The following Medicine Wheel describes these four parts. The representation chosen below is one of many possibilities. There are variations within and among nations and individuals regarding the layout of the Medicine Wheel. This layout was chosen based on information provided by the Collaborative Inquiry Committee.

Diagram One: the Inner Circle



Overview:

Saskatchewan Aboriginal perspectives maintain that people are born with all four aspects: the spirit, the heart, the body and the mind. The self/individual may be seen as situated in the center circle. However, each individual may be gifted in one aspect over another. Some people have strong spirits, others have great hearts, and others have powerful bodies or minds. One important task an individual has in life is to balance all four aspects by identifying and developing those in which they are weak. For example, a naturally gifted athlete might have to work harder to develop spirit, heart, or mind, or risk being out of balance. To be out-of-balance in Aboriginal worldviews is associated with imbalance in health. Medicine, or helping a person identify and seek balance, may be the origin of the term “Medicine Wheel”. The Medicine Wheel can help a person consider whether these four parts are in balance or not.

For an educator, the Medicine Wheel offers the possibility to reflect on resources or unit plans to see whether all four aspects are in balance. It is a chance to see whether our teaching is focusing more heavily on the mind or body, heart or spirit, or whether it is lacking one of these aspects. To integrate Saskatchewan Aboriginal perspectives into the teaching and learning of science education, all aspects of the Medicine Wheel must be in balance.

The Medicine Wheel is cyclic and never-ending. When we represent the four concepts spirit, heart, body, and mind in a linear fashion with a list, it appears that there is a beginning and end to the list. However, if we represent the concepts on the Medicine Wheel, we see that there is no beginning and no end to the arrangement, but rather steps in a continuous process; so again, the mind is not considered the privileged end point of the educational process. Rather, we have points of entry and exit to the Medicine Wheel. The east is the usual point of entry because of its connection with sunrise and spring, but other points of entry are possible. For example, sometimes relationships between people

begin with the body, in the west; educational practice which begins and ends with the mind, in the north, and does not travel around the wheel, leads to a severe imbalance.

Concepts:

Spirit: The concept of spirit is fundamental to the Saskatchewan Aboriginal worldview. This knowledge is so important for the beginning learner to know that the spirit is placed in the east, where learning begins. The concept that everything has a spirit, which may be thought of as a kind of energy, a potential to influence, serves as the foundation for all learning. Aboriginal cultures teach that all spirits are interconnected, and sacred.

Heart: The concept of the heart is similar to that of Western understandings. The concept of the heart includes our capacity for love, empathy, and our emotions and tendencies to exhibit certain emotions. One may be kind hearted, or lose heart or have heartache. The concept of the heart is placed in the south because being respectful to yourself, and everything thing around you is an essential element in learning to live in community with others. Appreciating the interconnectedness of everything and living together, in specific geographical areas is an important understanding. The heart is also placed in the south as it is important for young adults to learn to love themselves and those around them, without this base, a culture will not be healthy.

Body: The concept of the body is the same as in Western thought. The body is that which can be physically touched. Bodies have physical dimensions and measurements, strength, endurance, the capacity for movement, and so on. The body is placed in the west, as this is direction of transformation (autumn), movement, and action within the community.

Mind: The mind is also similar to that of Western thought, for it is connected with language, reason, and consciousness. The mind, in Aboriginal perspectives is a special gift, as are all parts of the person, but the mind is also a deficiency in that it allows us to rationalize and to make excuses. The mind is placed in the north because of that direction's association with winter, which, due to time spent indoors, is traditionally the time for passing on knowledge.

It is important to note that the north direction on the Medicine Wheel is not considered the top. In Western cultures, maps are often oriented with the north facing up, and in many perspectives, particularly in linear ways of thinking, to be 'at the top' is generally considered 'better'. Aboriginal ways of thinking consider the Medicine Wheel diagram as lying on the ground rather than displayed on a wall; placing the Medicine Wheel on a horizontal surface emphasizes the equality of the Four Directions. In this orientation, the mind is not superior to the other parts of the person. All four parts are considered equally important, and all four need to be developed in order to achieve balance.

Understanding and developing the four aspects of one's self is fundamental to one's personal development and eventual ability to do the task in life given by the Creator:

When we are born, the Creator gives us a task to do. Now it's up to us to find out what that task is and this could be to agree to visions, fasting, Sun Dancing or something of that kind. But you have to develop an understanding of yourself, you have to know yourself, know everything possible about yourself. In that process, you start resonating with different colours and different directions, and my colours may be different from yours or hers or anybody else's. We also use different animals or birds in different directions ... So we use, in those four directions ... mine are: the west is lightening, the north is a bison, the east is the elk, and the south is eagles and hawks. Now these for me, in my beseechment, because these are purer than I am, we use them as conjugates to take our beseechments to the Creator.

(Elder Ken Goodwill)

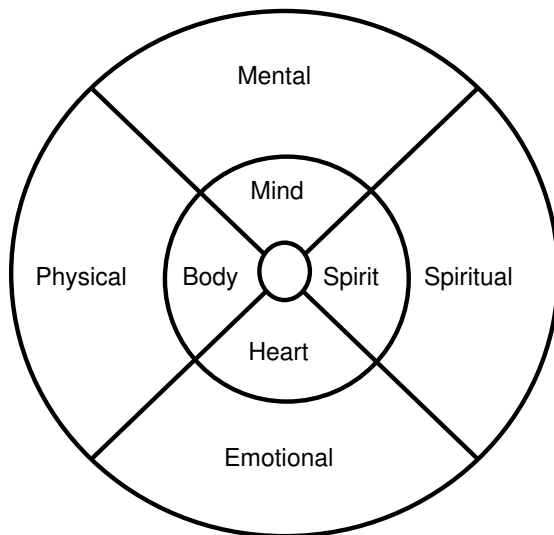
One aid to the process of self-discovery and self-development may be to seek out examples purer forms of the aspects of spirit, heart, body, and mind, and to follow the lessons of those examples. Seeking balance is a life long process.

It's taken me many decades to sort of get to the point in my life where I have some sense of peacefulness or sense of balance. ... In earlier times in my life, I didn't necessarily have four aspects in my life, and now, not necessarily through a conscious effort on my part, ... I've come to a point where I have a better balance of heart, body, mind, and spirit. ... I still struggle with it daily too, but ... I feel more balanced ... it's taken many years to come to that point but now that I'm kind of here, it's easy to look back and say, well, that's what was missing.

(Jan Phillips)

In the Aboriginal perspective teachers should strive to find a balance both personally and professionally. Teachers cannot balance their students; instead, the best they can do is balance themselves to provide an example that their students can follow.

Diagram Two: The Second Layer



Overview:

Each of the four sections of the Medicine Wheel, the spirit, heart, body, and mind, refers to an aspect of a person. Associated with people are ways of being that Aboriginal cultures classify as spiritual, which is associated with the spirit; emotional, associated with the heart; physical which is associated with the body; and mental, associated with the mind. Teachers need to balance these four states within themselves, and express that balance through planning, classroom organization, and when engaging with students in learning, so that students will better be able to balance their own selves by following an example.

Concepts:

Spiritual: Spiritual aspects of a person are usually associated with higher levels of awareness that develops through an understanding of a larger purpose to life. Spiritual skills are usually non-verbal, respectful ways of connecting with what a person already knows, what they are experiencing and learning, what they are feeling, and what they are determining they still need to know and do. It involves a process of stillness where the person can reflect on all they believe (and believe in) and feel connected and creative.

Emotional: This way of being is associated with emotions. To teach in a manner that encourages a child to grow in this holistic way, many Saskatchewan Aboriginal cultures believe it to be important for students to develop still in identifying, communicating, using, feeling, understanding and managing emotions.

Physical: Physical actions generally involve the use or movement of the body. This movement can involve movement within the classroom, or movement outside.

Mental: The skills associated with the mind include those such as thinking, reasoning, considering, and rationalizing. This is the same concept as with dominant Western styles of teaching and learning.

On the subject of the four aspects of a person, Grigas (1993) discusses the use of the Medicine Wheel concept by Russell Willier, a Cree healer from the Sucker Creek Reservation in Alberta:

The four animal spirits associated with Willier's Medicine wheel are the eagle [east], the mouse [south], the bear [west], and the buffalo [north]. The eagle flies high and has the ability to see great distances. The mouse is known for its abilities of collecting. The bear is recognized for its maternal qualities, and the buffalo exemplifies the ability to learn. Each section of the wheel is important in its own right, but the parts must work in harmony if the circle is to be closed and fulfillment reached. (Grigas, 1993, p. 47)

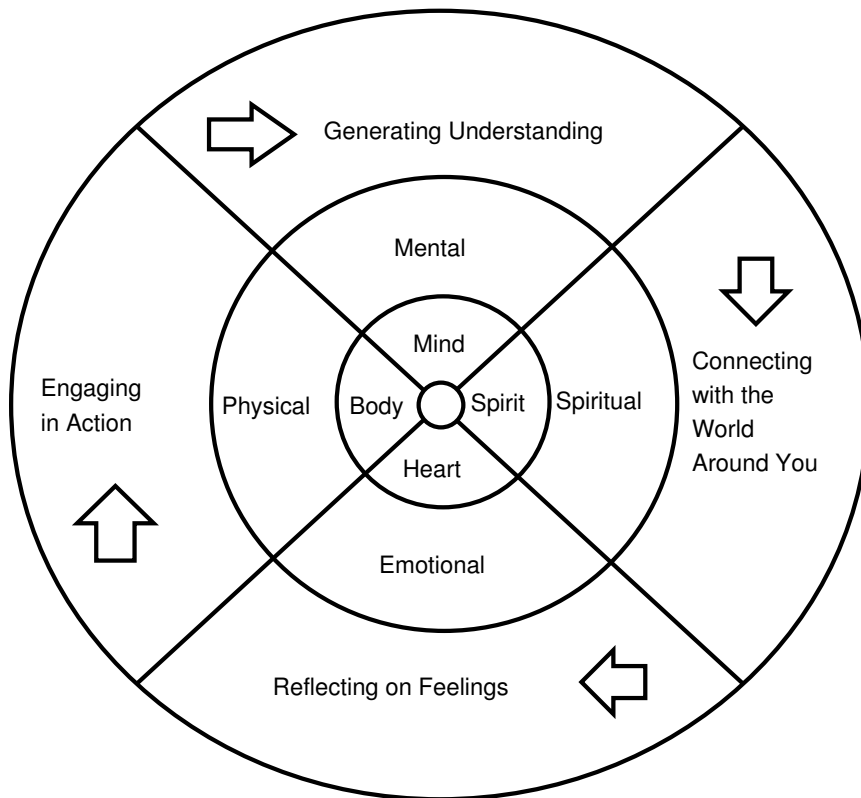
In Willier's scheme, the south is associated with the physical activity of collecting, and the west with the emotional qualities of motherhood. Although the details of where the four aspects of the person may be placed on the wheel, and the animals associated with those aspects, may differ from one nation to another or even from one traditional teacher to another, the general idea is nearly universal among the Aboriginal peoples of North America. There are four aspects of a person, all of which are inseparable, and all of which must be developed in order for one to reach one's full potential.

Every person begins life with their individual spirit, heart, body, and mind. However, the development of the spiritual, emotional, physical, and mental aspects of the self depends on one's experiences in life. Grigas (1993) continues, quoting Young, Ingram, & Swartz:

At a very early age, a child cannot have the Eagle Spirit's ability to plan ahead, but it does have the Buffalo Spirit's ability to learn. The child of course will roam a little and will begin to develop the Eagle Spirit. Eventually, the Mouse Spirit will become active, and the child will acquire a few possessions. The child may also begin to develop a good heart, a quality that will become important later when she or he grows up and raises a family. The child thus begins to develop qualities associated with all four segments of the Medicine Circle, even though these qualities will not attain their full potential until later in life. (p. 36)

Teachers should seek to provide experiences for their students which help them to grow in a balanced fashion. The goal is to help students to eventually attain their full potential, including the ability to act independently and respond to a changing environment.

Diagram Three: The Third Layer



Overview:

Teaching, in Saskatchewan Aboriginal perspectives, involves helping to activate each of the four aspects of the learner. The role of the teacher is to facilitate situations and experiences that encourage the learner to explore those four aspects. The Medicine Wheel reminds us to involve the various aspects of the learner in balance by facilitating events that include the spirit, ‘Connecting with the World Around You’; the emotional, ‘Reflecting on Feelings’; the physical ‘Engaging in Action’; and the mental, ‘Generating Understanding’.

Concepts:

Connecting with the World Around You: This section of the Medicine Wheel encourages teachers to facilitate links between the students and the world around them. It invites situations and activities that will enhance the ability of students to make connections that explore the spirit in all things and to appreciate the role of being still and reflecting on the spiritual.

Reflecting on Feelings: This section of the Medicine Wheel encourages teachers to create experiences that facilitate students’ awareness of their own thoughts and feelings,

the thoughts and feelings of others, and the importance of emotion in building relationships with the world around you.

Engaging in Action: In the west, the generation of action reminds teachers of the importance of movement, and the need to physically engage students in the learning process. Action can occur both inside and outside of the classroom. It can involve anything from just moving your body to being getting involved in actions to help your family, your natural environment or your community.

Generating Understanding: The north section of the Medicine Wheel supports the gaining of cultural knowledge and wisdom about what is currently known of the world. This external knowledge acquisition includes multiple cultural perspectives, and ways of coming to know the world.

Aboriginal philosophy teaches that everything is in motion. Hill (1999) relays the words of Ojibwa Elders J. Dumont and B. K. K. Bell:

The Creator said that all of life moves within a great circle bound together in harmony and balance in four directions. When the human being understands and lives by the principles and values that are the gifts of these four directions, he [sic] will know how to become a part of the natural harmony and balance of life. These gifts flow from the spiritual center of every human being, but people will need to learn how to exercise these gifts in their everyday lives (p. 34).

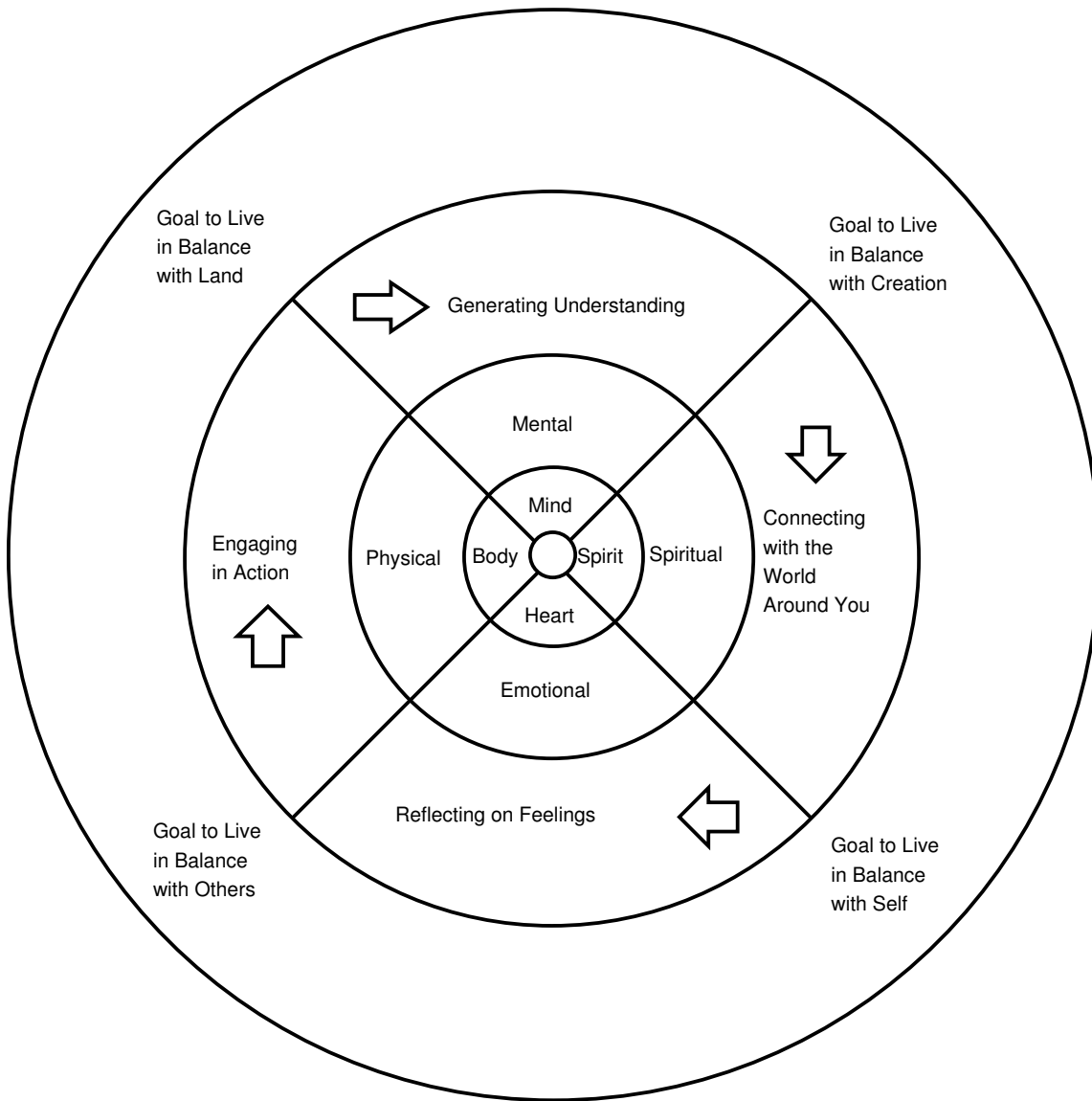
In the Ojibwa mind, the world teaches people about movement, so it is understood that all of life moves to maintain a balance. The earth is in constant motion, and so too will be the life of the human being that is viewed as a 'wheel' unto itself. A holistic approach to life will require a person to develop themselves in all four directions of the medicine wheel (p. 34)

In order to realize one's full potential in a world that is in constant motion, we ourselves must also be in constant motion. Only then can we become full participants in life. The role of the teacher is to enable and encourage students to explore their capacity for balanced action, eventually leading them to full engagement with the world. The Elder B. K. K. Bell, states in Hill (1992):

The whole person or the four aspects of one's self – body, mind, heart (emotions), and spirit – will need to be understood and developed within every human being. Later, a person will need to acquire the ability to balance the physical, mental, emotional, and spiritual energies both internally within one's self and then, externally within all of one's relationships in the world (p. 34)

It is not enough just to understand and develop the four aspects of one's self; one must also activate those aspects of the self, first in a limited domain and then in relation to the world.

Diagram Four: The Fourth Layer



Overview:

Aboriginal perspectives explore the interconnectedness of the individual or self to the world. The above diagram depicts the interconnectedness of the aspects of the individual to the world. In many Saskatchewan Aboriginal perspectives, the individual/self is represented as the central circle. Through ways of being that are spiritual, emotional, physical, and mental, a person is connected to the surrounding world, which includes the self, others, the land, and all the rest of creation.

Concepts:

Goal to Live in Balance with Self: In the Western world view, particularly in the view of some forms of Western science, self is often considered to be separate from the rest of the world. Scientists are sometimes encouraged to write in the passive voice so as to eliminate themselves from the situation they are describing; e.g., science writing will often contain sentences like, “The solution was prepared by ...” rather than “I prepared the solution by ...” or “My research assistant prepared the solution by ...”. However, in Aboriginal perspectives, and in the view of modern scientific theories such as quantum theory, the self is a major part of any endeavour and cannot be removed from a situation. The self is an essential part of the world.

It may seem paradoxical that the individual or self appears in two locations in the diagram above, both as the central circle closely held with aspects of spirit, heart, body, and mind; and as an element of the world. However, the Medicine Wheel may be regarded as a kind of mirror, which is another situation where the self may appear twice and is not regarded as paradoxical at all. Representing self in two locations on the diagram facilitates thinking about how one relates to one’s self.

“Living in balance with one’s self” first requires knowing one’s self, an important process in Aboriginal education, and then acting in the best interests of one’s self, within one’s limitations. Examples of living in balance with one’s self include avoiding addictive behaviours, engaging in healthy behaviours such as eating a good diet and exercising, and reflecting on one’s own actions and learning from one’s own mistakes.

Goal to Live in Balance with Others: Here the word ‘others’ means other people, such as immediate family, extended family; friends, strangers, community, and nation. Living in balance with others requires knowledge of custom, culture, and language. It involves living to reflect positive relationships with other people. This may also be extended out to other species: living in such ways to respect the lives of all other species that we share this planet with.

Goal to Live in Balance with the Land: ‘The land’ in the sense of a particular locality is an important concept in Aboriginal philosophy. The land, referring to the totality of the natural environment, gives us everything we need in order to survive, such as food, water, fuel, and clothing; in return, Aboriginal individuals and societies reflect the land in their behaviour, customs, stories, and means of making a living. Living in balance with the land requires knowing the land on which one lives and living in a respectful relationship with that environment. One should not take more than one needs, and should give in return for everything taken.

Goal to Live in Balance with Creation: All of Creation around us includes more than the land on which we live: it also includes the winds, the sun, the moon, the planets, the stars, spirits, and the Creator. Living in balance with Creation requires knowledge of those aspects of the world, some understanding of the messages that they may give us, and the

pursuit of constructive, respectful relations with the Creator through such spiritual activities as prayer and ceremony.

An important concept related to balance is the notion of forming reciprocal relationships, which is emphasized throughout Saskatchewan Aboriginal culture. For example, the custom of giving gifts of tobacco and cloth to Elders or teachers in traditional protocol is connected with the idea that if one is to receive a teaching or an answer to a question, one must also give. Similarly, if one receives healing from a traditional healer, one must give something in return. Depending on the complexity and length of the relationship, gifts may range from the tobacco and cloth used in traditional protocol to gifts of food, medicine plants, clothing, craft items, to payments of honoraria or provision of useful services in return.

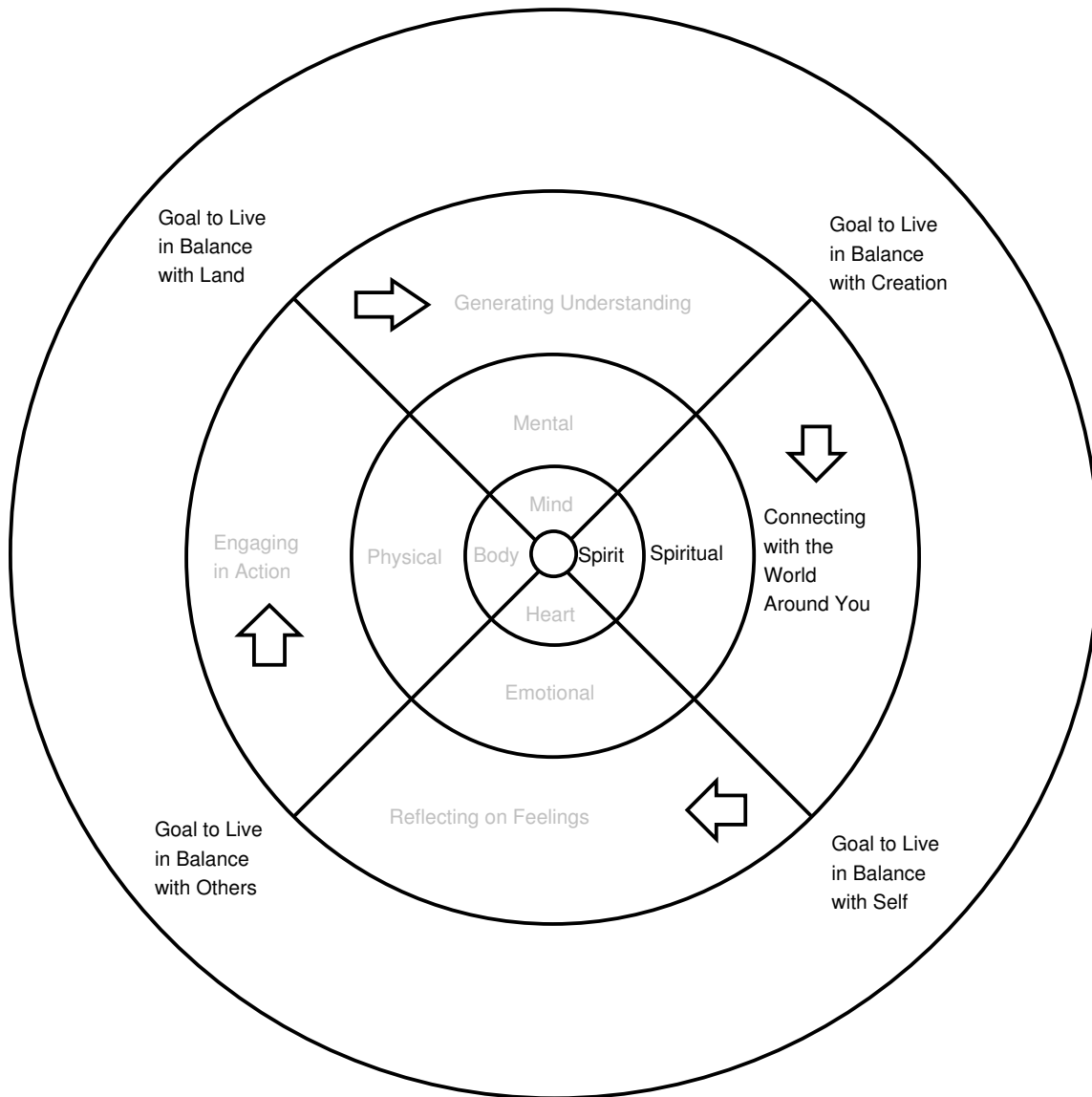
Reciprocal relationships are not confined to the human world. When one takes a plant for food or medicine, or an animal for food or clothing, one must also give in return if balance is to be maintained. Tobacco is often used by Aboriginal peoples as a reciprocal gift to spirits in the natural world; tobacco is a special gift to Aboriginal people from the Creator for that purpose. But once again, in complex or lengthy relationships, more than tobacco may be required for proper reciprocity. Maintenance of habitat for animals, or agricultural practices for plants, may be called for.

Creating balance is one of the major uses of the Medicine Wheel. Balance is a source of harmony, power, and wellness in Aboriginal philosophy. However, one must be careful when associating imbalance with powerlessness or illness. The Western Canadian Protocol Framework for Aboriginal Culture and Language Programs (Governments of Alberta, British Columbia, Manitoba, Yukon Territory, Northwest Territories, and Saskatchewan, 2000) warns,

The practices associated with creating balance have often been called “healing,” partly because imbalance has been seen to be the cause of so many personal problems. It is important, however, in Aboriginal language and culture programs, that this process not be called healing, but rather “creating balance.” Aboriginal students do not necessarily require healing. They may be seeking to balance their time and efforts between their cultural roles and their lives as teenagers with the mainstream. They may be seeking balance between the demands of their studies and the calls of friendship. Healing in this context diminishes the meaning it carries in areas where real healing is required (p. 25).

Nothing we do as humans is ever perfect, so we cannot expect perfect balance or harmony under any circumstances. Since lack of balance is inevitable, it is not necessarily something negative. One must consider the severity of the imbalance and the context in order to know whether it is a problem. Furthermore, many Saskatchewan Aboriginal people avoid making such judgments of others, instead concentrating on setting examples of balanced lives themselves.

Approaching from the East: Reaching the Spirit



Overview:

For the moment, consider the spiritual aspects of the person (while not totally neglecting the other aspects of the person, which are shaded in gray in the above diagram but not totally absent). Teachers should be aware of the role of the spiritual in meeting the four aspects on the diagram. In order to live in balance with any aspect of the world, one must be able to connect with it in a deep and meaningful way. Teachers should first consider their own spirituality and the question of how they might connect better with the world, and then the question of how to facilitate spiritual growth and connection in their students.

Points to Ponder:

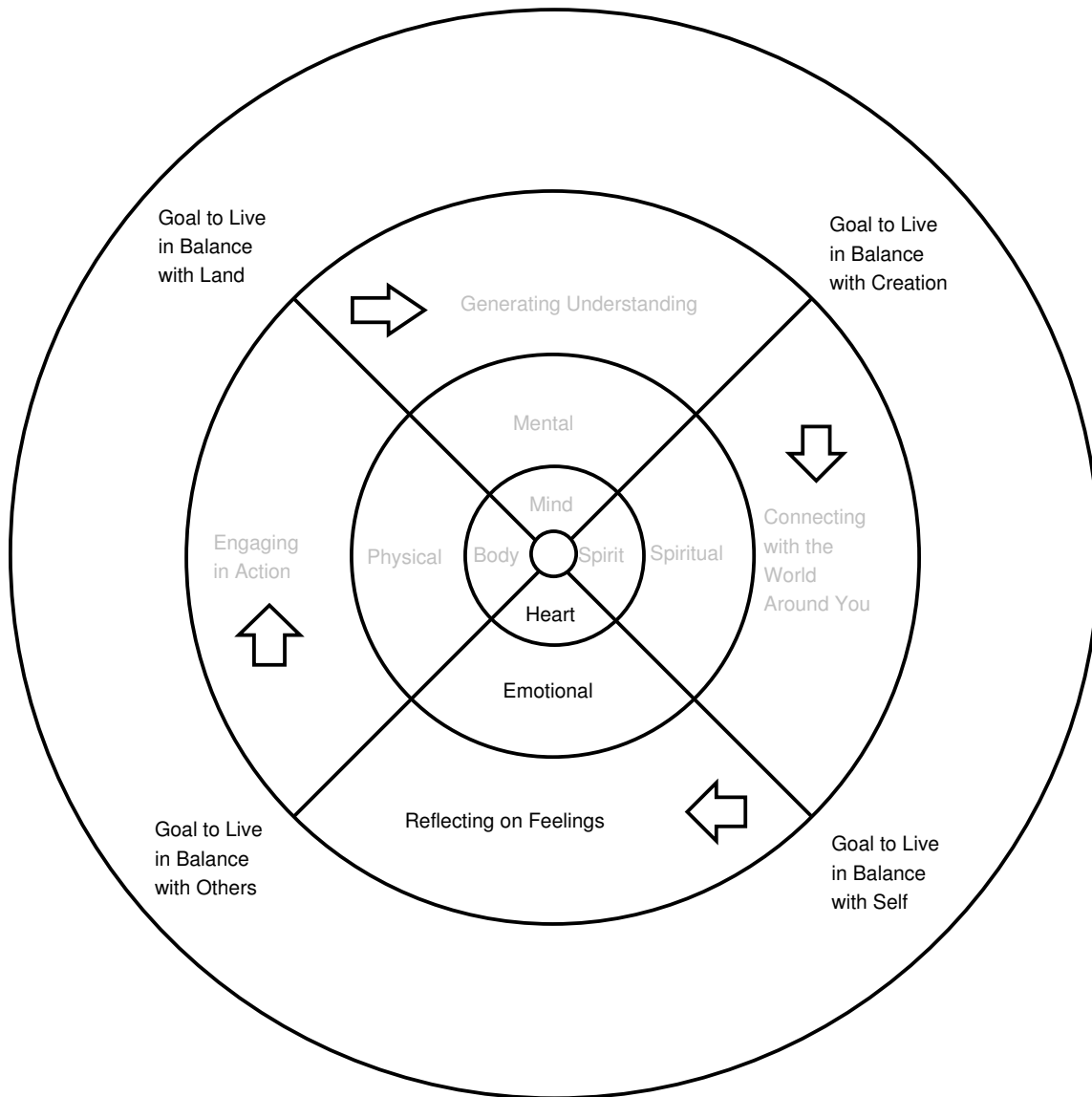
1. How can we understand the relationship between spirituality and religion? Spirit is in all things and all relationships. Teachers who act in caring and thoughtful ways in relation to children, all living and non-living beings are acting spiritually. Children who are learning in environments that are spiritually balanced will learn about spirituality through observation. It is not necessary for the teacher to talk about or define spirit. Telling stories and choosing science activities that exemplify respect for life and for the earth, that help children understand the many ways in which we are all related will help children learn about spirituality.
2. Is Western science influenced by, or related to spirituality? Explore the roles of dreams, visions, and intuition in Western science. Consider stories like Kekulé's discovery of the structure of benzene in a dream, or Ramanujan's discovery of mathematical results through spiritual means, or stories of intuitive leaps in scientific discovery. Learners might find Albert Einstein's views of the relationship between science and spirituality interesting if they learned about them in stories. Margaret Wheatley and other contemporary scientists acknowledge the spiritual beauty in scientific theories.
3. Consider the role of ethics in science education. How are ethics and spirituality related? For any given science topic, consider its ethical dimensions. For example, consider the ethics of dam projects in electricity generation or waterways management; or the ethics of appropriating land for environmental purposes; or the question of whether it is right to take non-human animals and plants for scientific investigations, and what should be given in return to maintain balance. Discuss with your students the ethics of everything you do together in your science classroom. It is not hard to ask, "Is it a good idea to do this? Will anyone or anything be hurt if we do this? What does hurt look like in plants or rocks? Teaching respect in this way is helping them to gain and maintain spiritual balance. Being sure to give back for everything we use in experiments is important. What might that look like in your classroom? Often this is symbolic, we might feed the earth with water when we take a plant, for example.
4. How can we situate our teaching so we are not in 'either/or' frames but recognizing the commonalities, relationships or the 'and/both' Aboriginal science and Western science? When an Elder says that "everything is living", and a biologist says that the environment can be divided into biotic and abiotic components, are the two necessarily in conflict? Explore with your students the knowledge and ideas of Aboriginal and Western scientists to seek answers to these questions. Situate the science you do in your classrooms in terms of real situations that the students might experience or could imagine experiencing. For example in Grade 6 students will be asked to learn about space. In some instances, and with the right kind of knowledge, the moon can help us find our way home. But if we were to use the knowledge of composition of the moon to help us find our way home if we were lost, it would not be helpful. However, the relationship of the moon, to the other stars and the patterns they make, and the stories that are told about them would talk us home if we were to know those stories. All knowledge

about the stars is helpful in its own context. The stories told by Saskatchewan Elders about Saskatchewan skies might be of help. Certainly they will increase learner's interest in the stars when they hear them from their teachers.

5. Take a 'medicine walk' with an Elder or traditional healer. A medicine walk is a walk through a natural setting to identify medicinal plants, in the local area. Pay special attention to the spiritual aspects of the situation. For example, why are plants are considered sacred? Many plants have special gifts for people, they have medicinal properties or their beauty is healing. Many are food. All plant life helps humans because plants maintain the oxygen in the air. But without the gifts or the intrinsic value they are still valuable because we are all in relationship. Most traditional teachers would be happy to answer respectful questions on the spiritual aspects of their teaching.

6. Consider Aboriginal science lesson plans or other resource materials. For example, consider <http://www.usask.ca/education/ccstu/>. Pick a lesson plan from that source and consider how the spiritual is present in that plan. Think about each part of the plan. Find the balance between the four modes of knowing and if it is not apparent, think about how it might be more evident in the instruction you plan.

Approaching from the South: Reaching the Heart



Overview:

Now consider the emotional aspects of the person. Educators should be aware of the role of the emotional in meeting the four goals of Aboriginal education, first through development of their own emotional side and ability to reflect on feelings, and then through the process of setting examples and activities for students to help them grow emotionally. Emotion cannot be thought of by itself, they need to be thought of in balance with the other sides of the Medicine Wheel.

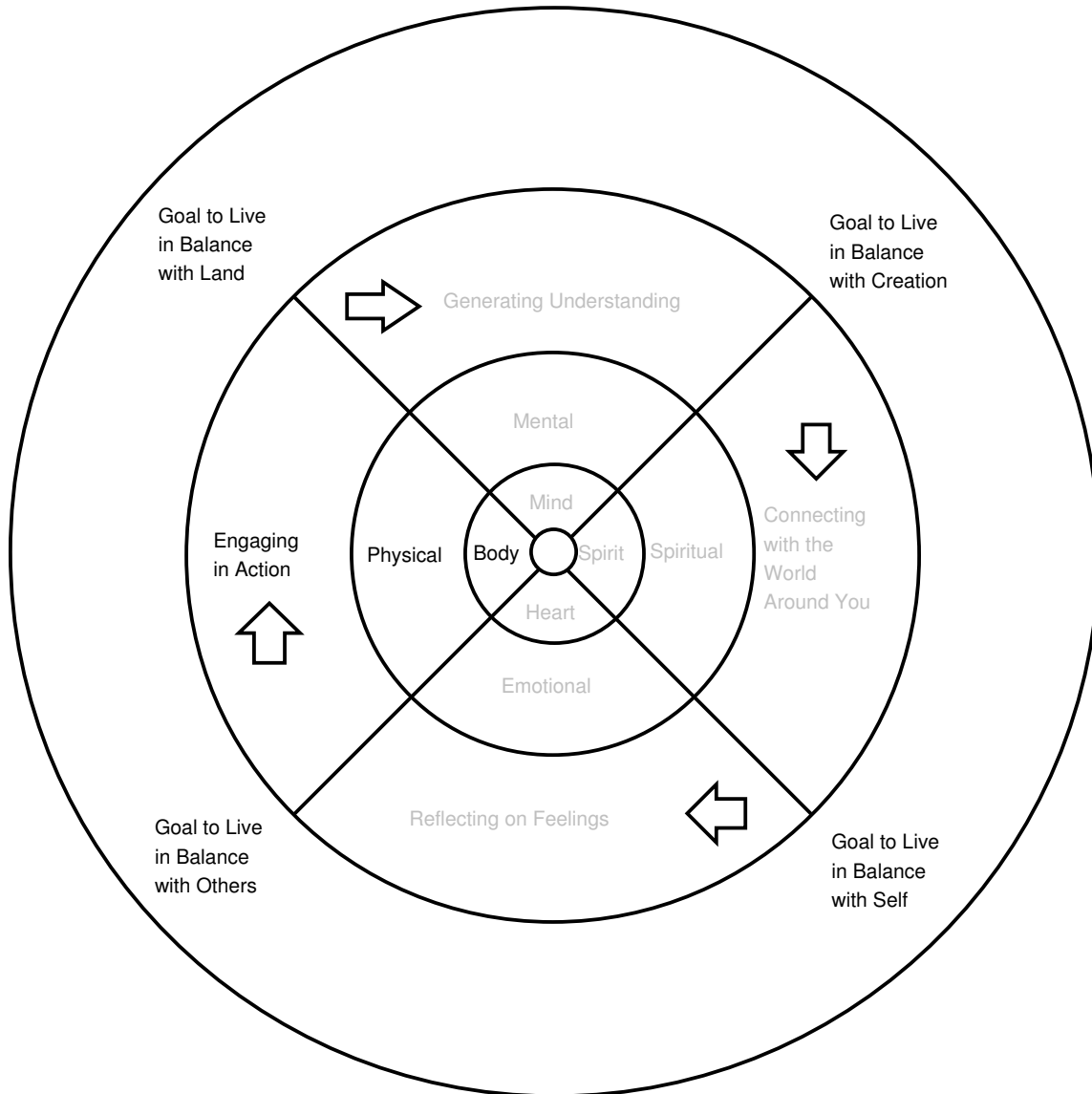
Points to Ponder:

1. Emotions related to what we believe to be true often keep us from learning new things. For example, as we learn about Aboriginal science we may find ourselves rejecting it or putting it down as simply nice stories, or as 'primitive' or 'weird'. Try to be aware of your own emotional reactions as you engage in including Aboriginal philosophies and perspectives in science education. Try and help your students to develop similar awareness. Deconstruct these reactions, try to find out where the emotional reaction comes from. Ask yourself why you are having these reactions and how do they keep you from respecting new forms of science knowledge.
2. Explore the role of emotion in Western science. All teachers and students have emotional reactions to aspects of scientific issues. These influence the decisions scientists, teachers and learners make when doing science. Consider dramatic stories in the history of science, such as Pasteur's discovery of a vaccination for rabies, or the story of Alan Turing and the Enigma code, or the Apollo 13 mission to the moon. Such stories are often retold. Why do you think that is? What emotions do those stories evoke? Does the emotional aspect of those stories affect teaching and learning? Have your students explore their own emotional reactions to historical and contemporary issues. There are many contemporary issues in science that promote strong public reactions. Public response does influence scientific funding and governmental laws. Have your students discuss the role of democracy on science. How can they play a role in the democratic process around scientific issues that they feel strongly about?
3. Have your students become aware of the way they feel about the activities they do in the classroom. Encourage them to better communicate their emotions and to explore what is it about an activity they are reacting to. If they can understand this, they may then be able to help in the designing of activities and experiments in order to demonstrate their new visions of how science could be.
4. The students might want to explore in more detail a community issue, local or global, that is causing them an emotional reaction. How does it make them feel? In what ways does it relate to science, or is science helping and or harming the situation...how can we find out about the impact of science? What are some of the students' reactions towards this science? What action could or will the students take, individually and/or collectively?
5. How can colours affect one's mood? How do colours and shades of colour affect how art is viewed? What kinds of lighting might enhance the learning experience in the classroom? How do the primary colours of red, yellow, and blue make colours of the rainbow? Which colours make you feel happy? Which colours make you feel sad? Which colours make you angry? These questions could be asked of anything, not just colour.
6. When studying the water cycles in the region, one learns in some Aboriginal perspectives that the water in a river contains not only rainfall and runoff from the land,

but also, in some measure, “the tears of the people”. How could the introduction of the emotional help in the study of the water cycle?

7. Consider an Aboriginal science lesson plan obtained from a source such as http://www.nativeaccess.com/teachers/links_abor_math.html. How is the emotional present in the lesson plan or resource you have chosen? Find the balance between the four modes of knowing. How could this look in your instructional plans?

Approaching from the West: Reaching the Body



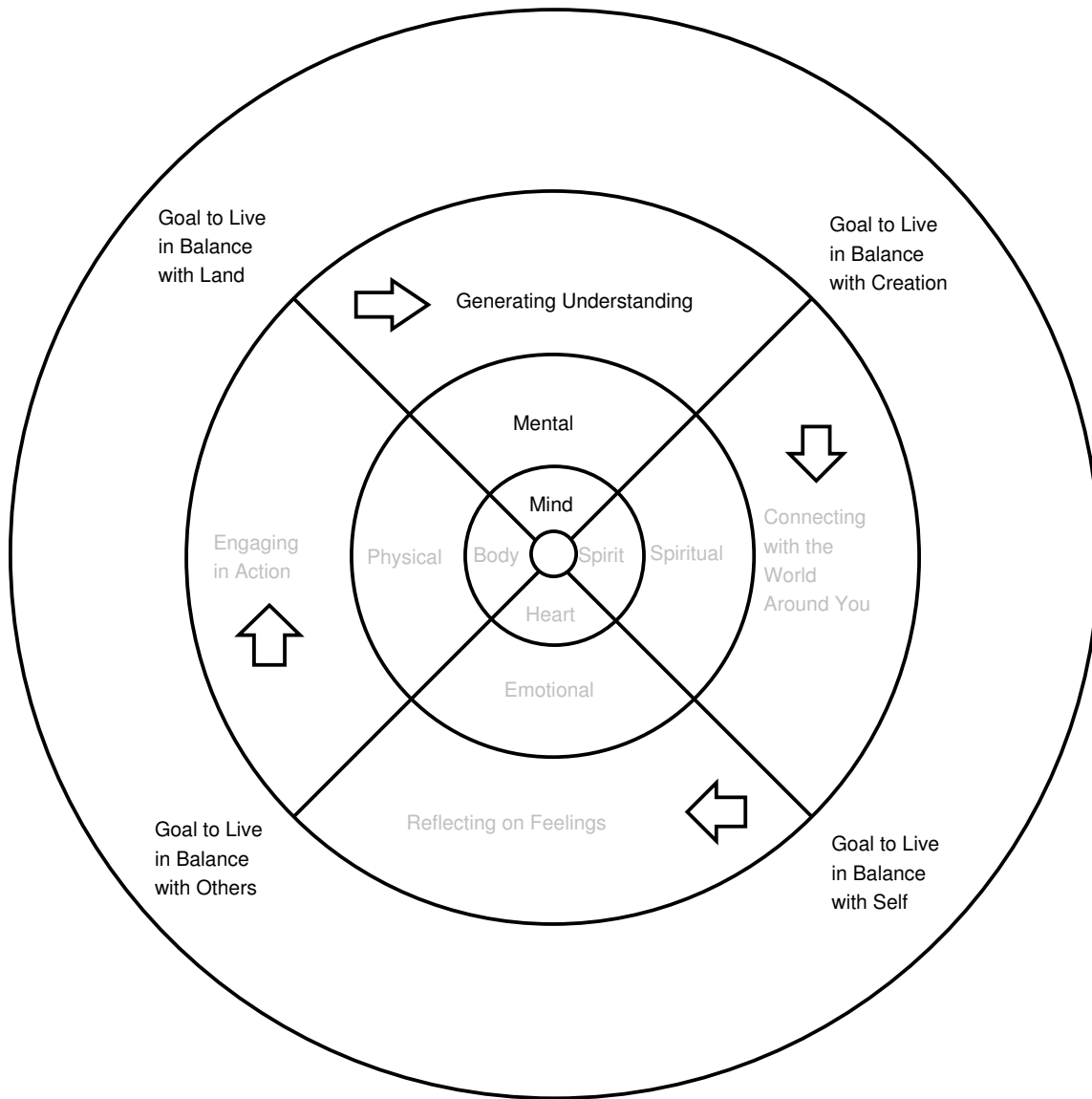
Overview:

Now consider the physical aspect of the person. Teachers should be aware of the role of the physical in meeting the four goals of Aboriginal education on the diagram. Teachers should first seek to understand their own physical natures and how they might best engage in action in the context of science education, and then how they might be able to set examples and create experiences for their science students which help them to grow physically.

Points to Ponder:

1. Science concepts can be explained through physical means; all students can enact science understandings through some means of physical activity. Understandings of how electricity flows, how heat moves, what happens in mixtures and solutions, and even how atoms and elements relate to each other can all be danced, hopped, wiggled or in anyway physically acted out.
2. Consider the role of physical activity in teaching Aboriginal or Western science content. For example, Einstein attributed some of his understanding of relativity to what it would be like to ride on a light wave. Richard Feynman would perform a physical trick of turning a glass of water without spilling it to introduce certain science notions. Certain Elders knowledgeable in plants might take students on walks to learn about plants in the local area. How might such activity enhance science education? Explore physical ways in which you can introduce science to students.
3. Rather than just looking at concepts and issues from a theoretical perspective, can students introduce an action element? In what ways can the students do something with their knowledge to help their local communities? The Royal Saskatchewan Museum runs an annual Youth Forum where teachers and student are supported in undertaking action projects in their communities (Contact the Museum, 306 787 2815, for more information about this worthwhile event). What would the students like to do about the topic? What action would they like to do educate others in the school? What actions would they like to do to in relation to the natural environment? How would they like to work with people in the community who are working towards the same goals? How can students learn by doing and give back to the community at the same time? How does action differ from just generating discussion or study?
4. What are your own physical gifts? What physical activities are you good at doing? How are you physically similar to and different from other two leggeds, and four leggeds, and swimmers, and winged ones?
5. Consider an Aboriginal science lesson plan obtained from a source such as <http://www.schoolnet.ca/Aboriginal/science/index-e.html>. How is the physical present in the sample lesson plan or resource you have chosen? If the physical is well-balanced, how could you use the lesson plan as an model for your own plans? If the physical is not well balanced, how would you change the lesson plan to better balance the physical?

Approaching from the North: Reaching the Mind



Overview:

The mental aspect of the person, and generating understanding of the world, is generally viewed as the domain of science. However, teachers should be aware of the role of the mental in meeting the four goals of Aboriginal education on the diagram in the context of science education. Teachers should first seek to understand their own mental natures, and then how they might be able to set examples and create experiences for their students which help meet the goals of Aboriginal education in the context of the science classroom.

Points to Ponder:

1. In a world that is so focused on the mind and the 'head' in learning, how can we encourage balance among all four directions in our science classes? Middle Years science is about students exploring and investigating all aspects of Aboriginal and Western science. It is important to remember that the intellectual mode of learning is not simply memorization. This mode includes all of the ways in which we think about things: judgment, guessing, puzzling and so on. What can we do to ensure that balance and not the focus on the memorization that most of us were exposed to in our Western science courses? How can you work with all of the aspects of mind in your classroom? How can you ensure that the activities and resources your students are using are not overly focused on the intellectual? Be sure that you ask yourself this every time you plan for science lessons.
2. Explore resources that offer multicultural understandings of science and highlight how knowledge from specific cultures is valuable for the day-to-day life of the people. For example, knowing the chemical nature and biological functioning of certain drugs may be important, depending on your context, but knowing how to identify the plants that contain the raw material of the drugs maybe even more important in other instances.
3. Aboriginal knowledge must be introduced into science class while we examine the limitations of Western science and the commonalities it has with Aboriginal knowledge. If this disrupting of Western science does not occur, Aboriginal science will not seem 'legitimate' in relation to what is perceived as the 'real' science. The students may tend to see Aboriginal science knowledge as 'nice stories'. Therefore, the teacher who wishes to strengthen cultural relations between Aboriginal and non-Aboriginal peoples, but does not help her students to see that knowledge is social and political may unwittingly be reinforcing stereotypes. Have your students explore the history of science and science concepts and allow them to see that rather than being the 'right' answer, science concepts are influenced by the time, the politics and the place and will change and be modified over time, due not only to scientific advancement, but also due to the times, the politics and the place. (For more information about this please see the section on Science, page 14)
4. Aboriginal languages should also come into the classroom whenever appropriate. The names we call things reflect the environment from which they come. But when a language like English is transferred into a territory through colonization the names they give to things may be less appropriate. For example the Canadian 'robin' is very different from the English bird whose name it wears. What did the Aboriginal persons call that bird? What did they call this place, that rock, that form of snow or wind? All of these words, even though we hear them in translation, may help us to think differently about the things they name.
5. Consider an Aboriginal science lesson plan obtained from a source such as <http://www.schoolnet.ca/Aboriginal/science2/index-e.html>. How is the intellectual mode of thinking and learning present in the sample lesson plan or resource you have chosen?

Is it in balance with the other learning modes from the Medicine Wheel or does that mode dominate?

Conclusion: Full Circle

Above, each of the four pathways to the learner, the eastern path to the spirit, the southern path to the emotions, the western path to the body, and the northern path to the mind were reviewed separately. However, remembering the theme of interconnectedness, we should keep in mind that the four aspects of the learner are inseparable. Similarly, the four aspects of teaching and learning (connecting with the world, reflecting on feelings, engaging in action, and generating understanding) cannot be separated from any situation. It is hoped that this guideline allows teachers to identify and facilitate teachable moments in any of the directions of the Medicine Wheel. All of the aspects of the Medicine Wheel could involve connecting, reflecting, engaging, and generating; all situations could invoke the spiritual, emotional, physical, and mental; all experiences could touch the spirit, heart, body, and mind. Generating and promoting balance, while encouraging growth and increased awareness of the interconnectedness of the world, is an important lesson taught by the Medicine Wheel.

Bibliography for Further Resources on (Saskatchewan) Aboriginal Perspectives

Alaska Native Knowledge Network. (1998). *Alaska standards for culturally-responsive schools*. Fairbanks, AK: University of Alaska Fairbanks.

Bancroft-Hunt, Norman. (1981). *Indians of the Great Plains*. London, England: Orbis Book Publishing Corporation Ltd.

Barkwell, Lawrence J., Leah Dorion and Darren R. Prefontaine. (2000). *Metis Legacy: A Metis Historiography and Annotated Bibliography*. Winnipeg, MN: Pemmican Publications.

Bell, Catherine E. (1999). *Contemporary Métis justice: The settlement way*. Saskatoon, SK: Native Law Centre, University of Saskatchewan.

Brendtro, Larry K, Martin Brokenleg and Steve Van Brockern. (1992). *Reclaiming youth at risk: Our hope for the future*. Bloomington, IN: National Education Service.

Cahill, Charlie. (2001). *Nunavut Territory, Canada*. (Version 4.0) [Computer Software]. Gjoa Haven, Nunavut: Central Arctic Management Services Ltd.

Cajete, Gregory. (2000). *Native science: Natural laws of interdependence*. Santa Fe, New Mexico: Clear Light Publishers.

Campbell, Maria. (2001). *Halfbreed*. Halifax, NS: Formac Publishing Company.

Canada. Indian and Northern Affairs. Definitions - March 2000 (QS-6119-001-EE-A2) http://www.ainc-inac.gc.ca/pr/info/info101_e.pdf . Ottawa, ON: Minister of Public Works and Government Services.

Cardinal, Harold and Walter Hildebrandt. (2000). *Treaty Elders of Saskatchewan: Our dream is that our people will one day be clearly recognized as nations*. Edmonton, AB: University of Calgary Press.

Cardinal, Phyllis and Dale Ripley. (1987). *Canada's people the Métis*. Edmonton, AB: Alberta Education.

Carter, Sarah. (1999). *Aboriginal people and colonizers of western Canada to 1900: Themes in Canadian social history* (Series). Toronto, ON: University of Toronto Press.

Castellano, Marlene Brant. Lynne Davis and Louise Lahache. (2000). *Aboriginal education: Fulfilling the promise*. Vancouver, BC: UBC Press.

Champagne, Duane. (1994). *Native America portrait of the peoples*. Detroit, MI: Visible Ink Press.

Christensen, Deanna. (2000). *Ahtahkakoop*. Shell Lake, SK: Ahtahkakoop Publishing.

Communication Canada. (1996). *Report of the Royal Commission on Aboriginal Peoples*. Vol. 1. Looking Forward, Looking Back. Ottawa, ON: Canada Communication Group Publishing

Communication Canada. *Report of the Royal Commission on Aboriginal Peoples*. Vol. 2. Restructuring the Relationship. Ottawa, ON: Canada Communication Group Publishing

Communication Canada. (1993). *Report of the Royal Commission on Aboriginal Peoples*. Vol. 3. Gathering Strength Ottawa, ON: Canada Communication Group Publishing

Communication Canada (1993). *Sharing the Harvest: The Road to Self-Reliance: Report of the National Round Table on Aboriginal Economic Development and Resources*. Ottawa, ON: Canada Communication Group Publishing.

Communication Canada. (1993). *Report of the Royal Commission on Aboriginal Peoples*. Vol. 4. Perspectives and Realities. Ottawa, ON: Canada Communication Group Publishing.

Communication Canada, Canadian Government Publishing. (1993). Report of the Royal Commission on Aboriginal Peoples – Sharing the Harvest The Road To Self Reliance. Ottawa, ON: Minister of Supply and Services Canada.

Coutu, Phillip R. and Lorraine Hoffman-Mercredi. (1999). *Inkonze: The stones of traditional knowledge*. Edmonton, AB: Thunderwoman Ethnographics.

Deiter, Constance. (1999). *From our mothers' arms: The intergenerational impact of residential schools in Saskatchewan*. Etobicoke, ON: The United Church Publishing House.

Dickason, Olive Patricia. (1992). *Canada's first nations: A history of founding peoples from earliest times*. Toronto, ON: Oxford University Press.

Dobbin, Murray. (1981). *The one-and-a-half men: The story of Jim Brady and Malcolm Norris, Métis patriots of the 20th century*. Saskatoon, SK: Gabriel Dumont Institute.

Four Worlds Development Project. (1988). *The sacred tree: Special edition*. Lethbridge, AB: Four Worlds International Institute for Human and Community Development.

Frideres, James S. (1993). *Native peoples in Canada: Contemporary conflicts*. Scarborough, ON: Pearson Education.

Goulding, Warren. (June 2002). *From humble beginnings: Indian education now flourishing in Saskatchewan*. Eagle Feather News Vol. 4, No. 4. Saskatoon, SK: ACS Aboriginal Consulting Services.

Government of Canada (2003). *Aboriginal peoples in Canada: a demographic profile*. Accessed on September 24, 2005 from <http://www12.statcan.ca/english/census01/products/analytic/companion/abor/canada.cfm>.

Graff, Joan. (1988). *Journal of child care, special issue, strength within the circle*. Nanaim BC: Malaspina University-College.

Greer, Sandy. (1999). *Aboriginal Voices Inc.* (Oct. Nov./99) Vol. 6. No. 5. Toronto, ON: Aboriginal Voices.

Igloriorte, John. (1994). *An Inuk boy becomes a hunter*. Halifax, NS: Nimbus Publishing Limited.

Indian and Northern Affairs Canada. (2001). *Aboriginal workforce participation initiative employer toolkit, Definitions*. Ottawa ON: Ministry of Public Works and Government Services Canada.

Indian and Northern Affairs Canada. Nunavut - March 2000 (QS-6119-000-EE-A3) http://www.ainc-inac.gc.ca/pr/info/info100_e.pdf Ottawa: ON: Minister of Public Works and Government Services Canada, 2002.

Kahtou News. (Feb. 2001). Vol. 10., No. 2. "Hidden Discrimination" and "Polite Racism". Sechelt, BC: K'watamus Publications Inc.

- Kyle, Anne. (Feb. 2002). Regina Leader Post. Regina, SK: Regina Leader Post.
- Lagimodiere, John. (July, 2001). Eagle Feather News. Saskatoon, SK: Eagle Feather News.
- LaPlante, Dwayne, Pilot Teacher. (2001). Mount Royal Collegiate, Saskatoon, SK.
- Laroque, Emma. (1975). *Defeathering the Indian*. Mississauga, ON: Doubleday (Canada) Limited.
- Laviolette, Gontran. (1991). *The Dakota Sioux in Canada*. Winnipeg, MB: DLM Publications.
- Littlepoplar, Alphonse. (1974). *Towards a new past: Sweet grass transcripts*. Vol. 12. Regina, SK: Culture, Youth and Recreation.
- MacLeod, Peter D. (1992). *Canadian Historical Review*, LXXIII, 2.
- Mandlebaum, David G. (1979). *The Plains Cree: An ethnographic historical and comparative study*. Regina SK: Canadian Plains Research Centre, University of Regina.
- McCue, Harvey and Associates, (1996). *Contemporary Aboriginal Issues: Health*. Ottawa, ON: Industry Canada.
- McCluskey, Murton. Buffalo Graphic. Montana Office of Public Instruction. website: <http://www.opi.mt.us/>.
- McDaniel, Kathryn N. (2000). *The history teacher*, Vol. 22, No. 3. Longbeach CA: Society for History Education, Inc.
- McGillvray, Anne and Comasky, Brenda. *Black eyes all of the time: Intimate violence, Aboriginal women and the justice system*. Toronto, ON: University of Toronto Press.
- McLean, Don. (1987). *Home from the hill: A history of the Métis in western Canada*. Saskatoon, SK: The Gabriel Dumont Institute.
- McLean, Don. (1987). *Fifty historical vignettes*. Regina, SK: Gabriel Dumont Institute.

Miller, Christine and Chuchryk, Patricia. (1996). *Voices through time*. Winnipeg, MB: University of Manitoba Press.

Milloy, John S. (1988). *The Plains Cree trade, diplomacy and war 1790 to 1870*. Winnipeg MB: The University of Manitoba Press.

Mills, Sheryl. (1996). *Aboriginal cultures and perspectives: Making a difference in the classroom*, No. 5. Saskatoon, SK: SPDU and SIDRU.

Monasrtycki, Jamie. (1999). *Aboriginal Voices. Where's the money! Native filmmakers struggle with the screen*. Toronto, ON: Aboriginal Voices Inc.

Montgomery, Kathleen. (2000). *The clearing house – A journal of educational strategies, issues and ideas*. Vol. 73, No. 6. Washington, DC: Heldref Publications.

Newhouse, David. (2000). *Modern Aboriginal economies: journal of Aboriginal economic development*. Vol. 1. North York, ON: CANDO (Council for the Advancement of Native Development Officers) and Captus Press Inc.

Oakes, Jill. (1998). *Sacred lands: Aboriginal worldview, claims and conflicts, occasional publication series*. Edmonton, AB: Canadian Circumpolar Institute.

O'Meara, Sylvia and West, Douglas A. (1996). *From our eyes: Learning from Indigenous people*. Toronto, ON: Garamount Press.

Orlich, Donald C. (1990). *Teaching strategies: A guide to better instruction*. Lexington, MA: D. C. Heath and Company.

Palmerton, Patrica P. and Bushyhead, Yvonne. (1994). *It's not getting at real: Exploring alternative approaches to critical thinking*. St. Paul, MN: Hamline University.

Payne, Ruby Dr. and Slocumb, Paul D. (2000). *Removing the mask: Giftedness in poverty*. Highlands, TX: RTF Publishing.

Petrone, Penny. (1999). *Native literature in Canada from the oral tradition to the present*. Don Mills, ON: Oxford University Press.

Pewewardy, Cornel. (1999). *Winds of change – American Indian education and opportunity*. Autumn 1999, Vol. 14, No. 4. Albuquerque, New Mexico: AISES Publishing Inc.

Ray, Arthur J. (1996). *I have lived here since the world began: An illustrated history of Canada's native people*. Toronto, ON: Lester Publishing Limited/Key Porter Books.

Ray, Arthur J., Miller, Jim and Tough, Frank. (2000). *Bounty and benevolence: A history of Saskatchewan Treaties*. Montreal: ON: McGill-Queens' University Press.

Rice, Harmony. (1999). *"Don't touch that dial!"* Toronto, ON: Aboriginal Voices Inc.

Riese, Kandis, Pilot Teacher. (2001). Churchill Composite High School. Churchill, SK.

Rogers, Edward S. and Smith, Donald B. (1994). *Aboriginal Ontario historical perspectives on the first nations*. Toronto, ON: Dundurn Press Limited.

Ruggiero, Vincent Ryan. (1990). *Beyond feelings: A guide to critical thinking*. Mountain View, CA: Mayfield Publishing Co.

Safarik, Allan. (1997). *Kiséwatotatowin Aboriginal parenting handbook*. Saskatoon, SK. Kiséwatotatowin Aboriginal Parent Program Inc.

Saskatchewan Education. (2001). *Aboriginal elders and community workers in schools*. Regina SK: Author.

Saskatchewan Education. (2000). *Aboriginal education provincial advisory committee: Action plan 2000-2005*. Regina SK: Author.

Saskatchewan Education. (2000). *Aboriginal education initiatives in Saskatchewan education*. Regina SK: Author.

Saskatchewan Education. (1999). *Aboriginal resource list for K-12*. Regina SK: Author.

Saskatchewan Education. (2000). *Core curriculum: Principals, time allocations, and credit policy*. Regina SK: Author.

Saskatchewan Education. (1984). *Directions, The five year action plan for native curriculum development*. Regina SK: Author.

Saskatchewan Education. (1995). *Diverse voices: Selecting equitable resources for Indian and Métis education*. Regina SK: Author.

Saskatchewan Education. (1999). *English language arts (ELA): A curriculum guide for the secondary level*. Regina SK: Author.

Saskatchewan Education. (1989). *Evaluation in Education: Report of the Minister's Advisory Committee on Evaluation and Monitoring*. Regina, SK: Author.

Saskatchewan Education. (1989). *Indian and Métis education policy from kindergarten to grade 12*. Regina SK: Author.

Saskatchewan Education. (1999). *Life transitions 20, 30: A curriculum guide for the secondary level, module 1*. Regina SK: Author.

Saskatchewan Education. (1997). *Our children, our communities and our future, equity in education: A policy framework*. Regina SK: Author.

Saskatchewan Education. (1997). *Priorities in Indian and Métis education 1997-98*. Regina SK: Author.

Saskatchewan Education. (1987). *Resource based learning*. Regina SK: Author.

Saskatchewan Education. (1999). *Saskatchewan education indicators kindergarten to grade 12*. Regina SK: Author.

Saskatchewan Education. (1999). *Social studies: A curriculum guide for the middle level (grade 9)*. Regina SK: Author.

Saskatchewan Education. (1999). *Student evaluation: A teacher handbook*. Regina SK: Author.

Saskatchewan Elocution and Debate Association (SEDA), (2001). *Guiding principles in teaching debate*. Regina, SK. Author.

Saskatchewan Indian Cultural College. Tipi Graphic.
<http://www.royalsaskmuseum.ca/see/firstnations/o2-tipi.html>

Steckley, John L. and Cummins, Bryan D. (2000). *Full circle: Canada's first nations*. Toronto, ON: Prentice Hall.

Tookoome, Simon and Oberman, Sheldon. (1999). *The shaman's nephew: A life in the far north*. Toronto, ON: Stoddart Kids.

Van Kirk, Sylvia. (1980). *Many tender ties: Women in the fur trade society 1670-1970*. Winnipeg, MB: J. Gordon Shillingford Publishing.

White, Bruce M. (2000). *Expressions in Canadian Native Studies*. Saskatoon, SK: University of Saskatchewan Extension Press.

Bibliography of Aboriginal Science and Aboriginal Science Education-related items

We would like to thank Professor Herman Michell of the Department of Science, First Nations University, for sharing his Aboriginal Science bibliography.

Aikenhead, G. (2000). *Rekindling traditions: Cross-cultural science & technology units*. Available at <http://capes.usask.ca/ccstu>.

Aikenhead, G., & Jegede, O. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. *Journal of Research in Science Teaching*, 36, 269-287.

Aikenhead, G. (1996). Science education: Border crossing into the subculture of science. *Studies in Science Education*, 27, 1-52.

Aikenhead, G. (1997). Toward a First Nations Cross-cultural science and technology curriculum. *Science Education* 81(2), 217-238.

Allen, G., & Seumtewa, O. (1988). The need for strengthening Native American science and mathematics education. *Journal of College Science Teaching*, 55, 364-369.

Allen, Nancy J. (1998). Voices from the Bridge: Worldview conflicts Kickapoo Students of Science. *Journal of Research in Science Teaching*, 35(2), 111-132.

Aveni, A. (Ed). (1975). *Native American Astronomy*. Austin: University of Texas Press.

Berkes, F. (1999). *Sacred Ecology: Traditional Ecological Knowledge and Resource Management*. Philadelphia: Taylor and Francis.

Bisbee, G. D. (1996). Building a Native American Drill: Students apply physics and engineering concepts to a Historical Technology. *Science Teacher*, 63(2), 40-42.

Black, Mary Bartholomew. (1967). *An Ethnoscience Investigation of Ojibwa Ontology and World View*. Ph.D. Dissertation, Sanford University.

Bol, M. C. (Eds). (1998). *Stars above, earth below: American Indians and nature*. Niwot, Colorado: Roberts Rinehart Publishers for Carnegie Museum of Natural History.

Bombay, H. (1996). *Aboriginal forest-based ecological knowledge in Canada*. Ottawa: National Aboriginal Forestry Association.

Buhner, S. H. (1996). *Sacred Plant Medicine: Explorations in the practice of Indigenous herbalism*. Boulder: Roberts Rinehart Publishers.

Caduto, M. J., & Bruchac, J. (1991). *Keepers of the Animals: Native American stories and wildlife activities for children*. Golden, Colorado: Fulcrum.

Caduto, M. J., & Bruchac, J. (1997). *Keepers of the Earth: Native American stories and environmental activities for children*. Golden, Colorado: Fulcrum.

Cajete, G. (1986). *Science: A Native American perspective: A culturally based science education curriculum*. Unpublished doctoral dissertation. International College, Los Angeles.

Cajete, G. (1994). *Look to the Mountain: An Ecology of Indigenous Education*. Skyland, North Carolina: Kivaki Press.

Cajete, G. (1999a). *Ignite the sparkle: A Native American Science Education curriculum model*. Skyland, North Carolina: Kivaki Press.

Cajete, G. (1999b). Reclaiming Biophilia: Lessons from Indigenous Peoples. In G.A. Smith, & D.R. Williams (Eds.). *Ecological Education in Action*. Albany: State University of New York Press.

Cajete, G. (2000a). *Native Science: Natural Laws of Interdependence*. Sante Fe, New Mexico: Clearlight Publishers.

Cajete, G. (2000b). Indigenous knowledge: The Pueblo metaphor of Indigenous education. In M. Battiste, (Ed), *Reclaiming Indigenous voice and vision*. Vancouver, BC: University of British Columbia Press. 181-91.

Christie, M. (1991). Aboriginal science for the ecologically sustainable future. *Australian Science Teachers Journal*, 37, 26-31.

Coburn, W., & Aikenhead, G. (1998). Cultural aspects of learning science. In B.J. Fraser & K.G. Tobin (Eds.), *International handbook of science education* (pp. 39-52). Dordrecht, Netherlands: Kluwer Academic Publishers.

Corsiglia, J., & Snively, G. (1997). Knowing home: Nisga'a traditional knowledge and wisdom improve environmental decision making. *Alternatives Journal*, 32, 22-27.

Corsiglia, J., & Snively, G. (1996). Global lessons from the traditional science of long-resident peoples. In G. Snively & A. MacKinnon, (Eds.). *Thinking globally about mathematics and science education*, (pp. 25-51). Vancouver, CA: University of British Columbia. Research and Development Group.

Couture, J. E. (1991). Explorations in Native Knowing. In J. W.Friesen, (Ed.), *The cultural maze: Complex questions on Native destiny in Western Canada*. Calgary: Detselig. 53-73.

Davison, D. M. (1992). Mathematics. In J. Reyhner (Ed.), *Teaching American Indian students*. (pp. 241-250). Norman, OK: University of Oklahoma Press.

Davison, D. M., and K. W. Miller. (1998). An Ethnoscience approach to curriculum issues for American Indian students. *School Science and Mathematics* 98, 260-265.

Deloria, V. Jr. (1995). *Red earth white laws: Native Americans and the myth of scientific fact*. New York, NY: Scribner.

Garrison, Edward R., (1995). Navajo Scientists of the next century – Laanaa Hasin. *Journal of Navajo Education* 12(3), 3-7.

Goodman, Ronald. (1990). *Lakota star knowledge*. Rosebud, South Dakota: Sinte Glaska College.

Greene, Rayna. (1981). *Culturally-based science: The potential for traditional people; Science and Folklore*. London: Proceedings of the Centennial Observation of the Folklore Society.

Griffin-Pierce, T. (1992). *Earth is my mother, sky is my father: Space, time and astronomy in Navajo sandpainting*. Albuquerque: University of New Mexico Press.

Hamilton, Candy. (1993). Combining High-Tech with Lakota Legend. *Winds of Change*, 8(3), 34-36.

Hampton, Eber. (1995). Towards a Redefinition of Indian Education. In M. Battiste, and J. Barman, *First Nations Education in Canada: The Circle unfolds*. Vancouver, BC: UBC Press. 5-46.

Haukoos, G., & Lebeau, D. (1992). Inservice activity that emphasizes the importance of the culture in teaching school science. *Journal of American Indian Education*, 32(1) 1-11.

Jegede, O., & Aikenhead, G. (1990). Transcending cultural borders: Implications for science teaching. *Research in Science and Technology Education*, 17, 45-66.

Johannes, R. (1989). *Traditional ecological knowledge: A collection of essays*. Gland, Switzerland and Cambridge, UK: IUCN.

Johnson, M. (1992). *Lore: Capturing traditional environmental knowledge*. Ottawa, CA: Dene Cultural Institute, International Development Research Center.

Kawagly, A. Oscar. (1990). Yup'ik Ways of Knowing. *Canadian Journal of Native Education*, 17(2), 5-17.

Kawagly, A. Oscar. (1995). *A Yupiaq worldview: A pathway to ecology and spirit*. Prospect Heights, Ill: Waveland Press.

Kawagley, A.O., & Barnhardt, R. (1998). *Education indigenous to place: Western science meets native reality*. ERIC ED426823, <http://www.ankn.uaf.edu/EIP.html>.

Kawagly, Angayuqaq, Oscar, D Noris-Tull, & Noris-Tull, R. A. (1998). The indigenous worldview of Yupiaq culture: Its scientific nature and relevance to the practice and teaching of science. *Journal of Research in Science Teaching* 35(2) 133-144.

Kidwell, C. (1991). Systems of knowledge. In A.M. Josephy, Jr. (Ed.), *America in 1492* (pp. 369-403). New York: Alfred A. Knops.

Kremer, Jurgen W. (1996). Indigenous science: Introduction. *ReVision* 18(3) 2-5.

Krugley-Smolka, E. (1994). An examination of some difficulties in integrating Western science into societies with an indigenous scientific tradition. *Interchange*, 25, 325-334.

Levy, D. (1992). *Bridging Tribal, Technological Worlds: Native Americans in science*. American Association for the Advancement of Science.

Lipka, J. (1990). Integrating cultural form and content in one Yup'ik Eskimo Classroom: A case study. *Canadian Journal of Native Education* 17(2) 18-32.

MacCallan, Sean. (1999). *Navajo Astronomy*. Unpublished manuscript. Albuquerque: University of New Mexico.

MacDonald, J. (1998). *The Arctic sky: Inuit Astronomy, star lore, and legend*. Toronto: Royal Ontario Museum; Iqaluit, NT: Nunavut Research Institute.

Martin, K. M. (1995). The foundational values of cultural learning: The Akhkwesahsne Science and Math Pilot Project. *Winds of Change*, 10 (4) 50-55.

Miller, D. S. (1997). *Stars of the First People: Native American star myths and constellations*. Boulder: Pruett Publishing company.

Moody, A. (1996). Connecting Native American stories and science. *Primary Voices K-6*. 4(3) 11-18.

Monroe, J. G. & Williamson, R. A. (1987). *The dance in the sky: Native American star myths*. Boston: Houghton Mifflin Company.

Nelson-Barber, S., & Trumbell Estrin, E. (1995a). Bringing Native American perspectives to mathematics and science teaching. *Theory into Practice*, 34 (3) 174-185.

Nelson-Barber, S., & Trumbell Estrin, E. (1995b). *Culturally responsive mathematics and science education for native students*. San Francisco: Far West Lab for Educational Research and Development.

Olstad, R., Juarez, J., Davenport, L., & Haury, D. (1981). *Inhibitors to achievement in science and mathematics by ethnic minorities*. Seattle: University of Washington. (Eric Document Reproduction Service No. ED 223 404).

Peat, F. D. (1994). *Lighting the seventh fire: The spiritual ways, healing, and science of the Native American*. Secaucus, New Jersey: Carol Publishing Group.

Pomeroy, D. (1994). Science education and cultural diversity: Mapping the field. *Studies in Science Education*, 24, 49-73.

Richau, D. (1981). *Introduce science to students using the environment: A guide for teachers of Native American students*. Native American Science Education Association.

Settee, P. (1998). *Honouring Indigenous science knowledge as a means of ensuring scientific responsibility*. Masters thesis. University of Manitoba, Canada.

Simonelli, G. (1994). Sustainable science: A look at science through historic eyes and through the eyes of indigenous peoples. *Bulletin of Science, Technology & Society*, 14, 1-12.

Smith, M. (1982). Science for the native oriented classroom. *Journal of American Indian Education*, 21, 13-14.

Snively, G. (1990). Traditional Native Indian beliefs, cultural values, and science instruction. *Canadian Journal of Native Education*, 17, 44-59.

Snively, G. (1995). Bridging traditional science and Western science in the multicultural classroom. In G. Snively & A. MacKinnon (Eds.), *Thinking globally about mathematics and science education* (pp. 1024). Vancouver: Centre for the Study of Curriculum & Instruction, University of British Columbia.

Snively, G., & Corsiglia, J. (2001). Discovering indigenous science: Implications for science education. *Science Education*, 85, 5-34.

Snow, Albert. (1972). Ethnoscience in American Indian Education. *The Science Teacher Magazine*, Vol. 39(7), 30-32.

Snow, A. (1974). *American Indian Ethnoscience: A study of its affects on student achievement*. Ed.D. Dissertation, University of Maryland.

Swift, D. (1992). Indigenous knowledge in the service of science and technology in developing countries. *Studies in Science Education*, 20, 1-27.

Weatherford, J. (1991). *Native roots, how the Indians enriched America*. Toronto: Random House.

Wendst, K. (1995). Ahkwesahsne Science and Math Pilot Project: A native approach to learning. *Pathways: The Ontario Journal of Outdoor Education* 8(3) 14-19.

Williamson, R. A., & Farrer, C. R. (1992). *Earth and sky: Visions of the cosmos in Native American Folklore*. Albuquerque: University of New Mexico Press.

Windham, T. L. (1997). Bridging Two Worlds: Native American students bring traditional knowledge to the study of Atmospheric Sciences. *Winds of Change* 12 (1) 38-42.

Zeilik, M. (1985). The Ethnoastronomy of the historic Pueblos: Calendrical sun watching. *Journal of the History of Astronomy*, 8, S1-S25.

Zwick, T.T., & Miller, K.W. (1996). A comparison of integrated outdoor education activities and traditional science learning with American Indian students. *Journal of American Indian Education*, 35. (2) 1-9.

References

- Alfred, T. (1999). *Peace, Power, Righteousness: An Indigenous Manifesto*. Don Mills, Ontario: Oxford University Press.
- Amadahy, Z. (2003). *The Healing Power of Women's Voices in Strong Women Stories*. Toronto, Ontario: Sumach Press.
- Bear, S. & Bear, W. (1980). *The Medicine Wheel*. Toronto, Ontario: Prentice-Hall.
- Brace, G. I. (2005). *Boulder monuments of Saskatchewan*. Boston and Saskatoon, Saskatchewan: Houghton.
- Cajete, G. (2000). *Native Science: natural laws of interdependence*. Santa Fe, New Mexico: Clear Light Publishers.
- Cruikshank, J. (1992). Oral tradition and material culture. *Anthropology Today*, 8(3): 5-9.
- Deerchild, R. (2003). *Tribal feminism is a drum song in Strong Women Stories*. Toronto, Ontario: Sumach Press.
- Dyck, L. (1998). An Analysis of Western, Feminist, and Aboriginal Science using the Medicine Wheel of the Plains Indians. In L. A. Stiffarm (Ed.), *As We See—: Aboriginal Pedagogy*. Saskatoon: University Extension Press.
- Federation of Saskatchewan Indian Nations, (2002). *A Research Report on The Schooling, Workforce and Income Status of First Nations Persons in Saskatchewan*. Regina: Education and Training Secretariat.
- Four Worlds Development Project. (1988). *The sacred tree: Special Edition*. Lethbridge, Alberta: Four Worlds International Institute for Human and Community Development.
- Governments of Alberta, British Columbia, Manitoba, Yukon Territory, Northwest Territories, and Saskatchewan (2000). *The Common Curriculum Framework for Aboriginal Language and Culture Programs: Kindergarten to Grade 12*. (Commonly known as the “Western Canadian protocol framework for Aboriginal language and culture programs” or “Western Canadian protocol”.) Retrieved September 23, 2005 from http://www.edu.gov.mb.ca/ab_languages/wncp_framework.html.
- Government of Canada. (2003). *Aboriginal Peoples of Canada: A Demographic Profile*. Ottawa: Statistics Canada. Retrieved September 30, 2005 from <http://www12.statcan.ca/english/census01/Products/Analytic/companion/abor/pdf/96F0030XIE2001007.pdf>. Accessed September 30, 2005 from

- <http://www12.statcan.ca/english/census01/Products/Analytic/companion/abor/contents.cfm>.
- Graveline, F. J. (1998). *Circle Works: Transforming Eurocentric Consciousness*. Halifax, Nova Scotia: Fernwood Publishing.
- Grigas, L. C. (1993). *Medicine Wheels: Tools of Adaptation in Aboriginal and non-Aboriginal Society* (Master of Arts dissertation, Department of Sociology and Anthropology, Carleton University). Ottawa: National Library of Canada.
- Hill, D. (1999). *Holistic Learning: A Model of Education Based on Aboriginal Cultural Philosophy* (Master of Adult Education dissertation, Saint Francis Xavier University, 1999). Ottawa: National Library of Canada. Retrieved September 20, 2005 from http://www.nlc-bnc.ca/obj/s4/f2/dsk1/tape8/PQDD_0020/MQ53622.pdf.
- Hodson, D. (2001). What Counts as Good Science Education. *OISE Papers in STSE Education*, 2, 7-22.
- Peters, E. J. (2005). *Atlas of Urban Aboriginal Peoples*. Accessed September 24, 2005 from http://gismap.usask.ca/website/Web_atlas/AOUAP/.
- Saskatchewan Education. (1991). *Native Studies: A curriculum guide for grade 10*. Regina, Saskatchewan: Saskatchewan Education. Accessed September 24, 2005 from <http://www.sasked.gov.sk.ca/docs/native10/>.
- Saskatchewan Education. (2000). *Aboriginal Education Provincial Advisory Committee Action Plan 2000-2005*. Regina, Saskatchewan: Saskatchewan Education.
- Saskatchewan Education. (2004). *Spiritual Development: An Overview* (draft). Regina, Saskatchewan: Saskatchewan Education.
- Tymchak, M. (2001). *School^{Plus} A Vision for Children and Youth. Final Report to the Minister of Education, Government of Saskatchewan*. Regina: Saskatchewan Instructional Development & Research Unit (SIDRU).
- Wheatley, M. (1994), *Leadership and the New Science: Learning about Organization from and Orderly Universe*. San Francisco: Berrett-Koehler Publishers, Inc.

Appendix: Collaborative Inquiry Committee Participants

The participants on the committee were invited as representatives of the diversity of actors and stakeholders involved in education in Saskatchewan. The Aboriginal members of the committee requested that they be identified by their Aboriginal heritage and First Nations or Métis affiliations. The Collaborative Inquiry Committee participants were:

Dave Baron
Director
Royal Saskatchewan Museum

Edward Doolittle – Graphic designer for the medicine wheel image in this document
First Nations University of Canada
Mohawk from Six Nations, Ontario

Dean Elliott
Science Curriculum Developer
Saskatchewan Learning

Ken Goodwill
First Nations University of Canada
Elder, Standing Buffalo Dakota First Nations

Sandra Jack
Nakoda Oyade Education Centre
Carry the Kettle Nakoda First Nation

Joanna Landry
Regina Catholic Schools
Cree/Métis from Cowessess First Nation

Betty McKenna
Moose Jaw Public School Division #1
Anishnabae Elder from Opaswayak, Manitoba

Iris O'Watch
First Nations/Métis Urban Partnership
Carry the Kettle Nakoda First Nation

Jan Phillips
Saskatchewan Science Centre

Sharon Poitras
First Nations/Métis Urban Partnership
Métis from Lebret

Ali Sammel – Principal Researcher and writer of this document
Chair of Science Education
University of Regina

David Still
Piapot First Nations School
Métis, Lebret Métis Local

Juanita Tuharsky – Writer of the section on Spirituality
Cochrane High School
Métis, Riel Local, Regina