Traditional Aboriginal Pedagogy Improves Learning in a Large-Enrolment University Biology Class

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Abstract: Our research indicates that didactic lecturing is commonly used within large, first year university courses despite criticism in the scholarly literature on pedagogy. There is value in considering alternative teaching approaches and perspectives on learning that exist in pedagogy that has sustained traditional aboriginal knowledge for thousands of years. Here we show that the methods for teaching and learning based on traditional aboriginal pedagogy are much different from those of postsecondary university education in North America. We focus on large, first year biology classes and experimentally test the use of learning objects as it is at the core of traditional aboriginal pedagogy; the result was improved learning, particularly within groups for complex learning outcomes. We suggest that our approach is a model that can provide insights into the assemblage of knowledge, which will only be achieved through the application of complex theories among different disciplines and knowledge systems.

Running Head: Ancient aboriginal pedagogy improves learning

Introduction

Didactic instruction is the predominant method of teaching biological science at the postsecondary level despite criticism within the literature on contemporary pedagogy, and despite the absence of a didactic approach in the time-tested traditional pedagogies of many aboriginal cultures throughout the world. The literature on the scholarship of teaching and learning (SOTL) suggests superior alternative instructional approaches, such as experiential or active learning, yet the uptake of these successful methods is lagging (1,2). Strategies that are designed to ensure student satisfaction with their education (e.g., small student centered classes and personal contact with faculty) are in conflict with the large traditional lecture-based classes necessitated by fiscal imperatives (3). First year university courses are getting larger and often range from 1200-2000 students at medium to large institutions where the prevailing pedagogical approach is based on factual content and memorization, which results in low student engagement (1). Although alternative teaching approaches and perspectives on learning exist in aboriginal
knowledge systems, there has been little research on the aboriginal pedagogies that have sustained traditional knowledge within many of the world’s cultures for thousands of years.

Learning objects can be a tool for teaching in the students engages within students centered learning. The student works with an object (calculator, flower, etc.) while considering a leaning activity that is at the core of a pedagogical learning outcome. Learning objects appear to be used in both western academic institutions and within aboriginal cultures. We hypothesize that these physical or conceptual learning objects facilitates learning. Objects of knowledge have been used to aid field research in anthropology, have had diverse applications in museums for over a century, and are embodied within ancient pedagogy as pictographs and art drawings, etc. (11). In education, a learning object is a resource – often digital and web-based (12) – that can be used and re-used to support learning. Learning objects offer a conceptualization of the learning process; they provide smaller, self-contained, re-usable units of learning, which is at the core of learner-centredness, and experiential or inquiry-based learning and can be reinforced in different contexts (13, 14).

Our research approach engages the concept of ‘assemblage’ of knowledge (4), which involves a coming together of different ways of knowing and learning from two different knowledge systems: western scientific knowledge (SK) and indigenous traditional knowledge (TK). Our novel approach seeks to add value to the SOTL and both TK and SK. There are two complimentary objectives in this study namely, 1) Pedagogical TK & SK Surveys, which are used to compare pedagogical methods from remote aboriginal cultures within India with that of the predominant method for teaching biological science at postsecondary universities in North America and, 2) Case study of utilizing TK learning objects in SK undergraduate curricula in which we focused on a large, first year biology classes and experimentally test the use of TK learning objects in these classes as they have proved successful in many aboriginal cultures, and are often at the core of their traditional pedagogy.

Methods

Pedagogical TK & SK Surveys

Surveys of traditional aboriginal knowledge was carried out between 2010-2012 with three indigenous cultures within India, including the 1) Irulas in the Vellingiri Hills of the Western Ghats, 2) Malayali in the Kolli Hills of the Eastern Ghats, and 3) Rajbonshi in the Tangla Foothills of Assam (Fig. 1). We worked with the Centre for Biocultural Diversity (CBG) a local NGOs in India that was critical in establishing contacts within communities. In each village we selected 20-30 informants previously identified as the most knowledgeable members of the community concerning teaching and learning. The data was gathered using participant observation and semi-structured interviews (Newmaster et al. 2007), and standard ethnobiology field methods (Ragupathy et al. 2008) used within our research on the assemblage of biodiversity knowledge. Ethics approval was attained from the University of Guelph Research Ethics Board.

Academic surveys were conducted at 100 Universities in North America. This included 50 large (>30,000 students) and 50 small universities (<25,000 students). These large and small university datasets were stratified by 25 first year course and 25 senior course (4 year) respectively. Professors and instrucors were asked to identify the different methods used in teaching their respective classes. The data was classified into four categories (didactic; experiential; Community learning; open learning) using a clustering technique. Nonmetric multidimensional scaling (NMDS) using “R” software (R Core Team, 2012 - version 2.15.1). In
NMDS, the Bray-Curtis distance measure was used because of its robustness for both large and small scales on the axes. Data were standardized by species maxima and two-dimensional solutions were appropriately chosen based on plotting a measure of fit (‘stress’) to the number of dimensions. Stress represents distortion in the data and a stress value over 0.15 is high enough that the results are invalidated. One thousand iterations were used for each NMS run, using random start coordinates.

Case study of utilizing TK learning objects in SK undergraduate curricula

Experimental Design – Our research took place within the winter offering of BIOL 1040, a first year biology class with 1200 students per semester. We presented the same lecture 2/day to 600 students at a time within one lecture hall in which each lecture utilized one of two contrasting instructional methods (randomly selected) including 1) a control group that was lectured using the traditional didactic method with no learning object, and 2) the experimental group, which utilized a hybrid lecture that incorporated both a didactic approach and learning objects utilized in the way that they would traditionally be used to share TK. Both the control and experimental groups were taught the same material by the same professor, and both groups worked toward identical learning outcomes. Our measure of learning was estimated using student assessment from two types of multiple-choice exam style questions recorded in-class by electronic “Clicker” (or “personal response system”) responses for i) individuals and ii) groups of 4-5 students both of which were randomly selected from different sections within the lecture hall. The first type of exam question was based on simple learning outcomes and the second was constructed on more complex learning outcomes, both of which were clearly stated in the course syllabus and where used in separate lectures. This experiment was completed over two years in order to control for variance among different years. Statistical tests included the use of the Kruskal-Wallis non-parametric analysis of variance ANOVA to test for significant difference amongst the means. We conducted a student survey in class that explored student reflection on the use of learning objects and group learning.

Results

Pedagogical TK & SK Surveys

Here we show that the methods for teaching and learning based on traditional aboriginal pedagogy are much different from those of current postsecondary university education in North America. In surveys of TK within 100 aboriginal communities in India, we identified four key methods of learning used in aboriginal pedagogical methods: community, experiential, place-based and spiritual (Fig. 1). Elders from three distinct aboriginal communities emphasized that these are the key teaching methods that have sustained there knowledge through many generations. We also examined the syllabi of 100 universities in North America and identified four key methods of learning in university pedagogical methods, including the didactic approach, experiential learning, open learning, and community learning. Of these four methods, only experiential and community learning were shared with TK, though community learning was not commonly (2%) used in university education (Fig. 2). Didactic teaching was by far the most common method used in university education, but it was not recognized as a TK method of learning within the aboriginal cultures studied.
Didactic pedagogy is most commonly used within first year classes and large universities. We surveyed 100 universities in North America in order to gain some perspective on how often these four pedagogical methods are used within 1st and 4th year classes in both large and small institutions. To our knowledge this is the first published quantitative account of the different pedagogical methods used in higher education in North America. We found that didactic methods are more commonly used in 1st year when compared to 4th year classes (Fig. 2). Large universities (>30,000 students) utilize didactic methods more than small universities (<25,000 students). This supports unpublished claims from within the SOTL community that didacticism is highly engaged within first year classes in large universities. This is a fundamental problem in post secondary education given that didactic methods have been widely criticised in the literature (2, 5). The foundational pedagogical theory of Piaget (6) suggests that didactic learning should not be allowed to stultify the learner's desire to explore and theorise. Supporting research in the SOTL provides convincing rationale for avoiding didacticism, stating that it delivers large quantities of information that are quickly forgotten, while effectively stifling independent thought, creativity, and the desire to learn (1, 7). The outcome of this research suggests that students in education programs with no or low use of didactic methods have better performance, are more likely to stay on in post-secondary education, and will have longer participation in lifelong learning (5). There is growing appreciation that the old approach of didactic teaching is ill-suited to the intellectual, social, motivational, and emotional needs of the new internet/digital savvy generation (8, 9). Ironically, the recent ‘digital native’ (10) movement is unknowingly entrenched in the aboriginal pedagogy of TK in the way that it focuses on the use of spatial recognition of knowing where and how to access knowledge through the use of learning objects; digital natives refer to the generation developing with digital technologies.

Learning objects are at the core of how indigenous cultures teach and share TK, and they include any physical or conceptual object that facilitates learning (e.g., leaf, diagram, story). In this study, aboriginal elders emphasized that learning objects are ancient teaching tools used by their ancestors as one of the key tools for learning, and are always employed when sharing knowledge; this finding was recorded within 100% of surveys on TK teaching in our surveys. We found that university education utilizes learning objects in less than 1/3 of courses and less than 10% of lecture based classes. Our understanding of TK learning objects is similar to that of the concept of the ‘knowledge object’ defined by Entwistle and Marton (15). This goes beyond physical objects and ultimately results in the student constructing an explanatory model (16) that they use to describe the details of the learning process. TK objects incorporate spatial and temporal factors in a complex learning model that begins with a simple object, and then with time and experience, builds it into a complex framework of knowledge concerning some topic such as health or environmental sustainability.

**Case study of utilizing TK learning objects in SK undergraduate curricula**

We used traditional aboriginal pedagogy to improve learning within a large 1st year university class. Here, we compare learning produced by two contrasting instructional methods in a large-enrolment biological science course. The control group was lectured using the traditional didactic method with no learning objects. The experimental group utilized a hybrid lecture that incorporated both a didactic approach and learning objects used by i) individuals and ii) groups of 4-5 students, with learning objects utilized in the way that they would traditionally be used to share TK. Both the control and experimental groups were taught the same material by
the same professor, and both groups worked toward identical learning outcomes. Student assessment from multiple-choice exam style questions using in-class clicker responses indicated considerable variation between the control and experimental groups (Fig. 3). The experimental group with learning objects had significantly higher ($p<0.05$) scores than the control. The experimental effect was greater for exam questions based on more complex learning outcomes; mean scores were 17% higher for students who used learning objects for more complex exam questions. We considered the number of responses from students using their clickers to be representative of their engagement, and results showed that responses were at least 2-fold higher when using learning objects (Fig. 3). Scores from students in groups were not significantly different ($p<0.05$) from those of individuals for exam questions based on simple learning outcomes; simple to complex would follow that of Bloom’s taxonomy of learning outcomes. However, there was a significant difference between group and individual scores for complex learning outcomes. Engagement measured as the number of clicker responses was highest (almost 3-fold) for the group responses. The use of learning objects within a group appears to improve learning for complex learning outcomes because students can discuss the course material and gain alternative perspectives from their peers (insight via student survey).

**Discussion**

There is value in considering alternative teaching approaches and perspectives on learning that exist in pedagogy that has sustained traditional aboriginal knowledge for thousands of years. Our research indicates that didactic lecturing is commonly used within large, first year university courses despite criticism in the scholarly literature on pedagogy. We demonstrate that the methods for teaching and learning based on traditional aboriginal pedagogy are much different from those of postsecondary university education in North America. We found learning objects are at the core of traditional aboriginal pedagogy. In a case study we utilized TK learning objects within a large, first year biology classes in which we found improved learning, particularly within groups for complex learning outcomes. Although this approach is novel, it is underpinned by previous pedagogical research and TK from other cultures.

Learning within a community enriches the experience and gives socially relevant context (17). The learning community or community of inquiry is a fundamental principal to learner centredness because it engages open sharing of intellect and critical evaluations among the students (18). The learning community can include peers and a local community such as that of service learning, which combines formal instruction with a related service to the community (19). Service learning is underpinned by the authentic learning hypothesis in which students are directly engaged through intrinsic inquiry as they take ownership in the products of their education, if they are applied to the benefit of others in socially conscientious ways (20). During our fieldwork with the aboriginal communities in India, community learning was the most common method of teaching TK, and the high level of participation by members within the groups observed was fascinating. We were told that engaging the participants is easy when they are allowed to choose from natural groups formed on some common ground. For example, before breaking into groups an elder would put different learning objects on the forest floor and ask the students gather around objects that interest them, and then discuss what it is that they know and do not know about these objects. The elder already had woven a common thread among the objects, which was the learning outcome that all students would be engaged in during
this teaching and learning experience. Elders referred to teaching as a gathering of knowledge through these types of learning experiences, which accumulate over time.

Experiential learning, also referred to as inquiry-based instruction, is at the foundation of teaching inquiry-based science (21). This form of learning has advanced into theory on the four levels of inquiry-based learning in science education: confirmation inquiry, structured inquiry, guided inquiry, and open inquiry (22, 23). Knowledge is constructed in a social inquiry context where the student or learner is an active participant in the construction, renovation and demolition of knowledge as they make sense of the world in which they live (6, 17, 24). The key is the learner-centredness (25) mechanism that places a student at the centre of their education, engaging them in active learning (26). Active learning (27) refers to several models of instruction that promote learning through engagement in activities, such as interactive class discussions, think-pair-share exercises, short written "one minute paper" exercises, reactions to a video, collaborative learning in groups, and student debates. Active learning is underpinned by the literature on discovery learning (28), which is a method of inquiry-based instruction entrenched in constructivist pedagogical theory (6). The Association for the Study of Higher Education (ASHE) promotes the use of active learning throughout the USA because of its positive impact on student learning. From the perspective of TK, experiential and active learning are key elements in gaining knowledge (Fig. 1), where individuals intrinsically engage in learning through inquiry in an iterative process; elders in India told us it is very important to have students ask a variety of questions from many perspectives. This process of learning is often entrenched within the aboriginal community and often occurs in a specific TK place.

Place-based educational practices are recognized as an important part of learning within the SOTL, and they are foundational within the pedagogy of TK. Place-based learning has received national recognition and support as a way to foster civic responsibility while also enriching the learning experiences of all students, whether from rural, urban, indigenous or non-indigenous backgrounds (29). Connecting learning to the physical and cultural environment in which students are situated has special significance in indigenous settings, where people have acquired a deep and abiding sense of place and relationship to the land in which they have lived for many generations (30, 31). Traditional knowledge associated with local environments is a critical ingredient for developing interdisciplinary research into how traditional indigenous ways of learning and knowing can be drawn upon to expand our understanding of basic educational processes for all students. Some of our recent research has revealed that TK of biodiversity is sustained through visits and teaching within the diversity of TK places on the landscape; there is no classroom, but rather outings to various TK places. During this research we were taken to indigenous places where knowledge was shared through detailed observation, stories, dance, music, and the collection and preparation of food. Although the concept of place-based learning (32, 33) has been documented in many aboriginal cultures, contemporary education within most aboriginal communities continues to place an emphasis on classroom learning (34, 35). There is considerable literature on the pedagogy of place in both the SOTL, and within various academic units in western civilizations (29), as well as in the emerging online community of practice within the designed place-based environment of a virtual community (36). There is an ironic parallel between the place-based TK pedagogy and contemporary open learning pedagogy, which focuses on an approach to learning that gives students flexibility and choice over where and when they learn, and often includes aspects of e-learning (37), including Internet-based and multimedia technologies (38, 39). It should be noted that some experiential learning courses within University use a place-based approach in that they have field trips and site visits that give
some text to learning outcomes within the respective curriculum. A report by UNESCO calls for
the reinforcement of conventional approaches to education through innovative open learning
methods, if the fundamental right of all people to learning is to be realized (40). Perhaps there
needs to be a reinvigoration of education through traditional aboriginal pedagogy, which appears
to resonate with some of current trends in the scholarship of teaching and learning.

The traditional forms of aboriginal education still practiced in communities throughout
the world are recognized as complex knowledge systems with an adaptive integrity of their own
(41). The role of traditional knowledge systems is moving from the margins to the center of the
SOTL, thereby confronting some of the most intractable and salient educational issues of our
times (35). Indigenous people have their own ways of looking at and relating to the world,
nature, and one another (42). Indigenous scholars have begun to identify the epistemological
underpinnings and learning processes associated with TK systems (43). Their traditional
pedagogy was developed from observing natural processes, adapting to changing environments
and forging profound relationships within their community. All of this was made understandable
through demonstration and observation accompanied by thoughtful stories in which the lessons
were embedded (43). However, indigenous views of the world and approaches to education have
been jeopardized by the spread of Western social structures and institutionalized forms of
cultural transmission (30). Recent initiatives are incorporating multiple research traditions and
theories associated with cultural and contextual influences on learning, teaching, and cognition
(41). These include current theories associated with various forms of contextually or place-based
driven teaching and learning (44).

Conclusion

A hybrid model of education may provide the best approach for both aboriginal educators
and post secondary education. There has been some interest in a hybrid approach that includes a
mix of didactic and other contemporary methods such as experiential, open or service learning
(45). We designed a hybrid model for a large (>1800 students per year) first year biology class,
which included several pedagogical methods commonly used in teaching traditional knowledge.
This hybrid model (fig. 4) has now been in place for one year and we are monitoring several
parameters of learning, all of which indicate enhanced engagement and higher scores on exam
questions. The only aboriginal pedagogical method not employed by our hybrid model is
spiritual education due to our lack of understanding and the scarcity of literature on the subject
with respect to the SOTL. Our research suggests that spiritual learning is paramount to the
assemblage of new traditional knowledge. This might include the discovery of a new herbal
medicine within an aboriginal community by an elder on a spirit quest. We suggest that this
engagement is similar to how research scientists spawn scientific discoveries during periods of
deep, focused inquiry within the laboratory. Perhaps there is a role for this type of creative and
innovative thinking within the classroom. Although there is little research on the coming together
of a hybrid approach for western and indigenous teaching and learning, we feel that our research
provides some evidence for the benefits of traditional aboriginal pedagogy for i) advancing
SOTL, and ii) applying to teaching methods within post secondary education. We suggest that
our approach is a model that can provide insights into the assemblage of knowledge, which will
only be achieved through the application of complex theories among different disciplines and
knowledge systems. We hope that the approach will act as a catalyst for understanding the
dynamics that occur when diverse knowledge systems collide with one another.
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References:


Fig. 1. A) Aboriginal pedagogical methods identified through surveys of traditional knowledge (TK) within 100 aboriginal communities in India, and B) university pedagogical methods from surveys.
Fig. 2. Proportion of different pedagogical methods used in 1st and 4th year courses within large and small universities.
Fig. 3. Comparison of responses from simple and complex multiple-choice student assessments between a control group that did not use learning objects (LO) and an experimental group that used LO for both individuals and within groups (i.e., community learning). Sample numbers for each group are included in brackets (error bars indicate SEM).
Fig. 4. Proportion of different methods of learning used within traditional aboriginal pedagogy, North American universities and a new first year biology course, BIOL 1040 (1800 students/year), at the University of Guelph.