Reports from the Field

Fostering Indigenous STEM Education: Mobilizing the Adventure Learning Framework through Snow Snakes

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In this contribution to JAIE’s new section, Reports from the Field, the authors examine a novel approach to engaging elementary students with science, technology, engineering, and mathematics (STEM) content through the culturally based context of an Indigenous game. In an attempt to engage students in meaningful ways, the framework for the curriculum contains three carefully integrated elements: (1) a culturally-based game, (2) an explicit integration of STEM content, and (3) a hybrid educational approach known as adventure learning (AL). The culturally based game of snow snakes, traditional to many American Indian communities, was the situating context. This curriculum integrated scientific content and inquiry, technological solutions, engineering design principles, and mathematical reasoning under the auspices of the snow snake context within an AL environment. This article also posits the organic coupling of the AL framework with elements of Indigenous education as offered by Cajete (1994). To achieve this, AL, Indigenous education elements, and the enacted snow snake curriculum are presented in unison.

STEM in K-12 Education

The role of science, technology, engineering, and mathematics (STEM) in K-12 education has become increasingly important, with millions of dollars being invested to support initiatives in this area (Kuenzi, Matthews, & Mangan, 2006; National Academies, 2006; National Governors Association, 2007; Sanders, 2009). STEM can be integrated into the K-12 classroom in meaningful ways, and reasons for doing this include the potential for improved student learning and achievement, an increase in awareness and interest in
engineering, and an increase in technology literacy (Katehi, Pearson, & Feder, 2009). One approach to integrating STEM into K-12 curriculum has been to highlight the natural connections between STEM disciplines (Katehi et al., 2009). Unfortunately, the current structure of schools does not allow for these connections to be easily made. Schools have traditionally “silod” topical areas and taught STEM subjects in isolation without drawing upon the holistic relational connections among them (Czerniak, Weber, Sandmann, & Ahern, 1999; Katehi et al., 2009; Sanders, 2009).

This article posits a potentially fruitful educational avenue by exploring how holistic Indigenous knowledge and an integrated STEM education approach can be mediated in part through an online environment to promote transformational learning experiences for American Indian youth. Although the authors observed transformational learning in students as a result of the snow snake curriculum, the emphasis here is on the melding of Indigenous knowledge, STEM content, and adventure learning (AL), precluding a full discussion of the data associated with the aforementioned transformational learning.

**Indigenous Education**

Today, the education system experienced by American Indian youth is, for the most part, derived from a Western model (Baker, 2003; McKinley, 2007). This model has failed to incorporate the knowledge so fundamental to American Indian being and understanding (Cajete, 1994, 1999). As a result, American Indian students have experienced a disproportionately large dropout rate in high school, and subsequent low enrollment in college (Hill, 1991; Nelson-Barber, 1995). To adequately meet the educational needs of American Indian youth, Cajete (1994) argues that a complete and thorough restructuring is needed. This would require an *indigenization* of the current K-12 educational paradigm as it relates to American Indian students (Deloria & Wildcat, 2001). Through an approach that reconceptualizes educational experiences for American Indian youth, the development of Indigenous scientists can be supported by addressing environmental, technological, societal, and resource management problems through an appreciation for nature and all its living creatures (Snively & Corsiglia, 2001). An appreciation for nature and all its living things is just one example of the holistic paradigm shift needed to accommodate diverse axiologies, ontologies, and epistemologies. According to Wilson (2008), “a change in one affects the others, which in turn effects new change in the original. All parts… are equal; no part can claim superiority over, or even exist without the [others]” (p. 70). Thus, a gestalt perspective must be considered for Indigenous education.

Deloria (1992) succinctly explained Indigenous knowledge as revolving around the idea that everything is interconnected. Cajete (2005) further explained this sentiment by recalling the Lakota phrase, *Mitakuye oasin* (we are all related), which conveys that many American Indian peoples view the world as fundamentally interrelated. This holistic and interrelated approach to knowing is derived from intimate interactions with the world for the purposes of survival.
Cajete, 1994, 1999). Consequently, this same view is equally related to American Indian students’ approaches and perceptions of education. Traditionally, American Indian education is holistic, taking into account all aspects of everyday life. Education then becomes “education for life’s sake” (Cajete, 2005, p. 70) where the approach to and the components of education flow seamlessly into how the learner interacts with various facets of life. According to Deloria and Wildcat (2001), it is the holistic nature of American Indian worldviews that was labeled as “savage superstition” (p. 1) by Western authorities in favor of individual subject areas. Thus, there are serious challenges when American Indian students are faced with assimilatory Western educational structures.

A number of scholars have contributed important work to the notion of students having to navigate multiple contexts within a school setting. Gutiérrez, Baquedano-López, and Tejeda (1999) discuss hybridity as the confluence of official and unofficial school activities forming a “third space.” It is within these third spaces that students begin to make connections between school and personal life worlds. Moje et al. (2004) build on the idea of third spaces by considering the varied and diverse funds of knowledge students have in a variety of contexts — from school, to home, to community and peer groups. Additionally, Moje, Collazo, Carrillo and Marx (2001) made inquiries specific to school science contexts, using the third space paradigm. Aikenhead and Jegede (1999) carefully address the negotiation students need to make in order to cross the “border” between a student’s life world and school science. They posit that through utilizing “matters of the heart,” such as flexibility, playfulness, and feelings of ease, students can successfully negotiate the borders between school science and their personal life world. As Aikenhead and Jegede explain, “collateral learning” occurs when a student is able to construct scientific and Indigenous concepts side by side.

The research is limited on how to engage learners in STEM education through an approach that respects and honors Indigenous pedagogies. Bang and Medin (2010) make an important contribution to this with their research exploring how students navigate multiple epistemologies. They note that American Indian students should be supported and encouraged to navigate the multiple epistemologies they are faced with in a school science setting. They also note that science, and in particular, STEM, is not acultural and should not be interpreted as such. Snively and Corsiglia (2001) highlight the dichotomy between Western modern science (WMS) and traditional ecological knowledge (TEK), and the necessity of supporting all students in crossing borders between the two. To assist students in crossing the border from the familiar to a facility with WMS, teachers should highlight students’ own diverse perspectives and instill a culture of appreciation for disparate perspectives. This can be done, in part, through combining Indigenous knowledge (IK) and TEK with WMS content (Snively & Corsiglia, 2001). Additionally, Brayboy and Castagno (2008) provide a valuable contribution by highlighting educational approaches that respect Indigenous youth (e.g. science-technology-society (Aikenhead, 1997), and the Rekindling
Traditions curriculum (Aikenhead, 2001); Brayboy and Castagno provide examples of how those approaches can unfold in the science classroom. Accordingly, our interest here lies in the role of pedagogical and educational technology practices that promote science as inquiry while fostering an Indigenous approach to STEM education.

Science as Inquiry

Inquiry-based instruction offers a strategy to bridge the divide between Indigenous and Western epistemologies. An example of utilizing science as inquiry is the science-technology-society (STS) approach offered by Yager (1993). An STS approach provides students an opportunity to explore a question or problem that is relevant and meaningful to them. In this way, student-centered inquiry can take place that engages scientific and technological tools within human experiential contexts (Yager et al., 2009). The essential features of STS, according to the National Science Teachers Association (NSTA) position statement include:

1. Student identification of problems with local interest and impact;
2. The use of local resources (human and material) to locate information which can be used in problem resolution;
3. The active involvement of students in seeking information that can be applied to solve real-life problems;
4. The extension of learning beyond the class period, the classroom, the school;
5. A focus on the impact of science and technology on individual students;
6. A view that science content is more than concepts which exist for students to master on tests;
7. An emphasis upon process skills which students can use in their own problem resolutions;
8. An emphasis upon career awareness — especially careers related to science and technology;
9. Opportunities for students to experience citizenship roles as they attempt to resolve societal issues they have identified;
10. Identification of ways that science and technology are likely to impact the future; and
11. Some autonomy in the learning process as individual issues are identified and used as the basis for science study. (Yager et al., 2009, p. 187-188)

Building on this approach is the idea of a place-based education offered by Sobel (2004). The interactions of the natural and built environment along with sociological factors of a place are combined for meaningful learning within a place-based education approach. This is especially true in Indigenous settings where the physical and cultural environment has shaped individuals, families, and communities and has engendered a deep connection to the land for thousands of years (Barnhardt & Kawagley, 2005). From a science education perspective, a place-based education approach carefully considers characteristics associated with a unique location geographically, the inherent interdisciplinary nature of a place, and the engagement of entities outside of the school setting (Semken & Butler Freeman, 2008).

The role of technology in connecting students to place should also be considered. Although there is scant research on the topic to date, using technological affordances to support a sense of place in students’ learning can have powerful pedagogical implications. As technologies continue to evolve to
accommodate sensory stimuli that attach students to place, the accessibility to those technologies will open up fruitful avenues for pedagogical inquiry for diverse learning needs.

To explore the issues identified above, we note that the outcomes of an Indigenous education parallel the adventure learning approach to education (Doering, 2004, 2006, 2007) in many ways. This understanding provided the motivation to explore how a STEM curriculum based on Indigenous practices could be aligned with the AL model of delivering education. Throughout the course of this work the first author communicated frequently and at length with a tribal elder (the fourth author) concerning the appropriateness of the experiences related to the AL approach. This article is therefore divided into two sections. In the first section we showcase the AL approach to education and the success of this approach in delivering culturally based curricula. The second section focuses on exploring how AL can foster Indigenous education through a project entitled Snow Snakes. We conclude by proposing future avenues for research.

**Adventure Learning**

The development of the AL approach to education is a result of the need to bring authentic contexts and content together through mechanisms that afford collaboration between students, teachers, and knowledge keepers around the world. Current AL initiatives have brought millions of students together online to discuss, debate, interact, and experience issues that range from global climate change to oil drilling to trans-boundary pollution (Doering, 2007). AL initiatives have focused on interdisciplinary education in K-12 contexts around the world (Doering, Miller, & Veletsianos, 2008). Importantly, the AL projects revealed numerous educational advantages ranging from enhanced cultural appreciation (Doering, 2004) to increased student learning and motivation (Doering, Scharber, Riedel, & Miller, 2010) to an enhanced global understanding while eliminating cultural misconceptions (Veletsianos & Eliadou, 2009).

Specifically, AL (Doering, 2006) is grounded in experiential (Kolb, 1984) and inquiry-based learning (Bransford, Brown, & Cocking, 1999; Dewey, 1997), where students become active participants in identifying and posing questions, solving real-world problems, and taking action within their own community (Doering, 2006). It is the synergy of these two learning theories infused into the design of AL environments that motivate student learning from experiences and inquiry — keys to authentic, meaningful learning (cf. Bransford et al., 1999; Dewey, 1997; Kolb, 1984; National Research Council, 1999; Rogers, 1969). The AL framework includes nine principles that define and guide the design and development of AL programs used throughout the world (see Figure 1) (Learning Technologies Collaborative, 2010).

The most notable AL programs to date are the GoNorth! Adventure Learning Series (Doering & Veletsianos, 2008) focused on global climate change in the circumpolar Arctic, and the Earthducation (www.earthducation.com) Adventure Learning Series focused on education and sustainability. In the
GoNorth! Adventure Learning Series, every year the GoNorth! expedition team of educators and explorers travelled live throughout circumpolar Arctic regions via dog sleds to provide opportunities for learners to explore real-world issues. The curriculum focuses on the issues and places of travel, travel experiences, and observations of the expedition team. Media artifacts from the field were delivered daily to an online learning environment that classrooms and individuals used to hold asynchronous and synchronous conversations with knowledge keepers and the expedition team. Knowledge keepers are defined as individuals that hold an understanding of concepts and content that supports the AL experience and associated curriculum. The Earthducation Adventure Learning Series focuses on researching the intersection of education and sustainability on every continent. The Earthducation team has traveled to Burkina Faso, Africa (http://lt.umn.edu/earthducation/expedition1/), Arctic Norway (http://lt.umn.edu/earthducation/expedition2/) and Australia (http://lt.umn.edu/earthducation/expedition3/) encouraging a global tapestry of learners who experience the culture, interviews, and collection of data, while at the same time sharing their own perspectives on education and sustainability on the EnviroNetwork (http://lt.umn.edu/environetwork/).

Adventure Learning as a Means to Foster Indigenous Education

The game of snow snakes was chosen as the context for this AL project because of its potential to be situated within historical and contemporary tribal traditions, while at the same time being used as a means to engage students with STEM content. The game of snow snakes is named from the way a carved piece of wood travels along a snow or ice track when thrown. The way the stick wiggles or
oscillates is said to look like a snake as it moves (Parker, 1909). Each participant has a carved and decorated stick (snow snake). Taking turns, participants throw their snow snake down a constructed ice track. Once all snow snakes are thrown by participants, the farthest snow snake is designated the winner.

The game of snow snakes has a rich tradition within tribal communities throughout North America (Culin, 1975; Parker, 1909; Reagan & Waugh, 1919; Skinner, 1914). Each tribe that played the game of snow snakes had unique variations and norms that guided play and participation. Snow snakes ranged in length from six inches to 10 feet and the tracks varied in form. Most typically a snow snake track is a narrow, concave trough set into snow or ice. Competitors use a throwing motion that allows them to release the snow snake very close to the surface of the track, therefore requiring bending at the waist and a side arm throwing motion. The snow snake game was a fun way to get outside during the long winter months in climates that fostered snow and ice (Culin, 1975). Today, the game of snow snakes is actively played by a number of tribal communities throughout North America. The Iroquois Confederacy currently represents the most active tradition. In communities within the White Earth reservation where this study took place, snow snakes is reemerging as a wintertime activity after a generation or two of dormancy. The accounts of those who actively played in their youth are coming from elders who are well on in their years. These stories are few and far between.

Through the past success of using AL to support the sharing of elder knowledge and cultural preservation, it was clear that the AL approach could be used to design and deliver the snow snake curriculum. The snow snake curriculum was developed for youth ages 11 to 14, through the Reach For the Sky (RFTS) program funded by the National Science Foundation as part of an Innovative Technology Experiences for Students and Teachers (ITEST) grant (for a related discussion of a RFTS program in northern Minnesota, see Carlson, Hardman, & Marczak, 2011). The snow snake activities took place within the White Earth reservation, which is located in the northwest quadrant of Minnesota. The snow snake program has been delivered each year since the winter of 2009.

The snow snake curriculum, which includes central questions and associated content, was co-constructed by a partnering tribal elder and university personnel. The snow snake context was identified through an expressed interest from the White Earth community to revisit the traditional game that was no longer being played by their young people. From this impetus, partnerships were sought with local schools within White Earth and other adjacent reservations to move forward with inclusion into science classes during the school day.

For this study, the snow snake curriculum was implemented through an AL online learning environment for nine weeks beginning in early January through early March, and encompassed five phases that took students through the adventure of learning, crafting, and competing within the snow snake context. The AL model was used to design the curriculum. The first phase had students explore local and academic knowledge about snow snakes. The second phase had students design
and test snow snake prototypes using appropriate STEM disciplinary knowledge. The third phase allowed students to apply their experiences from the second phase in creating their full-scale snow snake while also adding artistic renderings. The fourth phase enabled students to become familiar with the body mechanics associated with throwing a snow snake. Finally, the culminating event of the snow snake festival provided students, teachers, and the community an opportunity to celebrate the tradition and compete with one another.

To realize the connection between the snow snake curriculum, the AL model, and elements associated with an Indigenous education as offered by Cajete (1994), we detail each AL principle and explain the connections established with Indigenous education elements and the snow snake curriculum. The elements of Indigenous education as defined by Cajete (1994) were chosen because of the organic connections and similarities to that of the AL framework (see Table 1).

Table 1. Matrix of comparison between adventure learning and Indigenous education elements

<table>
<thead>
<tr>
<th>Adventure Learning Principle</th>
<th>Connections between Approaches</th>
<th>Indigenous Education Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration and interaction opportunities between students, knowledge keepers, peers, and content.</td>
<td>Empathy and affection were key elements in learning.</td>
<td></td>
</tr>
<tr>
<td>The utilization of the Internet for curriculum and learning environment delivery.</td>
<td>Many ways to learn, many ways to educate, many kinds of learners, many kinds of teachers, each honored for their uniqueness and their contribution to education.</td>
<td></td>
</tr>
<tr>
<td>The enhancement of curriculum with media and text from the field in a timely manner.</td>
<td>Learners need to see, feel and visualize a teaching through their own and other people’s perspectives.</td>
<td></td>
</tr>
<tr>
<td>Synched learning opportunities with the AL curriculum.</td>
<td>Teaching and learning are a collaborative contract between the teacher and learner. The teachable moment was recognized through synchronistic timing or creative use of distractions and analogies to define the context.</td>
<td></td>
</tr>
<tr>
<td>Pedagogical guidelines of the curriculum and online learning environment.</td>
<td>There are basic developmental orientations. Learning through each orientation involves finding personal meaning through direct experience.</td>
<td></td>
</tr>
<tr>
<td>Education that is adventure-based.</td>
<td>Life itself is the greatest teacher. It is only by experience and learning through all life’s conditions that one begins to understand how all we do is connected, and all the lessons that we must learn are related.</td>
<td></td>
</tr>
<tr>
<td>Identification of an issue and respective location of exploration.</td>
<td>Each learning situation is unique and innately tied to the creative capacity of the learner. Learning therefore, had to be connected to the life process of each individual.</td>
<td></td>
</tr>
<tr>
<td>Exploration of the issue, environment, local population, culture, and additional relevant factors that provide an authentic narrative.</td>
<td>Learning happens of its own accord if connections between self and natural world has been related.</td>
<td>Learning through reflection and sharing experience in community allows us to understand our learning in the context of greater wholes. In a group we come to understand that we can learn from another’s experience and perspective.</td>
</tr>
</tbody>
</table>
Therefore, a fruitful exploration into those similarities and connections through the enacted snow snake AL curriculum were undertaken with the hope of defining a new and powerful approach to serving American Indian students in the digital age. Although Cajete’s work (1994) is relied upon to characterize Indigenous education in this manuscript, an awareness of other Indigenous scholars’ work discussed in the literature review should be considered for similar curriculum projects in the future.

A Researched Curriculum Grounded in Inquiry
Inquiry-based problems provide a compelling context to explore content within an AL curriculum. By giving students the opportunity to enact their prior knowledge within real-world contexts while learning STEM content, learning and cultural appreciation are supported. Related to the AL principle of “a researched curriculum grounded in inquiry,” within the elements of an Indigenous education framework the idea of hardship is necessary for expanded consciousness and learning (Cajete, 1994). Hardship is proximate to problems, and problems require inquiry to be solved. When there is a hardship or a problem, the situation can be leveraged for student engagement and learning. This is consistent with the essential features of scientific inquiry as noted in the STS framework (NSTA, 2008-09) and place-based education (Barnhardt & Kawagley, 2005; Semken & Butler Freeman, 2008; Sobel, 2004).

The idea of hardship and problem solving was used within the snow snake curriculum design process. There were a number of problems that required resolution and a heightened consciousness from participating students. Learning outcomes drove the curriculum, which were:

1. Students will be familiar with STEM content associated with the context of snow snake;
2. Students will be familiar with the traditional game of snow snakes played during the winter months; and
3. Students will consider the similarities and differences between Western and Indigenous knowledge systems.

The STEM content associated with the curriculum was derived from the context and identified as appropriate for students’ level. For example, the physical science concepts associated with force and motion, including Newton’s laws of motion, friction, pressure, weight, surface area, etc., were derived from upper elementary content standards. Throughout the snow snake curriculum, we sought to highlight the similarities and differences between IK systems and Western thought.

STEM learning outcomes guided the central questions for each section of the curriculum. The following are examples of central questions for the prototype section:

1. What is a prototype?
2. Why use prototypes?
3. What scientific principles from preexisting technologies can inform the development of snow snake prototypes?
The central questions then guided the types of experiences students had in answering the questions. The overarching problem/question students set out to solve was: “How do you make the best snow snake?” Each section within the curriculum appealed to a part of this question, with all parts leading to a whole.

**Collaboration and Interaction Opportunities between Students, Knowledge Keepers, Peers, and Content**

Providing an opportunity for collaboration and interaction between participants in an AL environment is critical to the success of the learning process for students (Doering, 2007; Doering et al., 2008). Collaboration and interaction through the AL online environment can be both synchronous (e.g., knowledge keeper chats) and asynchronous (e.g., blog entries and discussion boards). Doering et al. (2010) found that student learning and motivation increased while learners were able to collaborate and interact around content shared through an AL environment.

This principle of the AL experience is well suited to meet multiple elements that Cajete (1994) has identified as important for Indigenous education. First, through collaboration and interaction, students, teachers, and knowledge keepers gain insight into the lived experience of others while developing the empathy and affection characteristics of learning within an Indigenous education model. Second, Cajete (1994) states, “teaching and learning are a collaborative contract between the teacher and learner” (p. 212). Both teachers and learners have valuable information to share and through collaboration both entities will grow in their respective understandings around a topic and of each other. The final element is that learning through reflection and sharing can further our individual thinking towards the greater whole. By opening ourselves to the understandings of others, our own preconceptions on a topic can be made more accurate, impacting learning (Cajete, 1994).

The snow snake AL program thrived when the collaborative opportunities were realized between students, teachers, and knowledge keepers. This was achieved through photo and video uploads, blogging (text and/or audio), and knowledge keeper chats. The online environment was known as the “snow snake den” and was the designated place where students, teachers and knowledge keepers could interact in meaningful ways as prescribed by the snow snake curriculum. For example, students and teachers uploaded photos and videos of their progress and experiences constructing and testing snow snake prototypes. By having the ability to see peer progress at a remote site, students were motivated by new design ideas that in turn promoted continued effort and varied design approaches. According to one of the students involved in the project, “…some kids really ask good questions and that kind of helps me find out some of the information that I need to know…” (student interview, February 16, 2010).

The knowledge keeper chats were conducted once a week during the snow snake AL program. The knowledge keeper chats corresponded with the content and activities of that week, thereby enriching the overall experience through a uniform and timely progression of the curriculum sequence. For this research,
knowledge keepers were identified and selected based on their facility with the subject matter as well as their proclivity towards seeking connections between Indigenous knowledge and other ways of knowing. Knowledge keepers included a tribal elder (the fourth author), an engineering education professor (a non-Native female), a STEM education specialist (a non-Native male), and an individual that had been identified as championing snow snake efforts in northern Minnesota (a non-Native male). An example of this, during the first phase of the snow snake curriculum the partnering tribal elder was the knowledge keeper. The elder discussed his experience and knowledge around snow snakes while providing an opportunity for students to ask questions through the online environment.

Utilization of the Internet for Curriculum and Learning Environment Delivery, and Curriculum Enhancement with Media and Text

The Internet and associated media and text are integral components of a successful AL program (Doering, 2007; Doering et al., 2010). The use of the Internet allows for sharing resources while affording collaboration and real-time updates. The enhancement of the curriculum with authentic media and text allows for static information to instantly become alive and real for the learners (Doering, 2006). Students who at one time only read about a phenomenon now experience it through media such as audio, video and Quicktime virtual realities.

In the spirit of an Indigenous education model, one of the important things to consider is “that there are many ways to learn, many ways to educate, many kinds of learners, many kinds of teachers, each honored for their uniqueness and their contribution to education” (Cajete, 1994, p. 212). The Internet and associated media afforded varied learning opportunities necessary for a quality Indigenous education. It brought geographically, philosophically, and culturally unique students and teachers from different schools together virtually to express ideas and learn from each other. For example, the design of the online learning environment allowed for interactive and collaborative experiences that were synched with the curriculum. Blogs and the ability to upload numerous images and videos enhanced student engagement through monitoring progress at other school sites. As students saw the progress of their peers, they were motivated by knowing that others were working towards the common goal of the snow snake festival while also providing snow snake design ideas.

The snow snake AL curriculum was further enhanced by “trail reports” from the field that provided progress for the week and an overview of activities conducted. The “field” included five school sites (each school had a majority Native American student population) participating in activities and their progression through the snow snake design and construction process. Trail reports were posted weekly to keep updates consistent with activities and to continue building momentum for the culminating snow snake festival and the developing “adventure.”
Synchronized Learning Opportunities with the AL Curriculum

The learning environment is magnified when aspects of the AL model are synchronized with one another. Using the archetype of the GoNorth! Adventure Learning Series as an example, experiences were designed so that during any week of the live expedition, students were able to learn science content through standards-based curricular activities that were brought to life through the media and experiences of the GoNorth! team. These experiences were then synchronized with a knowledge keeper chat on the scientific topic for that week that was also highlighted through media and text from the field.

An Indigenous education model recognizes the importance of synchronicity. Cajete (1994) identifies teachable moments as powerful opportunities to synchronize the current course of events with the serendipitous opportunity of a teachable moment. Coupled with this synchronistic timing is the idea of creatively using distraction for learning. A strategy of distract-to-attract-to-react is common for Indigenous educators. The Indigenous education model recognizes that leveraging the affordances presented in a learning context, either planned for or serendipitous, can result in powerful learning experiences for students (Cajete, 1994).

The snow snake AL curriculum provided three ways in which synchronized learning opportunities could be experienced, supporting the distract-to-attract-to-react approach posited by Cajete (1994). First, the online knowledge keeper chats paralleled the curriculum in the snow snake design and construction process. Second, all the STEM curriculum was aligned with snow snake construction and game experiences. As students designed their snow snakes, tribal elder accounts supported the STEM content. Thus, the snow snake curriculum engaged students in two-way learning through tribal elder accounts and Western STEM content. This type of learning was called “two-eyed seeing” by Mik’maq Elder Marshall (Hatcher, Bartlett, Marshall, & Marshall, 2009), meaning that a student had the advantage of learning the best from two knowledge systems and therefore had the potential to combine the two as needed. In this way students have more explanatory power through Indigenous knowledge and Western STEM.

The snow snake AL project strove to remain consistent with the prescriptions made by Doering (2006), keeping in mind that “the online learning environment where the media opportunities exist must be designed in tandem with the curriculum” (p. 210). Therefore, the activities and experiences students, teachers, and knowledge keepers had within the snow snake AL environment were directly linked back to a facet within the curriculum. For example, as students learned about preparing their snow snakes, they experienced a knowledge keeper chat with a tribal elder talking about traditional art.

Pedagogical Guidelines of the Curriculum and Online Learning Environment

Teachers need to have appropriate support for an AL curriculum to be integrated successfully (Doering & Veletsianos, 2008). Without structures to guide teachers with integration strategies, the effect on student learning is compromised.
Indigenous education embraces the complexities inherent in the classroom setting. However, instead of avoiding distractions, distractions are used for the benefit of the learning process.

The snow snake curriculum was written with pedagogical guidelines to assist teachers in the delivery of the curriculum while honoring the Indigenous education model through respect and accommodation for the rhythms of holistic perspectives. For example, the snow snake AL curriculum provided multiple pedagogical guidelines to use within the classroom that ranged from teacher directed to a more constructivist approach. Teachers were provided with a brief overview of each section of the curriculum. A teacher could choose to follow the scripted pedagogical guidelines exclusively, or, depending on existing curricular expectations unique to her or his situation, s/he could select the most congruent curricular components. It must be noted that throughout the delivery of the snow snake AL curriculum, the consistency by which the cultural implications were framed was limited. Efforts were made to highlight the similarities and differences between Indigenous knowledge and Western STEM constructs when addressing questions such as, “How do you make the best snow snake?”

**Education That Is Adventure-Based**

Adventure connotes interest and engagement for students. Dictionary.com defines adventure as “an exciting or very unusual experience” (Adventure, n.d.). For the GoNorth! Adventure Learning Series, the adventures unfolded in Arctic locales where expedition members explored scientific, cultural and sociological issues related to the curriculum. Each program had a beginning of the story, a heightened interaction, and an ending that students experienced.

Three elements associated with Indigenous education align with the adventure principle. First, “learners need to see, feel and visualize a teaching through their own and other people’s perspectives” (Cajete, 1994, p. 212). The second element highlights the importance of direct experiences for students and the associated personal meaning derived from those experiences (Cajete, 1994). Through student engagement with the adventure, their experience is heightened and personal meaning can be realized. Third, students experience community as they “learn from another’s experience and perspective” (Cajete, 1994, p. 213).

Contrary to what one may envision when s/he hears the word adventure, that of a large-scale expedition or a foray into a mountainous wilderness; the snow snake adventure was grounded in the revealing of the individual snow snakes and the mounting anticipation of the culminating activity, the snow snake festival. To support this adventure, a variety of mechanisms were in place: collaboration, competition, technology/media, and the snow snake festival. The progression of the snow snake curriculum lent itself to building anticipation and consequently motivating students.
Identification of an Issue and Respective Location of Exploration

An adventure can take place virtually anywhere. Through an AL environment, students can experience the adventure in meaningful ways, especially when the adventure resonates with local and cultural issues. Considering the use of local issues as a situating context, Indigenous education recognizes that all parts of life lead to a whole and are inherently related (Cajete, 1994). When coupling the AL curriculum development framework with Indigenous education it is paramount to incorporate local issues and contexts. Within these local issues and contexts there are innumerable STEM content connections that can be considered. Each local community has needs. Oftentimes these local needs parallel those of geographically distant communities. From these expressed local “issues,” the curricular experiences designed through an AL model can have powerful implications for students, teachers, and the community.

The culturally-based and historically played game of snow snakes and its effective dormancy during recent generations represents the “issue” in the “location” of the White Earth reservation. It was the expressed desire of White Earth community elders to inquire about this game that brought the issue to the forefront and has subsequently become the issue for exploration by students, teachers, knowledge keepers, and the community as part of the AL framework.

Exploration of the Issue, Environment, Local Population, Culture, and Additional Relevant Factors that Provide an Authentic Narrative

Once the “issue” is identified, the authentic narrative will take participants through the desired experience. The authentic narrative is the last piece of the puzzle (Veletsianos & Eliadou, 2009) that situates all of the aforementioned AL principles. The authentic narrative is important because it takes the AL principles discussed along with many of the Indigenous education elements and melds them together for transformational learning.

The authentic narrative of AL includes three Indigenous education elements. The first element states, “learning happens of its own accord” (Cajete, 1994, p. 212). By allowing learning to happen organically within the designed AL environment, authenticity is maintained. The second element emphasizes the unique nature of every learning situation and that in order for meaningful learning to occur it has to be connected to an individual’s life (Cajete, 1994). The narrative then is not only authentic to the place but also the individuals experiencing it. And lastly, the Indigenous education element of life itself being the greatest teacher (Cajete, 1994) supports notions of authentic narratives.

The authentic snow snake narrative began with students gathering local knowledge about snow snakes and then sharing it with their class. This local knowledge was gathered to paint a picture of the current practice and history of the snow snake game at White Earth. After local knowledge was secured, students explored historical academic or anthropological literature about snow snakes that highlighted not only snow snake traditions in Minnesota, or locally, but also gave a broad survey of snow snakes throughout North America.
Also important to the authentic narrative of snow snakes was the STEM content that drove many curricular efforts. The evolution of prototype designs provided students with an authentic personal narrative as they developed meaning around STEM concepts. The narrative continued as students applied the STEM knowledge gleaned from the prototype portion of the curriculum to the design and construction of the full-scale model. Students were able to inquire about how best to meet the design challenges of snow snake prototypes and full-scale models by manipulating variables of their choosing. In this way, each student’s authentic personal narrative contributed to the overall authentic narrative of the snow snake AL curriculum experience.

Summary

In this article we coupled two heretofore disparate educational frameworks — adventure learning (Doering, 2006, 2007; Doering et al., 2008) and elements of Indigenous education as offered by Cajete (1994) — within an inquiry-based STEM curriculum. To set the stage for this coupling we first looked at literature around STEM as an up and coming initiative for integrative curricular experiences. We then briefly looked at the state of Indigenous education in the United States followed by two thoughtfully identified prescriptions for addressing inquiry science education needs. The AL literature was reviewed and considered alongside Indigenous education as a foreshadowing of possibilities for providing a framework for promoting culturally relevant and inquiry-based STEM learning. In the second part of this article, AL, Indigenous education elements, and the enacted snow snake AL curriculum were presented in unison following an AL principle sequence.

AL has proven to be a powerful learning instrument for students from all over the world representing a myriad of cultural and philosophical backgrounds. American Indian youth deserve STEM learning experiences that highlight cultural aspects that resonate with who they are, where they live, and the experiences that shape their lives. Indigenous education elements capture these ways of knowing and provide a map that when coupled with inquiry-based STEM teaching and AL principles have the potential for transformational learning outcomes and experiences for American Indian youth.

From this discussion it is hoped that educational technologies, specifically through the lens of the AL framework, will be explored further for the design and delivery of Indigenous STEM education experiences. From the connections made herein, it is reasonable to call forth:

1. the design and development of learning experiences that utilize Indigenous contexts to deliver Western STEM content through AL and Indigenous education models;
2. further exploration of Indigenous ways of knowing that can be fostered through an AL environment; and
3. research on the interconnections between AL, Indigenous education, and STEM content for meaningful learning experiences for American Indian youth.
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