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Assessing The Impact Of Native American Elders As Co-Educators For University Students In Stem

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ASSESSING THE IMPACT OF NATIVE AMERICAN ELDERS AS CO-EDUCATORS FOR UNIVERSITY STUDENTS IN STEM

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DEDICATION

I dedicate my dissertation work to my mother and father, and all my family. A special feeling of gratitude to my loving parents, Omar and Mona, whose encouraging words and affection stay with me always. I dedicate this work and give special thanks to my husband and my wonderful daughter Kanzy for supporting me (and sometimes enduring me) during the entire doctoral program. Both of you were the foundation that enabled me to achieve all that I have. Finally, I also dedicate this dissertation to all those many friends and colleagues who supported me throughout everything. I will always appreciate all they have done.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Project Introduction

Community based participatory research (CBPR) is a partnership approach that aims to involve community members in research, as participants and/or researchers, in order to serve the community. Community based participatory research seeks to utilize community knowledge to improve research and provides benefits derived from the results to the research participants' community. The results of this type of research help to change communities for the better and improve quality of life (Agency for Healthcare Research and Quality, 2003). In addition, CBPR supports community members by helping them to learn new skills such as leadership and self-efficacy (Khanlou & Peter, 2005).

Community based participatory research serves an important role in improving quality of life, environment, and health for underrepresented minorities, specifically cultural-founded epistemological communities such as Native/Aboriginal (Jacklin & Kinoshameg, 2008; Bang & Medin, 2009). In academia, CBPR introduces cultural concepts and aspects to academicians, through the involvement of Indigenous and traditional peoples in pedagogy and research, which in turn positively impacts students' and instructors' learning, both for Indigenous and mainstream community members (Ferreira & Gendron, 2011). For instance, in courses focusing on Western science, utilizing different communities' epistemologies, values, and language not only broadens students' horizons and knowledge, but also improves teaching and learning (Bang & Medin, 2009).

This project aims to demonstrate CBPR's efficacy in supporting academic institutions that serve minority students in science, technology, engineering, and math (STEM), such as tribal colleges and minority serving institutions. Trained community members, including Indigenous Elders, participate in this project alongside academic scientists to address the

pedagogical needs of the underrepresented community, and to improve Indigenous students' learning in STEM courses, while benefiting all other students as well. By adding culturally relevant approaches and perspectives to the pedagogy, CBPR offers the potential for richer STEM research and teaching programs for minority and non-minority student populations, through appropriate cultural messaging and knowledge.

This dissertation project consists of three distinct phases. The first phase (chapter 1) aimed to find out where students learn about Indigenous science (e.g., natural health products (NHPs)), and if Elders comprise a part of this information source. The second phase (chapter 2) is a pilot study that attempted to locate differences between U.S. and Canadian as well as minority and non-minority university students taking an online STEM course concurrently. Further, the study examined students' perceptions of Indigenous Elders as STEM co-educators, student interest in STEM, and how students identify as scientists when Elders co-teach a STEM online course. Finally, the third phase (chapter 3) was a quasi-experimental study based upon the pilot study. It specifically aimed to find out if Elders are viewed as valuable educators of Indigenous science in a STEM course, and if their instruction (as an intervention) increases students' interest in STEM, strengthens their identification as scientists, and improves students' learning outcomes. The overall project findings may impact education, research, and policy towards increasing minority interest in STEM, while benefiting all students.

CHAPTER 1 (Phase 1): "Aboriginal and Non-Aboriginal Students Learn about Natural Health Products from Different Information Sources"

Introduction

Complementary and alternative medicine (CAM) is a broad term that includes many prevention and treatment methods, often used instead of allopathic Western medicine. Reasons people use CAM include maintaining health, relieving acute symptoms, treating chronic conditions, cosmetic purposes (Barnes et al., 2008) and improving physical or mental performance (Ferreira et al., 2012). Complementary and alternative medicine includes therapies such as meditation, massage, yoga, chiropractic treatment, and a variety of substances to be ingested or used topically (Barnes et al., 2008) such as natural health products (NHPs). Use of CAM has been increasing in North America. In the U.S., the number of adults who have ever used herbs or dietary supplements grew from 50.6 million in 2002 to 55.1 million in 2007 (Wu et al., 2011). In 2002, 36.0% of adults used CAM in the United States. By 2007, 38.3% of adults and 11.8% of children were using some form of CAM (Barnes et al., 2008). In Canada (1994–1995), a national telephone survey indicated that 15% of Canadians aged 15 years and over had visited at least one alternative health practitioner in the past year (Singh & Levine, 2006). The National Population Health Survey indicates that 15%, 16%, and 17% of the Canadian population consulted a CAM practitioner in 1994–1995, 1996–1997, and 1998–1999, respectively (Millar, 2001). A study conducted in 2002 about CAM use in the United States and Canada, has shown that the highest numbers of persons using CAM have the following characteristics: aged between age 20–64 years; are female; have higher education; and are White (McFarland et al., 2002).

One of the most common types of CAM used is NHPs. Natural health products, such as dietary supplements, functional foods, and ethnomedicines, are a multibillion-dollar per year

industry in North America. Largely unregulated, these products derive from whole organisms (e.g., plants, fungi, animals, algae, and bacteria) and are consumed in a variety of forms (e.g., fresh, dried, extracted, fermented, cooked) and ways (e.g., alone or mixed). While falling along the continuum of foods and drugs they are usually neither. They are often utilized primarily for disease prevention or treatment, physical/mental performance enhancement, or spiritual practice, rather than for food energy. The origins of many NHPs can be traced to regional traditional or ethnomedicine practices. In 2004, a new Canadian regulation (part of the Food and Drugs act) stated that NHPs include any plant, animal, or microorganismal products, vitamins and minerals, and homeopathic medicines used for disease prevention and treatment, as well as health and wellness maintenance (Andrews & Boon, 2005). Excluded from the mainstream definition of NHPs are blood products, commercial tobacco, marijuana, or any injectable form products (Andrews & Boon, 2005).

Two national surveys in the United States indicate that 12–14% of the sample used herbal preparations/natural supplements (Kaufman et al., 2002**)**. On the other hand, a national survey on NHPs used in Canada determined that 9.3% of Canadians had used botanical and naturally derived nonbotanical products in the past 2 days in 2000–2001 (Singh & Levine, 2006). In a Canadian study published in 2002 it was reported that 13% of the men and 16% of the women had used at least one herbal supplement within the last 24 hours (Troppmann et al., 2002). In 2010, a survey, conducted using computer assisted telephone interviews, indicated that up to 73% of the interviewees used NHPs (Health Canada, 2012).

Singh and Levine (2006) have assessed the prevalence of NHPs use, user characteristics, and user rationale for NHPs use in Canada. For example, they report that women were more likely to use NHPs than men, especially between the ages of 36–75 years where women were

1.5–2 times more likely to use NHPs. Natural Health Products use was more prevalent in White respondents compared to non-White respondents. However, this study and others excluded or insufficiently represented important ethnic subgroups (Singh & Levine, 2006). Another study indicates the importance of traditional medicine use across different ethnicities/cultures for disease treatment or illness prevention (Singh & Levine, 2006; Arcury et al., 2007). Many of the cited studies do not address the Aboriginal/Native American population (Arcury et al., 2007; Wu et al., 2011; Foote et al., 2003). However, the National Center for Complementary and Alternative Medicine report states that 43.2% of the sample, who used selected CAM categories in the past 12 months 2007, in the United States is American Indian/Alaska Native (U.S. Department of Health & Human Services, 2008). This suggests how important it is to include Aboriginal and Native populations in any study about CAM and NHPs.

There are some published studies that discuss the prevalence of NHPs use amongst students. A study regarding nonvitamin nonmineral (NVNM) supplement use amongst college students shows that college students use such supplements more than middle-aged adults. The authors suggest that college students more likely have higher exposure to advertising from television, internet, and magazines (Newberry et al., 2001). Another study assessed the prevalence of NVNM supplement use amongst university students (Perkin et al., 2002). It was found that 51.7% of the participants learned about NVNM supplements from their friends and family, 43% received their information from health food stores, 31.6% learned from magazine and newspapers, and 3.8% from dietetics professionals (Perkin et al., 2002). A Turkish study of NVNM supplement usage amongst university students indicates that the most frequently used sources of information about NVNM supplements are television (76.3%), magazines and newspapers (41.5%) and internet websites (37.3%) (Ayranci et al., 2005). In a study conducted at

the State University of New Jersey examining herbal use by students, it was found that the majority of students use non-health professional sources of information about NHPs such as family, friends, and media (Ambrose & Samuels, 2004). Amongst older adults, 51.6% of the participants using NVNM supplements revealed that the media was their source of information (Wold et al., 2007). Another study of older adults and their use of NHPs indicated that 49% of the sample, who used NHPs, learned about NHPs from friends and family (Levine et al., 2009). Despite the documented increase in the prevalence of NHPs use in the adult North American population, these prior studies do not yet show a clear picture about the NHPs used by students, and the sources of information from which students might learn about NHPs. Currently, it seems that most students learn about NHPs from non-health professional sources such as family, friends, and media.

In 2010, a telephone survey conducted in Canada indicates that respondents show strong interest in learning more information regarding NHPs, and indicate interest in all potential sources of such information presented to them (e.g., physicians, websites, publications, dieticians, nurses, family, and friends). The respondents indicate many possible ways to learn about NHPs, from traditional health care channels to various media sources. This survey indicates that the preferred ways to learn about NHPs are from physicians (55%), newspaper articles (48%), family and friends (46%), and magazines (46%). While this survey is indicative of preferred sources of NHPs information amongst adult Canadians, it does not clarify possible ethnic variations in utilized information sources by students (Reid, 2011).

Complementary and alternative medicine use amongst adult North Americans is increasing, and NHPs are a commonly used form of CAM. Some studies have begun to characterize the prevalence of CAM/NHP use amongst North American population subgroups,

such as adult ethnic minorities. Other studies have begun to characterize how adults learn about NHPs. To date, the prevalence of CAM/NHPs use amongst Aboriginal/Native university students is unclear, as are any differences in the sources of information utilized by Aboriginal/Native students to learn about NHPs as compared to mainstream (non-Native) students.

The main objectives of this study are to determine the proportion of NHPs users amongst Canadian university students (Aboriginal and non-Aboriginal) and to identify the sources of information utilized by students to learn about NHPs. We hypothesize that Aboriginal/Native students use NHPs more than non-Aboriginal students, and there will be a difference between Aboriginal and non-Aboriginal students in how they learn about NHPs. Plants are an important component of the Aboriginal culture and Aboriginal people have a long history of using these as food and medication. We would expect that they would use NHPs more than other mainstream groups. In addition, we hypothesize that Aboriginal students are more influenced by family/cultural members in how they learn about NHPs. Finally, we hypothesize that older students are more strongly influenced by family/cultural members than are younger students, who may be more strongly influenced by media sources of NHPs information.

Methods

Definition

In this study we define natural health products (NHPs) as naturally derived bioactive organisms (e.g., plants, fungi, animals, algae, and bacteria) and their products, excluding dietary supplements such as vitamins and minerals, food replacement formulas, protein formulas, amino acids, and weight gain formulas. In particular, we focus upon naturally derived botanicals and their products.

Study Sample

This cross-sectional study was conducted at First Nations University of Canada (FNUniv) and the University of Regina (UofR), Regina, Saskatchewan, Canada, during Fall 2011. Regina is the capital city of the Canadian prairie province of Saskatchewan. In the fall of 2010, UofR enrolment was 12,458 students, and FNUniv enrolment was 625 students. During that period, there were 389 Aboriginal students and 180 non-Aboriginal students enroled at the FNUniv. This compares to 689 Aboriginal students and 8,757 non-Aboriginal students enroled at the UofR. On average, the student body at the FNUniv is comprised of 77% females and average student age is 28–29 years. The FNUniv was established in 1976 as the Saskatchewan Indian Federated College through a federated partnership with the UofR. Its mission is to enhance the quality of life, and to preserve, protect, and interpret the history, language, culture, and artistic heritage of Native/Aboriginal people.

A total of 963 students completed the survey from both universities combined. To be admissible to participate in the research, students had to be 18 years and over, attend the FNUniv or UofR, and be able to complete the questionnaire. Tables were set up at the universities and students were invited to fill out the survey. With permission from the instructors, classrooms were also visited. Thus, the participants were recruited as a convenience sample. The survey was also sent to FNUniv campuses in Saskatoon and Prince Albert, Saskatchewan. Participation was voluntary and anonymous. The Research Ethics Board, UofR, approved this project (File #91R1011).

Questionnaire Design

The survey contained three parts. Part One asked the respondents about demographics (e.g., ethnicity, age, grade level, gender, self-reported health status, and commercial tobacco

smoking status). Part Two of the survey contained ten questions about medicinal plants and herbal product use. Part Three of the survey contained a list of medicinal plants and herbal products commonly used in North America. Students could add NHPs that they used, if they were not on the provided list of botanicals. Results from these questions will be examined in a companion paper.

Statistical Analysis

Of the 214 Aboriginal students and 749 non-Aboriginal students who participated in the survey (total=963), nine respondents did not fill in age, and were omitted from the age group comparison. In the data analysis, we used the full sample in Table 1 analyses; however, we only used 174 Aboriginal and 458 non-Aboriginal students in the other data analyses. Natural health products nonusers were omitted from further analysis. Chi square and Fisher's exact tests were used to assess associations between Aboriginals/non-Aboriginals and each source of NHPs information (e.g., family member, Elder or healers, media, etc.). Multiple logistic regression models were used to assess adjusted associations between respondent characteristics and each of nine NHPs information sources. These were applied to the demographic data (e.g., age, gender, grade level, self reported health, and smoking status). Descriptive statistics and 95% confidence intervals (CIs) were used to compare data between and within the Aboriginal and non-Aboriginal groups. A p value equal to or less than 0.05 was considered to be statistically significant. All data were analyzed by using SAS® 9.2 software.

Power analyses for this study determined 83% power to detect a difference in proportions of 40% versus 50%, and 84% power to detect a difference in proportions of 10% versus 17%, for the total sample size of 963 if the groups (Aboriginal and non-Aboriginal) to be compared split 2:1 (e.g., 642:321). For the analyses restricted to respondents reporting NHPs use, the total

usable sample size of 639, if split 2:1 for a factor, would give 82% power to detect a difference in proportions of 38% versus 50%, and 84% power to detect a difference in proportions of 10% versus 19%.

Results

Chi-Square

We found that only Aboriginal students showed a statistically significant relationship with Elders or healers, as a source of information about NHPs, $\chi 2(1)=169.85$, $p<0.001$. We also found that only non-Aboriginal students showed a statistically significant relationship with print media, as an information source, $\chi 2(1)=13.90$, $p=0.0002$. Non-Aboriginal students showed a statistically significant relationship with alternative and conventional health care providers as a source of information about NHPs, $\chi 2(1)=6.13$, $p=0.0133$ and $\chi 2(1)=9.56$, $p=0.0020$, respectively.

Table 1 shows the comparison of survey respondents with and without natural health product (NHPs) use amongst 963 responding students, excluding 9 respondents omitted from the age group comparison. There were 214 (22.2%) Aboriginal and 749 (77.8%) non-Aboriginal respondents (data not shown). Of the respondents, 639 (66.3%) indicated use of NHPs, while 324 (33.6%) indicated no such use. Thus, a majority of surveyed students use NHPs.

Table 1:
Comparison of Survey Respondents with and without Evidence of Natural Health Product Use

Variable	*Response*	*No NHP Use (N= 324)*	*NHP User (N= 639)*	*p-value*
Age	18-19 Years	167 (41%)	236 (59%)	<. 001
	20-21 Years	73 (35%)	134 (65%)	
	22-23 Years	35 (30%)	80 (70%)	

Variable	*Response*	*No NHP Use (N= 324)*	*NHP User (N= 639)*	*p-value*
	24-25 Year	11 (16%)	58 (84%)	
	26-30 Year	23 (27%)	61 (73%)	
	31-40 Year	12 (24%)	39 (76%)	
	41+ Year	1 (4%)	24 (96%)	
Older Age	18-25 Year	286 (36%)	508 (64%)	<.001
	26+ Year	36 (23%)	124 (78%)	
University Grade Level	1st Year	135 (36%)	238 (64%)	0.481
	2nd Year	94 (34%)	179 (66%)	
	3rd Year	42 (30%)	98 (70%)	
	4th+ Year	43 (34%)	84 (66%)	
	Graduate	8 (24%)	26 (76%)	
Gender	Male	97 (35%)	183 (65%)	0.933
	Female	219 (34%)	426 (66%)	
	Transgendered	2 (29%)	5 (71%)	
Canadian	Non-Canadian	34 (33%)	68 (67%)	0.666
	Canadian	232 (36%)	421 (64%)	
Health Rating	Poor	0 (0%)	5 (100%)	0.042
	Average	156 (34%)	308 (66%)	
	Good	86 (41%)	123 (59%)	
Tobacco Use	Yes	44 (23%)	150 (77%)	<.001
	No	278 (37%)	472 (63%)	

Variable	*Response*	*No NHP Use (N= 324)*	*NHP User (N= 639)*	*p-value*
Q1: Use of NHP for Health	Yes	0 (0%)	482 (100%)	<.001
	No	322 (67%)	157 (33%)	
Q2: Use of NHP for Health in Last Year	Yes	0 (0%)	409 (100%)	<.001
	No	45 (17%)	225 (83%)	
Q3: Age Learned About NHPs	0-10 Years	0 (0%)	142 (100%)	<.001
	11-16 Years	2 (1%)	221 (99%)	
	17-25 Years	3 (2%)	129 (98%)	
	26+ Years	0 (0%)	12 (100%)	
	Not applicable	6 (25%)	18 (75%)	
	Not sure	4 (4%)	97 (96%)	
Q5: Cost per Month	Less than $5	6 (2%)	364 (98%)	0.813
	$5-$10	1 (1%)	92 (99%)	
	$10-$25	0 (0%)	74 (100%)	
	$26-$50	0 (0%)	37 (100%)	
	$51-$100	0 (0%)	14 (100%)	
	More than $100	0 (0%)	10 (100%)	
Q6: Told Physician About NHP Use	Yes	0 (0%)	99 (100%)	0.014
	No	6 (2%)	303 (98%)	

Variable	*Response*	*No NHP Use (N= 324)*	*NHP User (N= 639)*	*p-value*
	Not applicable or don't remember	11 (5%)	198 (95%)	
Q7: Asked Physician About NHP Use	Yes	7 (9%)	73 (91%)	<.001
	No	266 (39%)	421 (61%)	
	Not applicable or don't remember	49 (26%)	140 (74%)	
Q8: Use Physician Prescribed Meds	Yes	180 (33%)	359 (67%)	0.747
	No	140 (34%)	267 (66%)	
Q9: Use OTC Meds	Yes	207 (33%)	412 (67%)	0.805
	No	114 (34%)	219 (66%)	
Q10: Have Sufficient Info on NHP	Yes	27 (13%)	189 (88%)	<.001
	No	76 (34%)	148 (66%)	
	Haven't looked for information	218 (42%)	298 (58%)	

Age and NHPs Usage Amongst Students (Aboriginal and Non-Aboriginal Students Combined)

Age was collapsed into two categories: one category for those who are “younger” (18–25 years), and a second category for those who are “older” (26 years and above). Amongst younger age (18–25 years), 64.0% (508/794) of the respondents use NHPs.

There is a significant difference ($p < 0.001$) between users and nonusers of NHPs by age. Amongst the older age group (26 years and above) 78% (124/160) use NHPs compared to 64%

(508/796) of those 25 years and younger. Natural health products are popular amongst students of all ages.

Gender and NHPs Usage (Aboriginal and Non-Aboriginal Students Combined)

Natural health products are popular for both genders, with 65.3% (183/280) of the male respondents and 66.0% (426/645) of the female respondents using NHPs.

Commercial Tobacco Products Users and NHPs Usage (Aboriginal and Non-Aboriginal Students Combined)

Amongst commercial tobacco users, 77.3% (150/194) use NHPs and 62.9% (472/750) of nonsmokers use NHPs. Although smokers are more likely to use NHPs, NHPs are popular amongst both commercial tobacco users and nonusers ($p < 0.001$).

Table 2 shows the comparison between Aboriginal and non-Aboriginal respondents who use NHPs. Respondents who did not report any direct or indirect information about NHPs use were omitted from this analysis. There were 174 (174/214= 81.3%) Aboriginal respondents and 458 (458/749= 61.1%) non-Aboriginal respondents who answered "yes" to the NHPs usage question, or who answered another question implying such use.

Use of NHPs for Health (Aboriginal versus Non-Aboriginal Students)

This question in Part Two of the survey asks the respondents if they use NHPs for health. There was a statistically significant difference between Aboriginal and non-Aboriginals in NHPs use. Aboriginals are more likely to use NHPs for health than non-Aboriginals (83% versus 62%, $p = 0.039$).

Figure 1:

Percentages Reporting each NHPs Information Source by Students Ethnicity.
*Significant Differences are Shown with an **

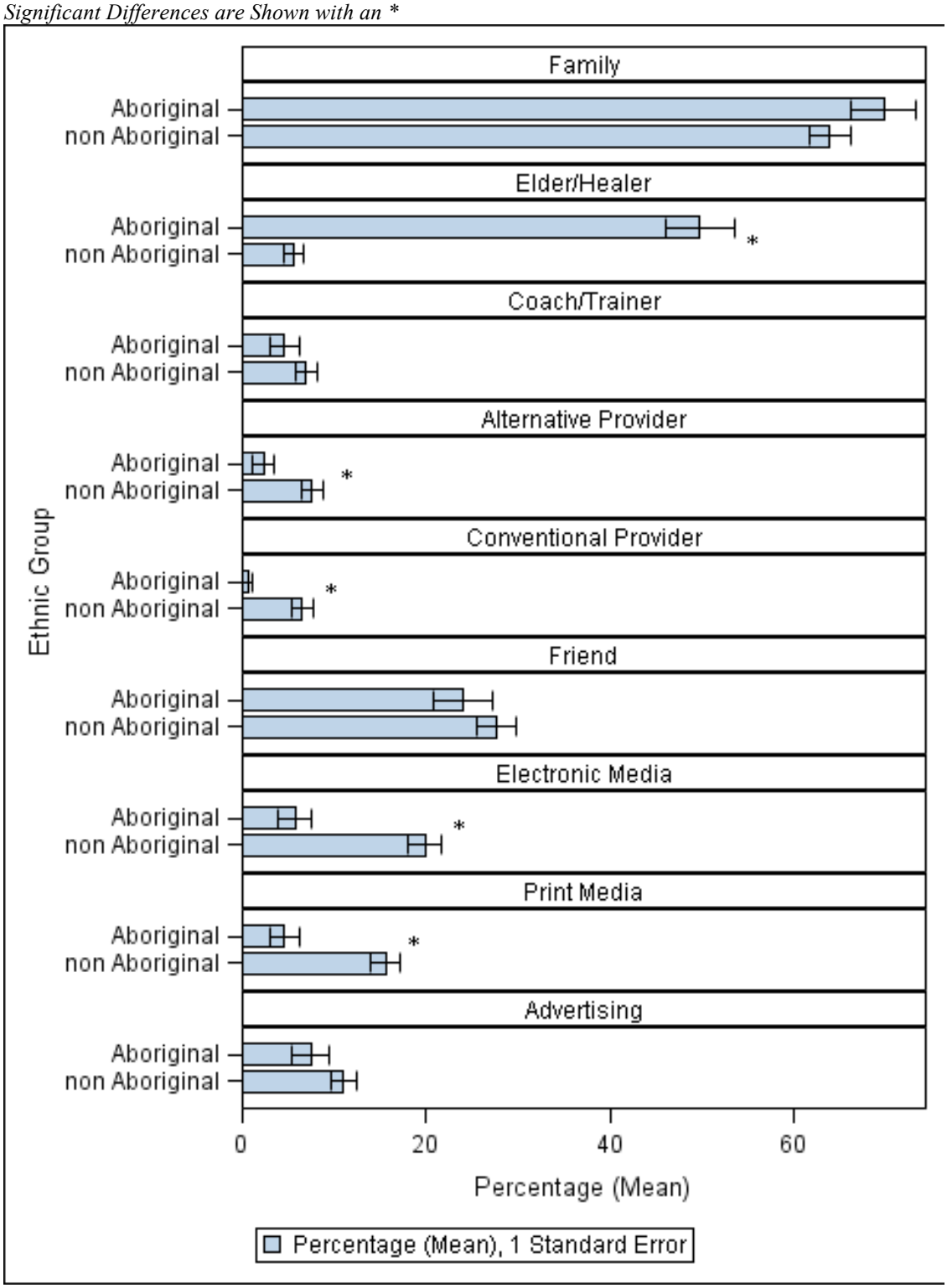


Table 2:
Comparison Between Aboriginal and Non-Aboriginal Respondents who use Natural Health Products

Variable	*Response*	*Non Aboriginal (N= 458)*	*Aboriginal (N= 174)*	*p-value*
Age	18-19 Year	203 (44%)	33 (19%)	<.001
	20-21 Year	109 (24%)	25 (14%)	
	22-23 Year	62 (14%)	18 (10%)	
	24-25 Year	34 (7%)	24 (14%)	
	26-30 Year	34 (7%)	27 (16%)	
	31-40 Year	15 (3%)	24 (14%)	
	41+ Year	1 (0%)	23 (13%)	
Older Age	26+ Year	50 (11%)	74 (43%)	<.001
University Grade Level	1st Year	190 (42%)	48 (28%)	0.007
	2nd Year	129 (28%)	50 (29%)	
	3rd Year	61 (13%)	37 (22%)	
	4th+ Year	55 (12%)	29 (17%)	
	Graduate	20 (4%)	6 (4%)	
Gender	Male	142 (31%)	41 (19%)	0.104
Canadian	Canadian	291 (81%)	130 (99%)	<.001
Health Self Rating	Poor	2 (1%)	3 (2%)	<.001
	Average	203 (65%)	105 (83%)	
	Good	105 (34%)	18 (14%)	
Tobacco Use	No	382 (85%)	90 (53%)	<.001
Q1: Use of NHP for Health	No	124 (27%)	33 (19%)	0.039
Q2: Use of NHP for Health in last year	No	166 (36%)	59 (34%)	0.655
Q3: Age Learned About NHPs	0-10 Year	86 (19%)	56 (33%)	<.001
	11-16 Year	178 (40%)	43 (25%)	
	17-25 Year	90 (20%)	39 (23%)	
	26+ Year	4 (1%)	8 (5%)	
	Not applicable	14 (3%)	4 (2%)	

Variable	*Response*	*Non Aboriginal (N= 458)*	*Aboriginal (N= 174)*	*p-value*
	Not sure	76 (17%)	21 (12%)	
Q4: Learned, Family Member	Yes	296 (64%)	122 (70%)	0.192
Q4: Learned, Elder or Healer	Yes	26 (6%)	87 (50%)	<.001
Q4: Learned, Coach/Trainer	Yes	32 (7%)	8 (5%)	0.360
Q4: Learned, Alternative Provider	Yes	35 (8%)	4 (2%)	0.015
Q4: Learned, Conventional Provider	Yes	30 (6%)	1 (1%)	<.001
Q4: Learned, Friend	Yes	128 (28%)	42 (24%)	0.422
Q4: Learned, Electronic Media	Yes	92 (20%)	10 (6%)	<.001
Q4: Learned, Print Media	Yes	72 (16%)	8 (5%)	<.001
Q4: Learned, Advertising	Yes	51 (11%)	13 (7%)	0.237
Q5: Cost per Month	Less than $5	260 (60%)	104 (67%)	0.225
	$5-$10	74 (17%)	18 (12%)	
	$10-$25	58 (13%)	16 (10%)	
	$26-$50	28 (6%)	9 (6%)	
	$51-$100	10 (2%)	4 (3%)	
	More than $100	5 (1%)	5 (3%)	
Q6: Told Physician About NHP Use	Yes	71 (16%)	28 (17%)	0.864
	No	217 (50%)	86 (52%)	
	Not applicable or don't remember	146 (34%)	52 (31%)	
Q7: Asked Physician About NHP Use	Yes	52 (11%)	21 (12%)	0.682
	No	304 (66%)	117 (68%)	
	Not applicable or don't remember	106 (23%)	34 (20%)	
Q8: Use physician prescribed Meds	No	199 (44%)	68 (40%)	0.332
Q9: Use OTC meds	No	159 (35%)	60 (35%)	0.902

Variable	*Response*	*Non Aboriginal (N= 458)*	*Aboriginal (N= 174)*	*p-value*
Q10: Have Sufficient Info on NHP	Yes	143 (31%)	46 (26%)	0.526
	No	105 (23%)	43 (25%)	
	Haven't looked for information	213 (46%)	85 (49%)	

Sources of Information about NHPs (Aboriginal versus Non-Aboriginal Students)

This question in Part Two of the survey asks the respondents to identify the sources of information used to learn about medicinal plants and their use. The respondents could select more than one choice. The choices were: family member, Elder or healer, coach, alternative health provider, conventional health provider, friends, electronic media, print media, and advertising. Table 2 and Fig. 1 show the information sources used by respondents to learn about NHPs.

There were no significant differences (p= 0.192) between Aboriginal and non-Aboriginal students in using a family member as a source of information about NHPs (64%–70%). Of the Aboriginal respondents, 50% (n=87) indicated that they learned about NHP from an Elder or healer. This dropped to 6% (n=26) amongst non-Aboriginal students. Thus, the percentage of respondents learning from Elders or healers is significantly higher (p< 0.001) in the Aboriginal student sample than in the non-Aboriginal sample. On the other hand, non-Aboriginal student users relied significantly more (p= 0.015) on alternative health providers, conventional health providers, electronic media, and print media as their sources of information, compared to Aboriginal student users of NHPs. In regards to learning information from a coach/trainer, friend, and advertising, there were no significant differences between Aboriginal and non-Aboriginal student users of NHPs (p= 0.225).

Table 3:

Comparison Between Younger (≤25 year old) and Older (≥26 year old) Respondents who use Natural Health Products (Aboriginal and Non-Aboriginal Respondents Combined)

Variable	*Response*	*Young Under 25 (N= 508)*	*Older Over 26 (N= 124)*	*p-value*
Age	18-19 Year	236 (46%)	0 (0%)	<.001
	20-21 Year	134 (26%)	0 (0%)	
	22-23 Year	80 (16%)	0 (0%)	
	24-25 Year	58 (11%)	0 (0%)	
	26-30 Year	0 (0%)	61 (49%)	
	31-40 Year	0 (0%)	39 (31%)	
	41+ Year	0 (0%)	24 (19%)	
University Grade Level	1st Year	215 (43%)	20 (17%)	<.001
	2nd Year	152 (30%)	26 (21%)	
	3rd Year	70 (14%)	28 (23%)	
	4th+ Year	55 (11%)	29 (24%)	
	Graduate	8 (2%)	18 (15%)	
Gender	Male	149 (30%)	32 (28%)	0.727
Canadian	Canadian	336 (86%)	82 (85%)	0.807
Health Self Rating	Poor	3 (1%)	2 (2%)	0.131
	Average	235 (69%)	70 (77%)	

Variable	*Response*	*Young Under 25 (N= 508)*	*Older Over 26 (N= 124)*	*p-value*
	Good	104 (30%)	19 (21%)	
Tobacco Use	No	400 (81%)	69 (57%)	<.001
Q1: Use of NHP for Health	No	136 (27%)	20 (16%)	0.014
Q2: Use of NHP for Health in last year	No	190 (38%)	34 (27%)	0.031
Q3: Age Learned About NHPs	0-10 Year	111 (22%)	29 (24%)	<.001
	11-16 Year	188 (38%)	31 (26%)	
	17-25 Year	90 (18%)	38 (32%)	
	26+ Year	0 (0%)	12 (10%)	
	Not applicable	18 (4%)	0 (0%)	
	Not sure	87 (18%)	9 (8%)	
Q4: Learned, Family Member	Yes	335 (66%)	77 (62%)	0.462
Q4: Learned, Elder or Healer	Yes	72 (14%)	41 (33%)	<.001
Q4: Learned, Coach/Trainer	Yes	39 (8%)	1 (1%)	0.003
Q4: Learned, Alternative Provider	Yes	29 (6%)	10 (8%)	0.305
Q4: Learned, Conventional Provider	Yes	28 (6%)	2 (2%)	0.095
Q4: Learned, Friend	Yes	131 (26%)	39 (31%)	0.215
Q4: Learned, Electronic Media	Yes	81 (16%)	21 (17%)	0.786
Q4: Learned, Print Media	Yes	64 (13%)	16 (13%)	0.881

Variable	*Response*	*Young Under 25 (N= 508)*	*Older Over 26 (N= 124)*	*p-value*
Q4: Learned, Advertising	Yes	48 (9%)	16 (13%)	0.248
Q5: Cost per Month	Less than $5	295 (62%)	67 (59%)	0.287
	$5-$10	71 (15%)	20 (18%)	
	$10-$25	58 (12%)	15 (13%)	
	$26-$50	26 (5%)	10 (9%)	
	$51-$100	14 (3%)	0 (0%)	
	More than $100	9 (2%)	1 (1%)	
Q6: Told Physician About NHP Use	Yes	64 (13%)	34 (29%)	<.001
	No	240 (50%)	58 (49%)	
	Not applicable or don't remember	172 (36%)	26 (22%)	
Q7: Asked Physician About NHP Use	Yes	48 (10%)	24 (20%)	<.001
	No	333 (66%)	82 (67%)	
	Not applicable or don't remember	124 (25%)	16 (13%)	
Q8: Use physician prescribed Meds	No	219 (44%)	48 (39%)	0.274
Q9: Use OTC meds	No	181 (36%)	37 (30%)	0.208
Q10: Have Sufficient Info on NHP	Yes	136 (27%)	50 (40%)	0.010
	No	118 (23%)	28 (23%)	
	Haven't looked for information	250 (50%)	46 (37%)	

NHPs Usage (Younger versus Older Students, Aboriginal and Non-Aboriginal Respondents Combined)

Table 3 shows the comparison between younger (≤ 25 years) and older (≥ 26 years) respondents amongst those with NHPs use (Aboriginal and non-Aboriginal respondents combined). Age was collapsed into two categories: "younger" aged 18–25 years old *(n*=508*)*, and "older," 26 years and older *(n*=124*)*.

Older respondents were significantly more likely to use commercial tobacco (older 43% versus younger 19%, $p< 0.001$), to use NHPs for health purposes (older 84% versus younger 73%, $p=0.014$), and more likely to have learned about NHPs from an Elder/healer (older 33% versus younger 14%, $p< 0.001$).

Logistic Regression

Table 4:

Summary of Nine Multivariable Logistic Regression Models for the Probability of Reporting a Source of Natural Health Production Information

Characteristic	Information Source					
	Family Member		Elder or Healer		Coach/Athletic Trainer	
	Odds Ratio (95% C.I.)	*p*	Odds Ratio (95% C.I.)	*p*	Odds Ratio (95% C.I.)	*p*
Aboriginal	1.31 (0.75-2.31)	0.344	20.64 (10.5-40.57)	<.001	1.1 (0.43-2.78)	0.841
Older Age (26+)	0.66 (0.37-1.18)	0.162	1.07 (0.56-2.06)	0.837	0.11 (0.01-0.87)	0.036
Male	0.79 (0.48-1.31)	0.363	1.59 (0.83-3.06)	0.164	2.74 (1.27-5.93)	0.010
Tobacco Use	0.82 (0.48-1.41)	0.473	1.03 (0.55-1.94)	0.919	0.66 (0.25-1.77)	0.411
	Alternative Health Provider		Conventional Health Provider		Friend	
	Odds Ratio (95% C.I.)	*p*	Odds Ratio (95% C.I.)	*p*	Odds Ratio (95% C.I.)	*p*
Aboriginal	0.09 (0.02-0.41)	0.002	0.0 (0.00-3.802)	0.947	0.88 (0.51-1.51)	0.635

Older Age (26+)	2.54 (1.01-6.35)	0.047	1.14 (0.24-5.34)	0.867	1.39 (0.79-2.47)	0.257
Male	0.66 (0.27-1.62)	0.367	0.87 (0.26-2.9)	0.827	1.42 (0.87-2.31)	0.162
Tobacco Use	1.21 (0.47-3.09)	0.692	1.2 (0.31-4.58)	0.793	0.85 (0.5-1.47)	0.572
	Electronic Media		Print Media		Advertising	
	Odds Ratio (95% C.I.)	*p*	Odds Ratio (95% C.I.)	*p*	Odds Ratio (95% C.I.)	*p*
Aboriginal	0.24 (0.1-0.56)	0.001	0.14 (0.05-0.41)	<.001	0.31 (0.1-0.95)	0.040
Older Age (26+)	2.38 (1.15-4.93)	0.019	3.4 (1.57-7.35)	0.002	3.57 (1.45-8.81)	0.006
Male	1.56 (0.84-2.88)	0.160	0.86 (0.42-1.78)	0.689	1.57 (0.69-3.59)	0.286
Tobacco Use	1.12 (0.55-2.26)	0.755	1.18 (0.54-2.59)	0.677	0.79 (0.29-2.12)	0.637

- All data are presented after adjustments.

Table 4 shows the results from multiple logistic regression models for the probabilities of use of nine potential information sources: family member, Elder or Healer, coach, alternative health provider, conventional health provider, friends, electronic media, print media, and advertising. The predictor variables for each model were indicator variables for: Aboriginal and non-Aboriginal, age groups, gender (transgender responders were omitted), and commercial tobacco use. An odds ratio of 1.0 indicates there is no association; a value above 1.0 indicates the variable is associated with a higher likelihood of an information source being reported by respondents; and a value below 1.0 indicates the variable is associated with a lower likelihood of an information source being reported by respondents (all data shown in Table 4 are after adjustment of age group, gender, and commercial tobacco use).

There were no significant associations with family members as an information source about NHPs, (Odds Ratio= 1.31, p= 0.344). Aboriginal status was strongly associated with an

Elder or healer as a source of information about NHPs (Odds Ratio = 20.64, $p< 0.001$). However, age group was only significant by itself (Odds Ratio = 3.1, $p< 0.001$ (data not shown), because it was not significant after adjustment (Odds Ratio = 1.07, $p= 0.837$). Younger respondents and males were more likely to use a coach or trainer as a NHPs information source ($p= 0.036$). Non-Aboriginal and older respondents were statistically more likely to report an alternative health provider as an information source ($p= 0.047$). There were no significant associations with conventional health provider as an information source ($p= 0.947$).

Similarly, there were no significant associations with friends as an information source ($p= 0.635$). There was a statistically significant finding that Aboriginal respondents were less likely to report electronic media as an information source (Odds Ratio= 0.24, $p< 0.001$). After adjustment for age group, gender, and commercial tobacco, older age was statistically associated with a greater likelihood of reporting electronic media as a source (Odds Ratio= 2.38, $p= 0.019$). Similar to the electronic media findings, Aboriginal respondents were significantly less likely to report print media as an information source (Odds Ratio= 0.14, $p< 0.001$). After adjustment for age group, gender and commercial tobacco, older age was significantly associated with a greater likelihood of reporting print media as a source of information to learn about NHPs (Odds Ratio= 3.4, $p= 0.002$). Older respondents were more likely ($p= 0.040$) to report advertising as an information source for NHPs. After adjustment for age group, gender, and commercial tobacco, Aboriginal status was not significantly associated with a lower likelihood of reporting advertising as a source of information regarding NHPs.

Discussion

The present study is an analysis of the data of a large survey of Canadian students to determine prevalence of NHPs use and predictors of information sources. We hypothesized that

there will be differences between Aboriginal and mainstream non-Aboriginal students. Two national surveys in the United States indicate that 12–14% of the adult population uses NHPs (Kaufman et al., 2002), while in 2010, a survey (conducted using computer assisted telephone interviews) indicates that up to 73% of the interviewees use NHPs (Health Canada, 2012). In our study, we find that 66.3% of all student respondents indicate use of NHPs, which corroborates previous findings in the general population. This indicates that NHPs use amongst students is clearly an important health phenomenon, worthy of attention. We also discover that NHPs use is greater amongst Aboriginal students compared to non-Aboriginal students (81.3% versus 61.1%). We suggest that future studies looking at NHPs use should include this ethnic group in their sample. While the current study was performed with Aboriginal students, we do find that older Aboriginal students are more likely to use NHPs compared to non-Aboriginal students.

In Canada, between 1996–2006, the Aboriginal population grew by 45%, which is 8% faster than the non-Aboriginal population. In 2006, there were more than one million Aboriginals in Canada (Statistics Canada, 2008). Aboriginals represent 4% of the Canadian population (Statistics Canada, 2008). Growth in the Aboriginal population, juxtaposed with known health disparities, suggests a need to include Aboriginals in future population and public health research (Reading & Nowgesic, 2002; Adelson, 2005). Studies comparing Aboriginal and non-Aboriginal samples (Wilson et al., 2010) can be used to better understand health disparities. Our study includes Aboriginal students and focuses on comparing Aboriginal with non-Aboriginal students.

In a review paper that examined previous social science research regarding the Aboriginal population (Wilson & Young, 2008), the authors find that there is a paucity of information regarding certain aspects of health care in the Aboriginal population. For example, they find that while there is knowledge focusing on this group in regards to conventional health care (e.g.,

allopathic), there is not enough research about traditional approaches to healing and traditional medicines. In addition, there are some papers discussing the use of community-based participatory research methods. It is recommended that more community-based participatory research seek to improve health, well-being, and access to culturally appropriate care (Ferreira & Gendron, 2011; Wilson et al., 2008). These authors show the importance of including the Aboriginal population in future studies as part of ongoing efforts to tease out health-related differences and causes amongst various ethnic subgroups from the dominant culture.

Elders and Healers

Previous studies have shown the importance of traditional healing for Aboriginal communities and that Elders and healers play an important role in traditional healing (McCabe, 2007; Crosato et al., 2007). In addition, culturally relevant pedagogical approaches to education can provide important help in treatment and wellness programs for Aboriginals, through appropriate cultural messaging, knowledge, and learning (Green, 2010). There was a study in which Native American patients were interviewed regarding the use of traditional healers together with the use of physicians (Marbella et al., 1998). The authors found that 38.0% of those patients interviewed use traditional healers concurrently with physicians, indicating the importance of both complementary and alternative medicine and allopathic medicine in Native American healthcare practices today (Marbella et al., 1998). Our study supports the importance of Elders and healers for Aboriginal students as a source of information about NHPs use. We find that approximately half of the Aboriginal respondents indicate that they learn about NHPs from an Elder or healer. This dropped to only 6% (n= 26) amongst non-Aboriginal students. Thus, the percentage of respondents learning from Elders or healers is significantly higher for Aboriginal students than for non-Aboriginal students.

The major objectives in the current study are to clarify the extent of NHPs use amongst university students (Aboriginal and non-Aboriginal) and to determine the predictors of NHPs information sources (family member, Elders or healer, coach, alternative health care provider, conventional health care provider, friends, electronic media, print media, and advertising). We hypothesized a difference between Aboriginal and non-Aboriginal students in use prevalence of NHPs and in how they learn about NHPs. In addition, we hypothesized that Aboriginal students are more likely affected by family members than non-Aboriginal students, and older students are more affected by family members than are younger students in learning about NHPs.

We find no difference between Aboriginal students and non-Aboriginal students regarding the family as a source of information. This was surprising since we thought that NHPs would sometimes be used as traditional medicines and hence be learned from Aboriginal family members. Traditional knowledge is often passed from generation to generation with Aboriginal children spending time on the land with their parents and grandparents collecting medicines.

A strength of the current study is the large sample size of the Aboriginal and non-Aboriginal student groups, permitting a detailed analysis of predictive factors underlying NHPs use and sources of information used to learn about NHPs, amongst university students. The inclusion of the Aboriginal students in this study is an important contribution to the literature, which insufficiently includes or outright excludes this ethnic category. However, some study limitations are noteworthy. Important information was not captured in the survey such as anthropometrics (e.g., body mass and height for BMI), which would give us more information about health in addition to self-reported health status. Also, in Part One of the survey (demographic section) the question about health states could have been more specific than: *Good*, *Average*, and *Poor*. In addition, there is a possibility of sample bias (e.g., students who participated could have been

more interested in NHPs).

In our study we deliberately sought to characterize the use of NHPs by Aboriginal and non-Aboriginal university students, in an attempt to capture important information about an ethnic student population that is known both for health disparities and continued use of traditional medicines. To better understand the prevalence of NHPs use by university students, and to better understand how Aboriginal students come to learn to use NHPs, our findings can facilitate the Aboriginal community to address health care issues from within the community, as well as at the interface of allopathic medicine and traditional medicine.

Prior research shows how traditional ways of disease prevention and treatment are important for Aboriginal communities (McCabe**,** 2007; Crosato et al., 2007). It is important to document the current uses of NHPs by Aboriginal students today, as well as to understand the continued importance of Elders or healers in the transfer of traditional knowledge of products in relation to health care practices. The findings of the current study indicate that indeed, Aboriginal university students do use NHPs more than mainstream students, and rely on Elders as an important source of information regarding NHPs use as compared to mainstream students. We suggest that Elders can play a larger role in Aboriginal students' postsecondary and traditional education in ethnomedicine. For example, Elders can be involved in novel pedagogical approaches and delivery modalities to reach Aboriginal university students, such as live and distance delivery of health-related courses, as STEM co-educators and as Indigenous science practitioners.

CHAPTER 2 (Phase 2): "Assessing the Impact of Western Science and Indigenous Science Educators in an Online STEM Course: A Pilot Study"

Introduction

Science, technology, engineering, and mathematics (STEM) are fast growing fields in the United States (U.S.) (U.S. Department of Education, 2010). In the U.S., there has been an investment in research to encourage growth of a diverse, talented, and innovative STEM workforce to maintain national leadership and competitiveness in STEM fields globally (Committee on Underrepresented Groups, 2010). Underrepresented minorities (URMs) in the U.S. include Native Americans (American Indians, Alaska Natives, and Native Hawaiians), Mexican-Americans, African Americans, Pacific Islanders, mainland Puerto Ricans, and women (Association of American Medical Colleges Executive Committee, 2004).

Minorities are the most rapidly growing part of the population; in 2012 they comprised approximately 37% of the U.S. population ages 18-64 years, and they will comprise approximately 57% of the U.S. population by 2060 according to Census Bureau projections (National Center for Science and Engineering Statistics, 2015). The growth is evident in the Native American population in the U.S., which has increased from 237,000 people in 1900 to 2.5 million people in 2000 (Babco, 2003). However, they still only comprise 2% of the U.S. population in 2012 (National Center for Science and Engineering Statistics, 2015). In 2011, according to the National Household Survey (NHS) in Canada, the Canadian Aboriginal population was 1,400,685 people, which represents 4.3% of the total Canadian population (National Household Survey, 2013). The Native/Aboriginal population increased 20.1% between 2006 and 2011, compared with 5.2% for the non-Aboriginal population (National Household Survey, 2013).

In the U.S., URMs are less likely to enrol in programs of higher education (Swail et al. 2003). In U.S. 2012, for every six students who earn a bachelor degree or higher, one student is considered as URM (National Center for Science and Engineering Statistics, 2015). Thomas and Richardson find that White students are more likely to achieve better grades than minority students (Thomas & Richardson, 2012). Compared to White students, minorities are less likely to complete their courses (Thomas & Richardson, 2012). In 2010, only 16% of all high school seniors choose STEM fields for their careers at post-secondary level more so than other majors, in the U.S. (U.S. Department of Education, 2010). Furthermore, the Native/Aboriginal group is the least characterized underrepresented minority in academia (National Science Board, 2012). In 2000, the percentage of Natives/Aboriginals in the U.S. who had completed high school was 71%, which is lower than the high school completion rate of other minority groups (Babco, 2003).

Native/Aboriginal students are the least representative group in STEM-related courses, and have low college attendance rates compared to other minorities in the U.S. (Babco, 2003). In 1999 Native/Aboriginal students represented slightly over 1% of the total undergraduate enrolment, and were much more likely to attend two-year institutions such as community colleges (Babco, 2003). In 2012, very similar statistics could be reported, with no significant change in Native/Aboriginal students' representation in STEM fields, nor in their attendance at two-year institutions, as compared to 1999 (National Center for Science and Engineering Statistics, 2015). Tieney (1991) notes some factors that might explain the low retention of Native students in academia, such as conflicts between Western science and Native/Aboriginal traditional knowledge. Another factor is a student's need to return home for ceremonies, which may be more important to her/him than academics (Tieney, 1991).

Mayo and colleagues (1995) find that campus life and formal social integration are positively correlated with Native/Aboriginal academic performance (Mayo et al., 1995). Huffman (2001) suggests that Native/Aboriginal students who adapt to campus life while maintaining their culture are more likely to succeed in academia than other Native/Aboriginal students (Huffman, 2011). Aikenhead discusses major factors leading to educational failure in science at mainstream schools amongst students who belong to certain cultures, such as Aboriginal/Native (Aikenhead, 2006). Contributing factors to weakening participation of Aboriginal/Native students in science related fields are due the perception that science is not their culture (Aikenhead, 2006).

Education supported with culturally relevant concepts is linked to improved academic performance by Native/Aboriginal students (Demmert & Towner, 2003). In order to provide better learning experiences and support for Native/Aboriginal students in STEM courses (online and live), it is important to include culturally relevant content and assignments for students (Vogel, 2011). As cited by Chemers and colleagues (2011), previous studies show that inclusion of cultural aspects within a science-learning environment provides strong support to Native/Aboriginal students for science self-efficacy and identity as a scientist (Chemers et al., 2011).

Tribal colleges and universities (TCUs) serve Native American/Aboriginal students, specifically those in remote places, who might otherwise stop schooling after high school. Tribal colleges and universities provide a support system for students through acknowledgment of language and culture. They also offer STEM-related courses and research opportunities. All of these components may help Native/Aboriginal students be more engaged in their academic programs (National Clearinghouse for English Language, 2011).

In a recently published study, students *(n=963)* were surveyed at a mainstream university (University of Regina; (UofR) and a TCU (First Nations University of Canada; (FNUniv)–Regina) (Alkholy et al., 2013). It was found that Native/Aboriginal students learn information about NHP from traditional Elders significantly more so than do non-Native/Aboriginal students, which supports the importance of Elders as a source of science-related information amongst Native/Aboriginal post-secondary students.

Due to cultural factors, Native/Aboriginal students are less likely to join online courses or programs compared to other students (Newell & Adesope, 2011). These cultural issues could be due in part to difficulty in accessing computer-related technology. Traditional Native/Aboriginal students may also have concerns about engagement with Western science and fear that it will lead to the loss of traditional values (Bissell, 2004). Some Elders are trusted Indigenous science practitioners within their own cultures; they could impact post-secondary students when present. They could be the link between Indigenous science and Western science to help students fill the gap between cultures and sciences (Michell, 2011).

In order to provide an attractive atmosphere for students (especially Native/Aboriginal) in live and online STEM courses, inclusion of cultural aspects might increase interest in science, self-efficacy, and scientist identity. Thus, the presence of traditional Elder co-educators in STEM courses (live or online) could benefit students. Therefore, the purpose of this pilot study is to determine regional and racial/ethnic differences in post-secondary student perceptions regarding these variables: role of traditional Elders as STEM co-educators; interest in STEM; and self-identity as a scientist. It was hypothesized *a priori* that Aboriginal students believe traditional Elders are appropriate post-secondary STEM co-educators more so than do non-Aboriginal

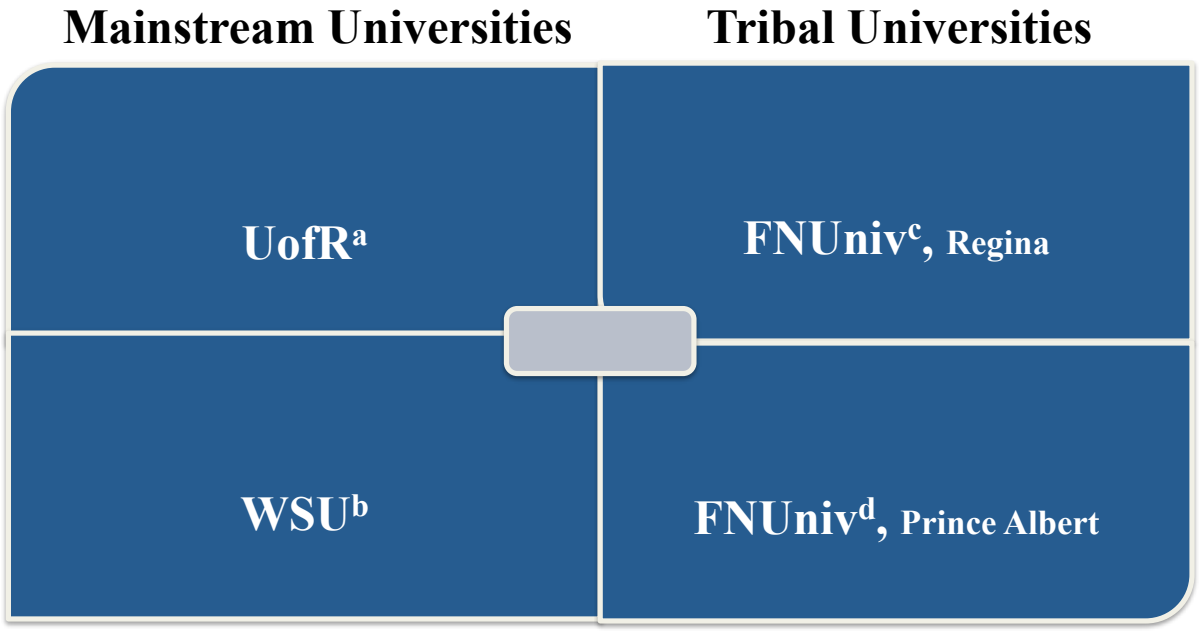
students; we also hypothesized *a priori* that non-Aboriginal students are interested in STEM and identify themselves as scientists more so than Aboriginal students.

Methods

Study Design

A short-term longitudinal pilot study of an online course was conducted (spring 2013). The distance-learning course entitled Evidence-Based Ethnomedicine: Medicinal Plants & Culture was offered in the spring of 2013 concurrently at four universities (Figure 2). Two were TCUs (First Nation's University (FNUniv), Regina, SK, Canada; FNUniv–Other, Prince Albert, SK, Canada) and two were mainstream research universities (University of Regina (UofR), Regina, SK, Canada; Wayne State University (WSU), Detroit, MI, U.S.A.). Students from all institutions received the same online course, which was delivered by the same STEM course professors. The course professors were: a Nutrition professor from WSU, a Biochemistry professor from UofR, and a Biology professor from FNUniv. The course content covered native plants of the Great Lakes and Great Plains bioregions of North America, used as functional foods/NHP in Indigenous and mainstream cultures. Non-PhD Indigenous Elders were online guest lecturers delivering online presentations to explain their cultural uses of the plants. The three PhD professors held a Western scientific approach to deliver their course materials, whereas the Elders delivered the cultural aspects of the plants, consistent with Indigenous science approaches.

Figure 2 :
Study Design Diagram



Regions

Regina is the capital of Saskatchewan and home of UofR, a liberal arts institution with teaching and research. In the fall of 2013, there were 11,950 undergraduate students at UofR, from different ethnicities including Aboriginals (1,403), non-Aboriginal (10,547), domestic (10,800), and international (1,150) (Fall Term UofR 2013). The FNUniv, is an Indian Federated College founded in 1976 in partnership with the UofR, in order to preserve and protect language, culture and history of the Native/Aboriginal community to improve their quality of life (History of First Nations University of Canada 2013). In winter 2013, 667 students were enroled at FNUniv (Annual Report First Nation University of Canada, 2013). Of these students, 93% of the students were Native/Aboriginal, and 7% of the students were non-Native/Aboriginal (Gauthier,

2013).

Detroit, Michigan is the 11th largest city in the U.S.A., and has a population of more than 5 million people. Wayne State University, located in Detroit, was founded in 1868 and is a research institution offering more than 400 academic programs to nearly 32,000 students (Students Profile Wayne State University, 2012). Wayne State University has the most diverse student body amongst Michigan's public universities, representing nearly every U.S. state and more than 75 countries. In fall 2012, there were 19,448 undergraduate students at WSU, from different ethnicities such as African American (7,806), Native American/Aboriginal (147), Asian/Pacific Islander (2,094), and other ethnicities (2,497), such as Middle Eastern (WSU Students Profile, 2012). In the fall 2012, there were 705 Canadian students out of 2,330 students newly enroled (Canadian Students Wayne State University, 2012).

Participants

A total of 11 students participated in this pilot study; there were students from WSU *(n= 6)*, UofR *(n= 2)*, FNUniv–Regina *(n= 3)*, and none from FNUniv–Other *(n= 0)*. Due to the low number of Aboriginal participants we re-framed our hypotheses *a posteriori* to compare White versus non-White students on the outcome variables of interest. In this study, we identified as White *(n= 7)* those students who chose "White" on the survey; and we identified students as non-White *(n= 4)* who chose any other options (e.g., Native/Aboriginal (regardless of race), Black, Asian, and other). The students were sent an invitation to participate in the pre- and post-course survey via the course email. Participating students (18 years or older) accessed the survey via SurveyMonkey to submit their responses. The UofR Research Ethics Board (FNUniv partnership with the UofR) and WSU Institutional Review Board approved this project.

Table 5:
Characteristics of Study Participants

Demographics	Number of Students
Regions:	
U.S.A.	6
Canada	5
Race/Ethnicity:	
White	7
Black	0
Native/Aboriginal (regardless of race)	0
Asian	2
Hispanic or Latin	0
Pacific Islander	0
Other	2
Gender:	
Male	1
Female	10

Study Instrument

Pre- and post-course surveys were administered to participating students. The survey was used to assess the regional (U.S.A. and Canada) and racial (White and non-White) differences in post-secondary students regarding: perceptions toward traditional Elders as STEM co-educators; interest in STEM; and self-identity as a scientist (Chemers et al., 2011). The survey contained five parts, the first asking respondents about demographics (e.g., race/ethnicity, age, grade level, gender), the second section asking about students' perception of the merit of Elders as co-educators in post-secondary STEM education. The third section surveyed students about their interest in STEM fields and careers; the fourth section (developed following recommendations by Chemers) contained questions that addressed students' identity as scientists, and the fifth section probed their commitment to a science career (Chemers et al., 2011). Each survey question followed a 1 to 7-point *Likert scale* (1 referred to *strongly agree*, and 7 referred to

strongly disagree with numbers 1 or near to 1 meaning the respondent was in agreement with this concept; and every answer with 7 or near to 7 meant the respondent disagreed with this concept).

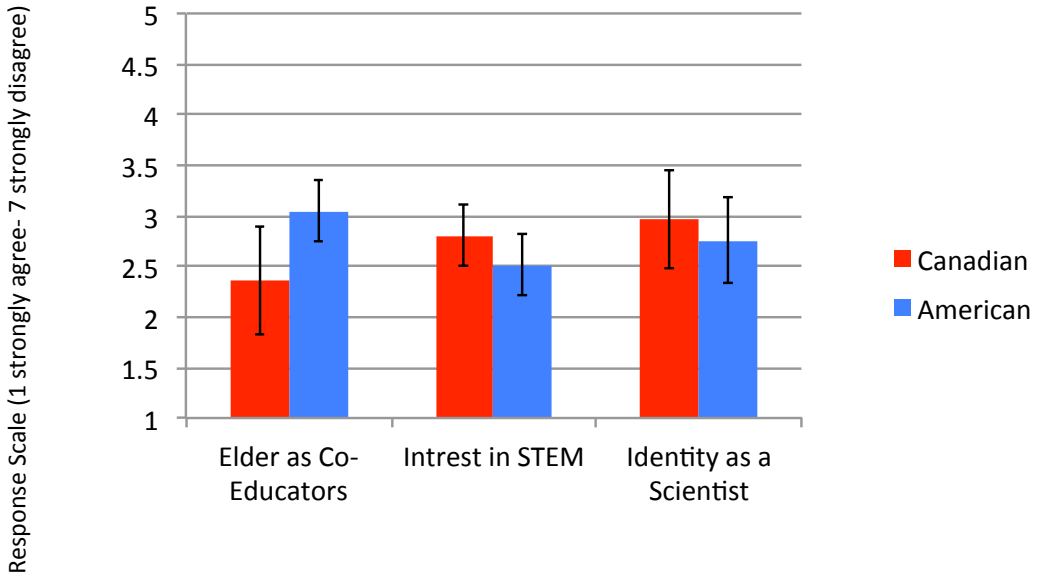
Statistical Analysis

For data analysis, ANOVA models were used to provide a statistical test of whether or not the means of several groups were equal; a *t*-test was used to determine if two sets of data were significantly different from each other. The *p* level was set at 0.05 for statistical significance, and SPSS 21 software was used to analyze the data.

Results

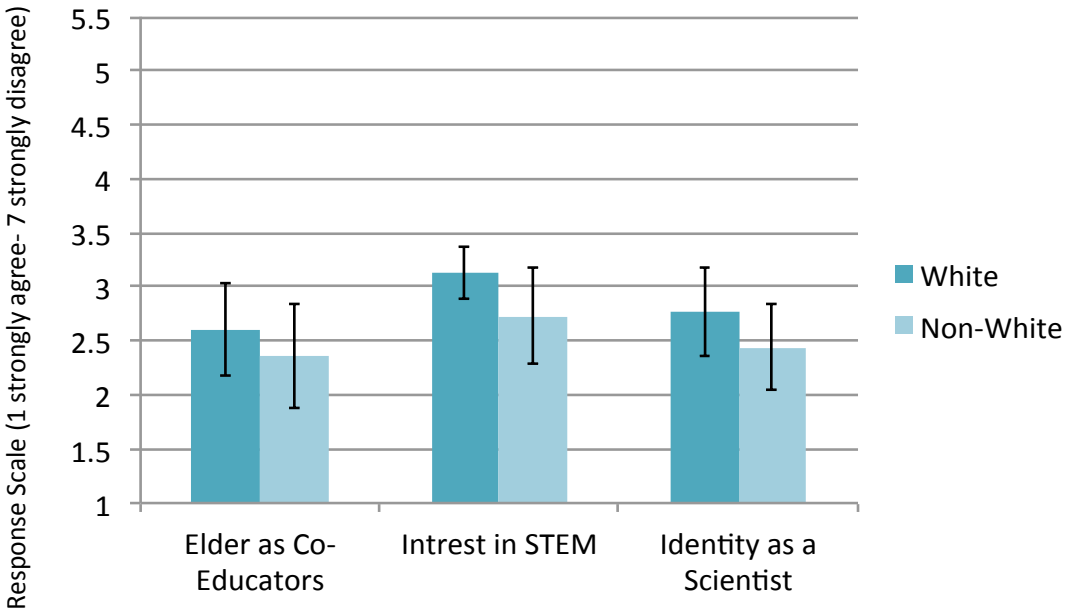
There were no statistically significant results upon data analyses. First and foremost, this means that when the same course is delivered to U.S. and Canadian students, there are no differences across groups. However, the following observed trends do suggest the need for future research.

Figure 3:
Regional (U.S. vs. Canada) Student Perceptions Regarding: Elder Co-educators, Interest in STEM, and Self-identity as a Scientist



Results from one-way ANOVA analyses in Figure 3 shows Canadian and U.S. students' perceptions about: Elder co-educators, interest in STEM, and self-identity as a scientist. Figure 3 shows that Canadian students trended towards accepting that traditional Elders are appropriate as post-secondary STEM co-educators as compared to U.S. students' beliefs *(p*= .31*)*. Also, U.S. students showed a weak trend to be more interested in STEM fields than Canadian students *(p*= .52*)*. Finally, U.S. students showed a weak trend to self-identify as scientists more so than Canadian students *(p*= .77*)*. Again, Figure 3 suggests that when the same course is delivered to U.S. and Canadian students, there are no differences across groups.

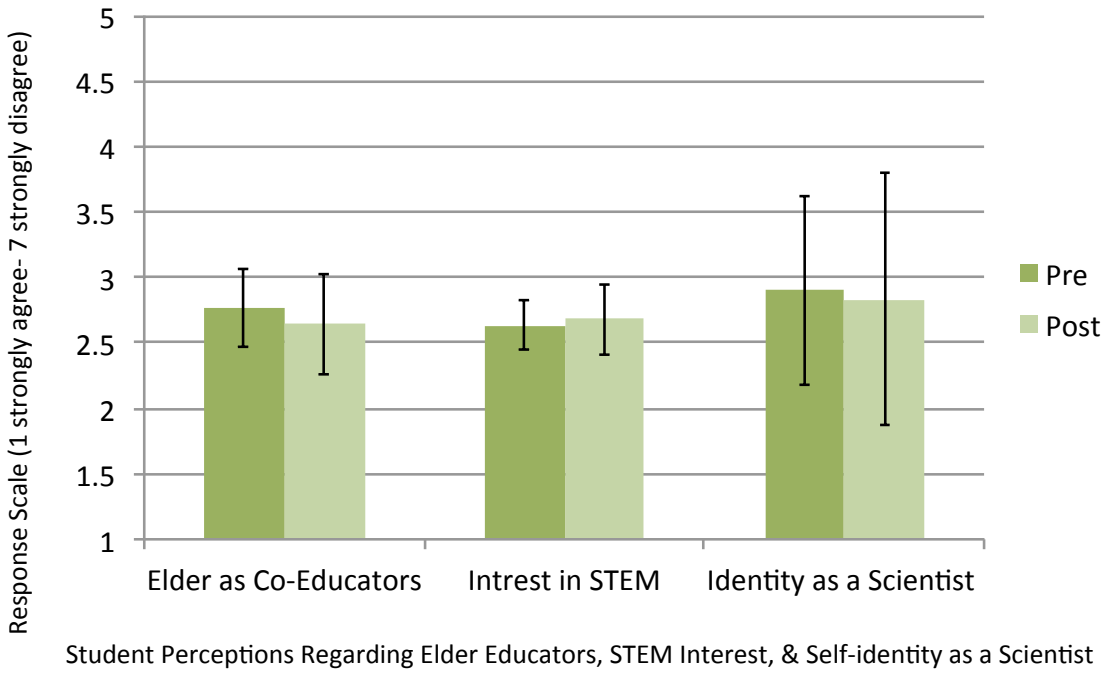
Figure 4:
Racial (White vs. non-White) Student Perceptions Regarding: Elder Co-educators, Interest in STEM, and Self-identity as a Scientist



Student Perceptions Regarding Elder Educators, STEM Interest, & Self-identity as a Scientist

Results from one-way ANOVA analyses in Figure 4 shows White and non-White student perceptions regarding: Elder co-educators, interest in STEM, and self-identity as a scientist. Figure 4 suggests that non-White students showed a trend towards accepting traditional Elders as appropriate post-secondary STEM co-educators more so than White students *(p*= .45*)*. On the other hand, White students showed a weak trend to be more interested in STEM fields than non-White students *(p*= .80*)*. Finally, non-White students showed a trend to self-identify as a scientist as compared to White students (*p*= .31*)*.

Figure 5:
Pooled Student Perceptions (pre- & post-course) Regarding: Elder Co-educators, Interest in STEM, and Self-identity as a Scientist



A *t*-test was used to analyze the data for Figure 5 pooled student perceptions (pre- & post-course) about: Elder co-educators, interest in STEM, and self-identity as a scientist. Figure 4 suggests no trends for students' perceptions (pre- & post-course) regarding: Elder co-educators

(p= .62), interest in STEM *(p= .85)*, and identity as a scientist *(p= .55)*. This means that students' perceptions did not change over the semester.

Discussion

The main purpose of this pilot study is to set the stage toward understanding post-secondary students' perceptions of traditional Elders as STEM co-educators; interest in STEM; and self-identity as a scientist, according to their region and ethnicity/race. Although there are no statistically significant results, this indicates that when the same course is delivered to U.S. and Canadian students, there are no differences across groups. We also discover trends of regional and racial differences in student perceptions regarding Elder co-educators at the interface of Indigenous science and Western science in a distance-learning course. We find that Canadian students show a trend to believe that traditional Elders are more appropriate as post-secondary STEM co-educators when compared to U.S. students' beliefs. We had hypothesized that non-White students believe that traditional Elders are appropriate post-secondary STEM co-educators more so than do White students. Our findings weakly support this; we find that non-White students tend to accept traditional Elders as appropriate post-secondary STEM co-educators more so than do White students. We also had hypothesized that White students are interested in STEM more so than non-White students. We find that White students show a weak trend to be more interested in STEM fields than are non-White students.

Previous studies show the importance of traditional healing in Native/Aboriginal communities and that Elders play an important role in traditional medicine (McCabe, 2007; Crosato et al., 2007). In addition, culturally relevant pedagogical approaches to education offer richer wellness programs for Native/Aboriginal populations, through appropriate cultural messaging, knowledge, and learning (Green, 2010). We expect that Elder co-educators may then

impact student science identity and interest in STEM. Involvement of traditional Elders in novel pedagogical approaches and delivery modalities to reach minority students (especially Native/Aboriginal) may thus facilitate their interest and retention in STEM courses (Michell, 2011).

Study Limitations

Statistical power is limited due to the low number of study participants. The lack of Native/Aboriginal participants in the study prevented us from determining the effect of the course up on Native/Aboriginal students. This course was offered for the first time at FNUniv and UofR and the ethics approval came late, so we did not have time to advertise the course widely at these universities. This led us to modify our purpose and hypotheses *a posteriori*.

Implications for Future Directions

The negative findings of this pilot study (same course at U.S.A. and Canada; no differences across groups) lead us to the next investigation (Elder versus No Elder institutions). Building upon this pilot study, a quasi-experimental pedagogical study will be conducted in spring 2014 to test our hypotheses regarding the impact of the presence/absence of Elder co-educators for the same online STEM course. The interdisciplinary, multi-institutional, and cross-cultural online STEM course will be offered at two TCUs (FNUniv–Regina; FNUniv–Other), and two mainstream research universities (WSU and UofR). In the experimental group, traditional Elders will participate as co-educators at UofR, and FNUniv–Regina (e.g., online medicine walks, online lectures, other online interactions). In the control group, STEM-trained ethnobotanists will co-teach at FNUniv–Other, and WSU (e.g., online botanical garden tours, online lectures, other online interactions), along with the STEM PhD course professors. We will investigate whether the presence of Indigenous science Elder co-educators alongside Western

science professors in an online STEM course will be associated with benefits to the students: (1) cultural relevance/supportiveness of course; (2) improved learning outcomes; (3) improved interest in STEM; and (4) perceived merit of Indigenous science educators in STEM education. A power analysis will be conducted for the upcoming study. We thus continue to strive to uncover strategies that may improve teaching in STEM courses, especially for Native/Aboriginal students, by providing innovative ways to increase underrepresented minority students' inspiration.

CHAPTER 3 (Phase 3): "Convergence of Indigenous science and Western science impacts students' interest in STEM and identity as a scientist"

Introduction

Aboriginal Elders are the wisdom-keepers of indigenous science (Ferreira et al., 2014), while PhD trained scientists are the gate-keepers of Western Science, or STEM, in North America; both may be the key to attracting and retaining the next generation of scientists. While minorities are the most rapidly growing segment of the U.S. and Canadian populations today, they remain underrepresented in STEM. In the U.S. in 2010, minorities -Asian-, Black-, Latin-, or Native-American (Humes et al., 2011) comprise approximately 30% of the U.S. population (Committee on Underrepresented Groups, 2010) with rapid growth of the Native population by 39% since 2000 (Norris et al., 2012). In Canada, the Aboriginal population in 2011 represented 4.3% of the total Canadian population (National Household Survey, 2013).

Yet, the demand for STEM professionals has been rising steadily; between 1995 and 2007, the STEM workforce grew by 36% in the U.S. (Guterl, 2014). While Whites and Asians are well represented in STEM, Black-, Latin-, and Native Americans are underrepresented minorities (URMs) in STEM, and Native Americans (North American Aboriginals) are least represented (Guterl, 2014). In 2006, U.S. Native students earned only 0.7% of bachelor degrees in science and engineering (Fiegener, 2009). In between 1997–2006, for every 150 U.S. students there is only one Native student graduated with a bachelor's degree in science and engineering (Fiegener, 2009). In Canada in 2006, 33% of Aboriginal adults aged 25 to 54 years had less than a high school education compared to nearly 13% of the Non-Aboriginal population (Statistics Canada, 2010).

A significant factor explaining the low retention of Native/Aboriginal students in STEM majors in North America is the apparent conflict between Western science and traditional

knowledge (Tieney, 1991), or Indigenous science. Native/Aboriginal students contend that much of STEM appears incompatible with their culture and that their participation will lead to the loss of traditional values (Bissell, 2004), thus diminishing their involvement in science-related fields (Aikenhead, 2006). The culture of Western STEM also creates a chilly environment for Indigenous science. Yet, it has been shown that the inclusion of cultural aspects in STEM courses provides strong support for Native/Aboriginal students toward science self-efficacy and identity as (Western) scientists (Chemers et al., 2011).

A 10-year project at Cape Breton University demonstrates the successful delivery of courses integrating Indigenous and Western science to students in Canada (Marshall & Marshall, 2009). The researchers reported that while Western science scrutinizes objects, Indigenous approaches focus on subjects; learning activities with a cultural component develops a connection to nature rather than a separation from it (Marshall & Marshall, 2009). The findings of three studies examining work styles of students in STEM fields show that Native/Aboriginal students significantly favor communal/cooperative work more than White male students, suggesting that curricula linking real-world science to culturally-relevant communal work increases Native/Aboriginal student success in STEM courses (Smith et al., 2014). The integration of Indigenous values into STEM curricula facilitates a comprehensive cross-cultural, as well as multi-disciplinary approach- and highlights the multi-directional features of the different science fields (Marshall & Marshall, 2009).

The Elder as educator in this initiative plays a major role in the convergence between Indigenous and Western sciences. Elders can teach Indigenous science to all students-minority or otherwise-who pursue a Western education (Marshall & Marshall, 2009). Such an approach facilitates acknowledgement of Indigenous science in the post-secondary STEM environment.

Recently we found that Native/Aboriginal students learn information about natural health products from traditional Elders significantly more so than non-Native/Aboriginal students (Alkholy et al., 2013) further supporting the importance of Elders as a source of science-related information for Native/Aboriginal students. Many Elders are trusted Indigenous science practitioners and when present, may play a major role in post-secondary science education for students. Respected traditional knowledge keepers can strengthen the bond between Indigenous science and STEM, and fill the gap between culture and science (Michell, 2011).

In this study, we aimed to determine the impact of traditional Elder co-educators upon students taking an online STEM course. We examined the impact of the intervention (Elders) upon the following variables: student perceptions of the role of Elders as Indigenous science educators, student interest in STEM, student self-identity as a scientist, and student learning outcomes. We also probed racial/ethnic differences across these variables.

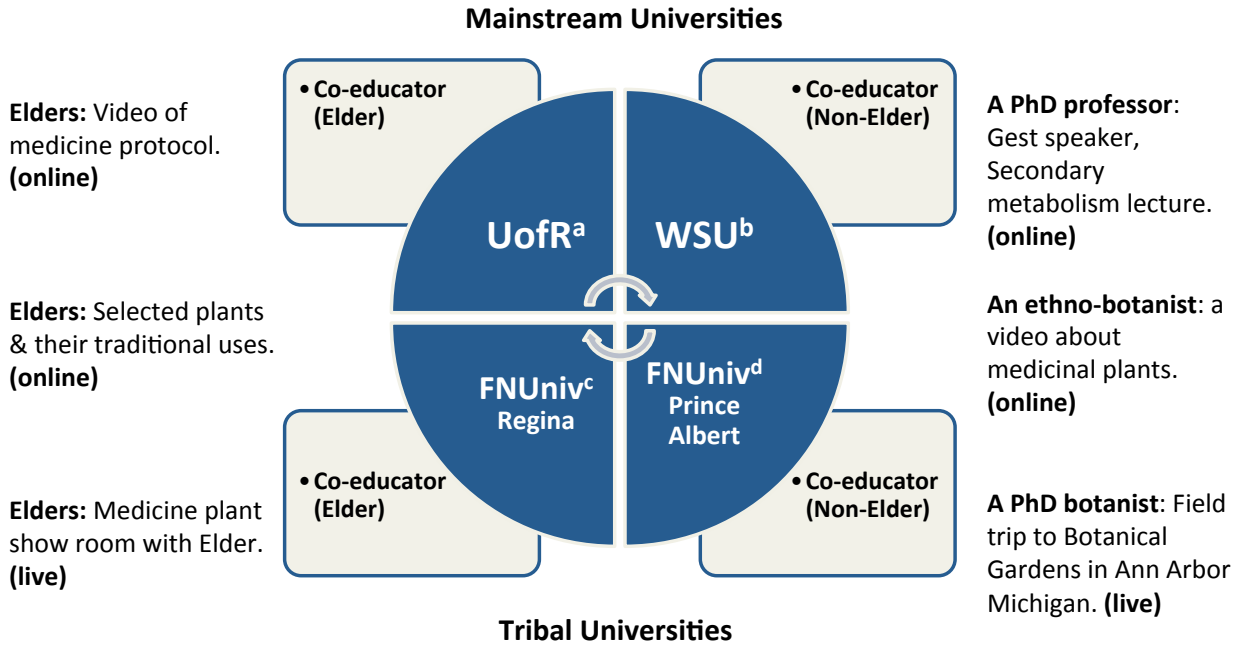
Methods

Study Design

A pedagogical quasi-experiment of factorial design was conducted in the spring semester of 2014. A hybrid course entitled Evidence-Based Ethnomedicine: Medicinal Plants & Culture was offered at four universities (Figure 6). Two were tribal colleges and universities (TCUs) (First Nations University of Canada (FNUniv), Regina, SK, Canada; FNUniv–Other, Prince Albert, SK, Canada) and two were mainstream research universities (University of Regina (UofR), Regina, SK, Canada; Wayne State University (WSU), Detroit, Michigan, U.S.A.). In the experimental group of institutions, non-PhD Indigenous Elders (Intervention) co-taught the students live and online (e.g., medicine room workshop, prairie medicine walk, and presentation videos) at the UofR and FNUniv, Regina. In the control group of institutions, PhD trained non-

elders (Control; not course instructors) co-taught the students live and online (e.g., botanical garden tours, online lectures) at WSU and FNUniv–Other, Prince Albert. The Ethnomedicine online course taught at all participating institutions was otherwise the same in content and taught by the same 3 course instructors each specializing in different disciplines (Biology, Nutrition, and Biochemistry). Elders (Intervention) and the PhD-trained non-elders (Control) were co-educators to the online Ethnomedicine course taught at all participating institutions.

Figure 6:
Study Design Diagram



[a]University of Regina
[b]Wayne state University
[c]First Nation University of Canada, Regina
[d]First Nation University of Canada, Prince Albert

Participants

A total of 28 students participated in the study: students from WSU (n=11), UofR (n=11), FNUniv–Regina (*n*= 6), and from FNUniv–Other (*n*= 0). Participating students (18 years or older) accessed the survey via SurveyMonkey. The project was approved by the UofR Research Ethics Board (FNUniv partnership with the UofR) and WSU Institutional Review Board.

Our original goal was to determine the efficacy of Elders co-teaching a post-secondary STEM course to encompass Native/Aboriginal ethnic values, with a specific focus on Native/Aboriginal versus non-Native students. However, due to the small number of participants in the study (*N*= 28), low number of students from FNUniv–Regina (*n*= 6), and lack of students from FNUniv-other (*n*= 0), we divided the institutions according to intervention (No Elders; U.S.A. versus Elders; Canada) and the students according to racial/ethnic group, with White (*n*= 15) and non-White (e.g., Native/Aboriginal, Black, Asian, and other) (*n*= 13) students. The "No Elders" institution was the U.S. university (WSU, non-Elder co-educators) and the "Elders" institutions were the Canadian universities (UofR and FNUniv, Regina Elders co-educators).

Analyses were conducted to assess *a posteriori* hypotheses regarding intervention (U.S.A. ("No Elders") versus Canada ("Elders") and racial/ethnic (White versus non-White) differences in post-secondary student perceptions regarding these variables: role of traditional Elders as STEM co-educators, interest in STEM and learners self-identifying as scientists.

Study Instrument

Pre- and post-course surveys were administered to participating students to assess student perceptions regarding: merit of traditional Elders as co-educators, interest in STEM, and self-identity as a scientist (Chemers et al., 2011). The survey contained five parts, the first asking respondents about demographics (e.g., race/ethnicity, age, grade level, gender), and the second

section questioning students' perception of Elders' role in post-secondary STEM education. The third section surveyed participants about their interest in STEM fields and careers; the fourth section, addressed participants' self-identification as scientists, and the fifth section questioned their commitment to a science career (Chemers et al., 2011). Each survey question followed a 1 to 7-point *Likert scale*. Learning outcomes were measured by weekly research quizzes, each with five multiple-choice questions based upon the topic of the week. The online survey was administered to the students during the first week of the course, and the same online survey was administered at the final week of the course. The weekly research quizzes were not part of the course content and did not contribute to students' final marks, but rather comprised data for 'outcome measures'. Course instructors were not involved in data collection (e.g., survey and quizzes), which were collected by a research assistant.

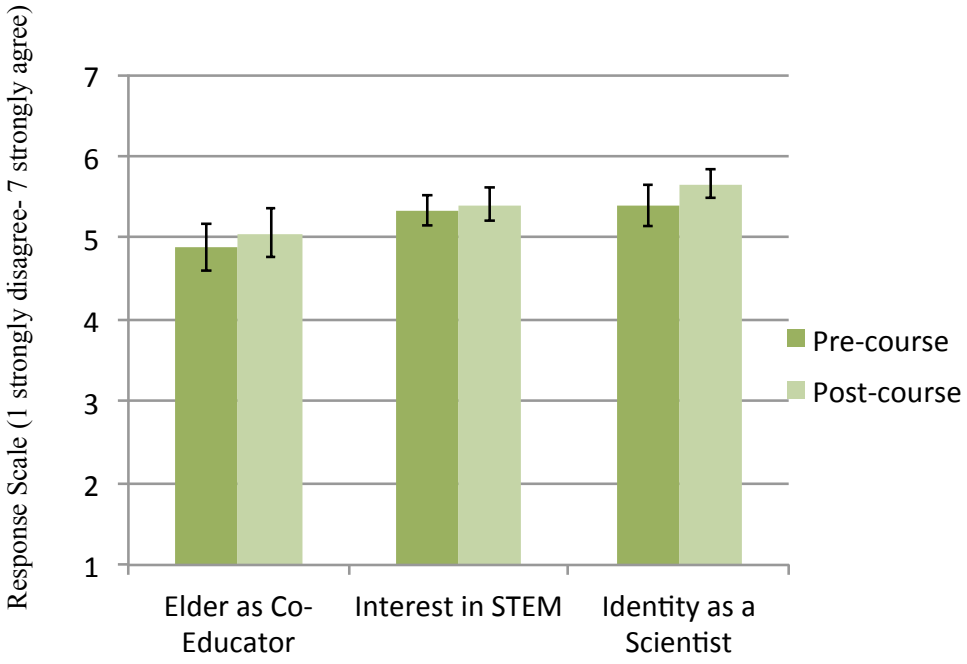
Statistical Analysis

ANOVA and ANCOVA models were used to provide a statistical analysis of significant difference in means for several groups and a student's *t*-test was used to determine if two sets of data were significantly different. The alpha level was set to less than or equal 0.05 to indicate statistical significance, and SPSS 21 software was used to analyze the data**.** Power analysis for this study determined 80% power with medium effect to calculate and estimate the total sample size (*N*) and number estimated in each group (n) in 4 groups (K) (*d*= .50, f = .25, and 80% power), *(n*=45*)* subjects per group for *(K*= 4*)* groups (*N*= 180 subjects total).

Results

Pooled Student Perception Pre- and Post Course

Figure 7:
Pooled Student Perception Differences: Student Perceptions Regarding Elder Co-educators, STEM Interest, & Self-identity as a Scientist

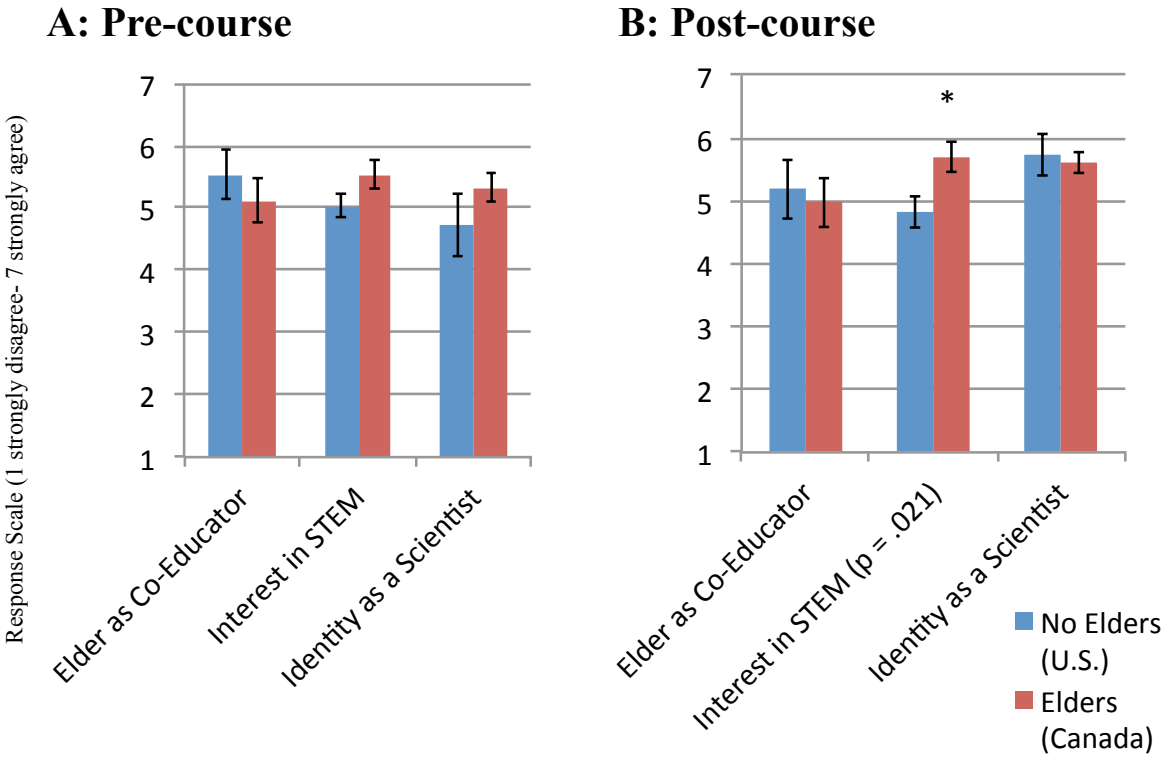


Student Perceptions Regarding Elder Educators, STEM Interest, & Self-identity as a Scientist

Pooled student responses, in Figure 7, did not show any significant differences indicating identical average perceptions (pre- & post-course) of students regarding: Elder co-educators, interest in STEM, and identity as scientists.

Racial/Ethnic Differences Pre- and Post- Course Survey

Figure 8:
Intervention Differences: Student Perceptions Regarding Elder Co-educators, STEM Interest, & Self-identity as a Scientist

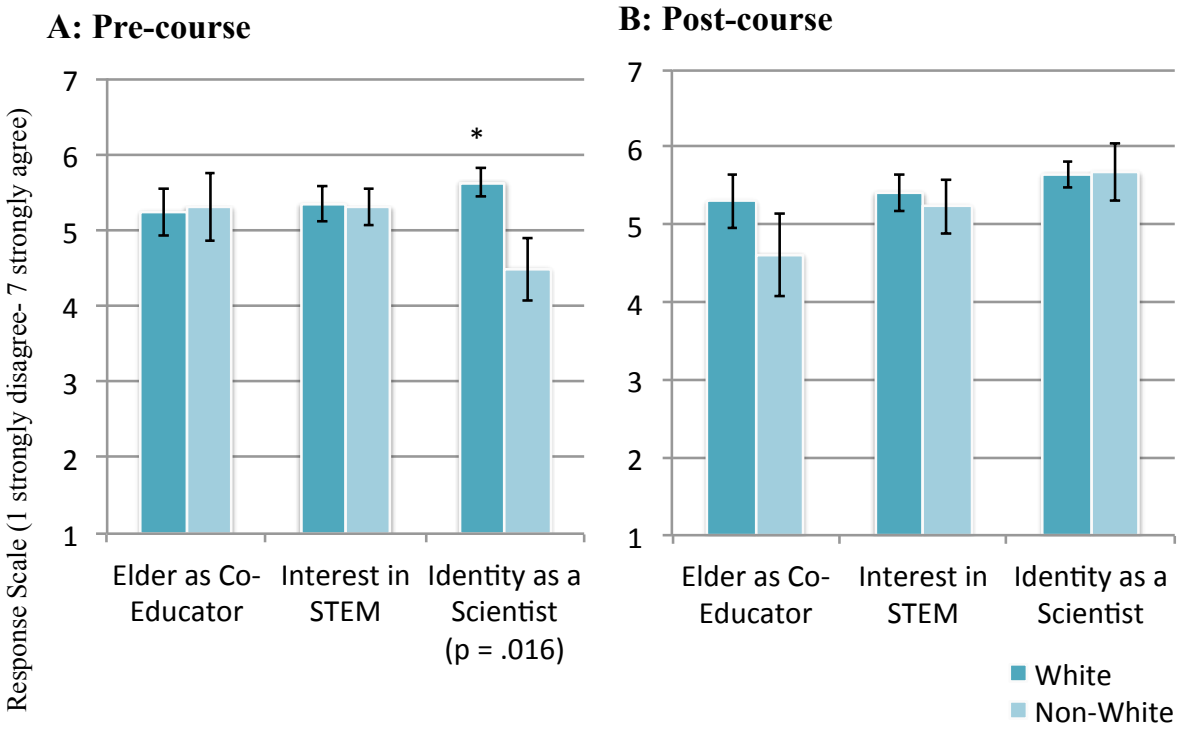


Student Perceptions Regarding Elder Educators, STEM Interest, & Self-identity as a Scientist
*$p < .05$

Figure 8 shows intervention differences between No Elders (U.S.) *(n=11),* and Elders (Canada) *(n=17)* pre-class (A) and post-class (B). We noted no significant differences between pre- and post-class opinions of participants in the context of Elder as a co-educator or self-identify as a scientist. There was no statistically significant variation in STEM interest between students taught an online STEM course without Elders co-educators (U.S.) or with Elder co-educators (Canada) pre-course. However, post-course students who were exposed to Indigenous science co-educators (Elders, Canada) reported significantly greater (p= 0.021) interest in STEM than students lacking such exposure.

Racial/Ethnic Differences Pre- and Post-Course Survey

Figure 9:
Racial/Ethnic Differences: Student Perceptions Regarding Elder Co-educators, STEM Interest, & Self-identity as a Scientist



Student Perceptions Regarding Elder Educators, STEM Interest, & Self-identity as a Scientist
*$p < .05$

Figure 9 shows pooled U.S. and Canadian participants in regards to racial/ethnic differences, designated White and Non-White students, with no significant differences pre- (A) and post- (B) course in STEM interest and their opinion on the merit of Elders as co-educators. Examining how students identify themselves as scientists, we note a statistically significant difference between White and minority students in the pre-class survey (p= 0.016). White students initially identified more strongly as scientists, but after taking the online Ethnomedicine course blending Indigenous and Western science, regardless of exposure to Elder co-educators, both student pools reported similar self-identity as a scientist.

Learning Outcome (Quiz Results)

Figure 10:
Quiz Scores: Average Quiz Score

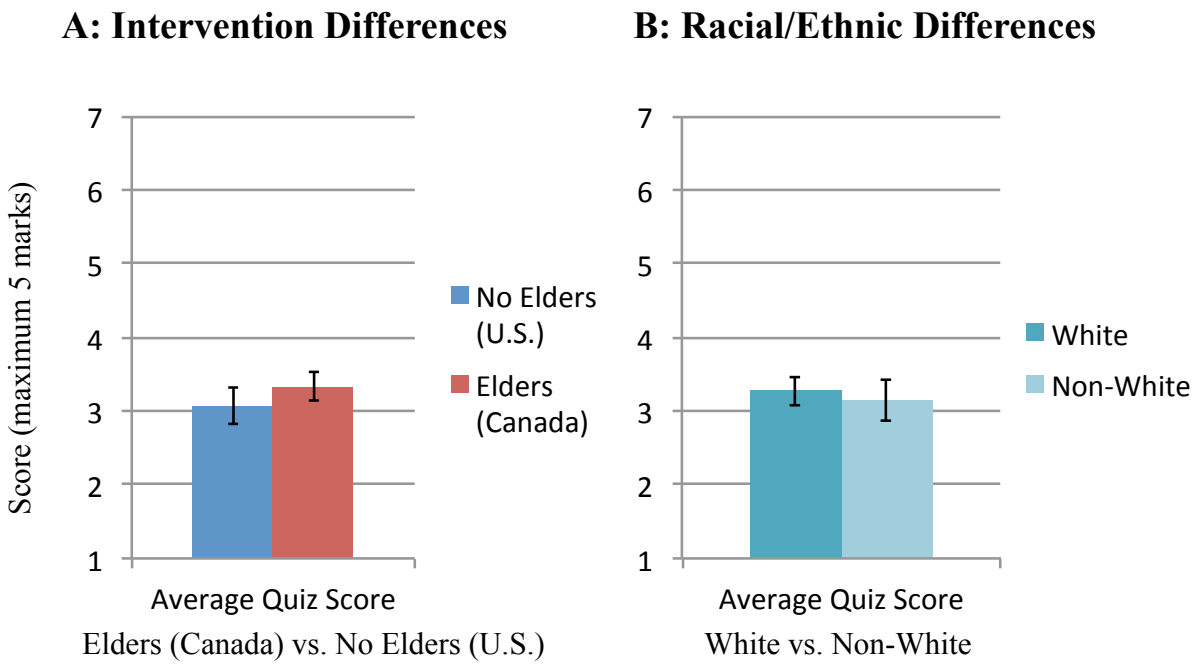


Figure 10 shows learning outcomes as a function of average weekly quiz scores, with no significant differences between students exposed to (A) Elder knowledge (intervention differences) or (B) their ethnicities (racial/ethnic differences).

Discussion

Our findings from the pilot study (conducted one year prior to this quasi-experimental pedagogical study) established that when the same course is delivered concurrently to U.S. and Canadian students, there are no differences across groups (Alkholy et al., under review). The findings of this quasi-experiment show significant positive impact of Indigenous

science/educators upon post-secondary STEM students. Upon completion of the online Ethnomedicine course with Indigenous science Elders as co-educators (Canada), students report considerably greater interest in STEM than those without (U.S.), affirming the important role Elders can play toward improving interest in STEM, regardless of student ethnicity. Minority students reported significantly less self-identification as scientists than White students before taking the blended Indigenous and Western science class, but then report a similar self-identification afterwards, regardless of exposure to Elders in both cases. Our findings corroborate the work of Bang and Medin (Bang & Medin, 2010) with community-based summer science programs, designed to support students through multiple ways of knowing, including teachings by Elders. Students stated after the culturally competent program that they learn science from conventional sources (e.g., textbooks and school teachers) and from Elders; whereas before the program they indicated that they learn science from conventional sources. Mindful design of science learning environments supportive of cultured meanings benefits Native/Aboriginal students.

While we show the positive impact of Elders upon all students' interest in STEM, we also demonstrate that the convergence of Indigenous science and Western science in a hybrid STEM course can have a positive impact on minority student nascent identity as a scientist, irrespective of the presence of Elder co-educators. However, the small number of study participants gave rise to an insufficient number of Native/Aboriginal participants (n=6), which precluded statistical analysis of the course impact specifically upon Native/Aboriginal students. Consider this an urgent call for greater participation both by Tribal Colleges and participation of Native/Aboriginal students in such studies in the future, for full representation and impact.

These findings support the notion of exposing post-secondary STEM students to Indigenous science, which could either be direct with the presence of Indigenous science Elder co-educators or indirect, through course design with science cultural competence (Ferreira et al., 2014). Competency in 'science-culture' entails acknowledgement of science as a human endeavor such that science is a cultural construct and therefore, Indigenous and Western science *is* science. Science is the effort by humans to systematically explore and explain the natural world, through inquiry and pedagogy, and since certain Elders are the gatekeepers to Indigenous science, they can act as Indigenous scientists to all students. Increasing numbers of mainstream and tribal colleges and universities utilize Elders' services as educators and co-educators in their courses (Michell, 2010). This practice has been successfully implemented with Native/Aboriginal students, and demonstrates the importance of bringing Elder knowledge to higher education, as outlined by Michell (Michell, 2010). Elders play myriad roles at the interface of Indigenous and Western science such as: course curriculum design, teaching, and research. Above all, the very presence of these respected professionals adds an invaluable sense of community and overall integrity to Native/Aboriginal students (Michell, 2010), and benefits all STEM students as we show. At the 2014 American Association for the Advancement of Science presidential address, the convergence of scientific fields was described as an important means to achieve advancements in discovery and innovation with both social and scientific value (Sharp, 2014). Recognizing the value of exchange at the interface of Indigenous and Western science remains a challenge, underscoring the need for more research in this area-both quantitative (Alkholy et al., under review) and qualitative (Bang & Medin, 2010).

Project Summary

Background Information

Between 1995 and 2007, the demand for science, technology, engineering, and mathematics (STEM) professionals rose by 36% in the United States (Guteral, 2014). While White and Asian students are well-represented in STEM fields, some minorities (especially Native/Aboriginal students) are underrepresented (Guteral, 2014). A significant reason for the low retention of minorities in STEM fields is the perceived conflict between Western science (STEM) and Indigenous science (Tienet, 1991). Students' perceptions toward STEM fields improve when their respective cultures are supported in academia (Demmert & Towner, 2003). The practice of employing respected Indigenous Elders as co-educators in post-secondary education may play a positive role in the convergence between Indigenous and Western science.

Some Elders are trusted Indigenous science practitioners, and when present, they may play an under-appreciated but beneficial role in post-secondary science education for all students (Marshall & Marshall, 2009). Elders can bring a new set of knowledge to the classroom and set it on equal footing with Western science. This has a several-fold impact: 1) it expands the scope of "accepted" definitions of science, 2) it creates a more inviting classroom experience for minorities because it gives them culturally relevant scientific role-models, 3) it provides validation of Indigenous science or traditional knowledge. This project used a three-phase quantitative approach designed to determine if Elders are a source of scientific information for post-secondary students, and if Elders create a positive impact when they serve as co-educators in STEM-related courses.

About This Project

This three-part project is a community-based participatory research (CBPR) study intended to help support minority students in STEM fields. Community-based participatory research is a partnership approach that allows community members to participate, as researchers or as participants, in research related to the underserved community groups of which they are members (Agency for Healthcare Research and Quality, 2003). Further, CBPR research is frequently used with the traditional and Indigenous peoples of North America. At First Nations University of Canada (FNUniv), institutionally trained Campus Elders contribute to the research as Indigenous science researchers alongside academic scientists, and also contribute to pedagogical approaches implemented to serve the needs of both the underrepresented student community as well as mainstream students.

Project Aims and Phases

The first phase of this study aimed to determine the source of information Canadian post-secondary students use to learn about Indigenous knowledge (e.g., natural health products (NHPs)). This work also led us to consider what role Elders play in teaching students about science. Phase two was a pilot study that targeted the differences between U.S. and Canadian, minority and non-minority university students on issues related to this project. Phase two examined students' perceptions of Indigenous Elders as STEM co-educators, their interest in STEM, and whether or not they self-identify as scientists when Elders co-teach an online STEM course. The third and last phase was a quasi-experimental study based upon the results from phase two. Phase three aimed to determine if Elders are viewed as valuable STEM co-educators, if their presence increases students' interest in STEM, strengthens students' self-identification as scientists, and improves students' learning outcomes.

Project Findings

Results from the first phase show that Elders are an important source of information regarding Indigenous science (e.g., NHPs), especially for Native/Aboriginal students (Alkholy et al., 2013). In this first phase, the results demonstrated that 50% of Aboriginal students learned about NHPs from Elders (Alkholy et al., 2013), which was significantly greater as compared to non-Aboriginal students. Although there were no statistically significant results from the pilot study conducted during phase two (Alkholy et al., under review), when Elders co-taught the same STEM online course delivered in the U.S.A. and Canada, these negative findings were invaluable to show that there were no inherent differences across institutions and across countries. This informed and inspired the subsequent experimental study (Elder versus non-Elder instruction) that was undertaken during phase three to assess the importance of Elders as co-educators (Alkholy et al., under review).

The quasi-experiment that took place during phase three shows us that having Elders serve as co-educators in post-secondary education increases Canadian students' interest in STEM. While White students identified more as a scientist at the beginning of the course (as compared to non-White), upon completion of course, there was no difference between White and non-White students' identity as a scientist. These findings are associated with the impact of Elders and Indigenous science course content, respectively.

Interpretation and Discussion

The findings from phase one of this project support the importance of Elders as a source for certain Indigenous science knowledge (e.g., NHPs) by Native/Aboriginal students. The findings from phase two demonstrate that there are no differences between Canadian and American students taking a concurrently offered online STEM course. Phase three findings

suggest the value of exposing post-secondary STEM students to Indigenous science through course design that includes cultural science competence, delivered by Indigenous science educators, and STEM trained PhDs cognizant of Indigenous science as science. These findings also support the positive changes that Elders can make on students' interest in STEM and that Indigenous science exposure can have upon their identity as a scientist.

This project establishes the need for the convergence of Indigenous science and Western STEM in academia; it also suggests that the addition of Indigenous science/Traditional knowledge approaches to the Western teaching methods typically found in STEM courses expands both minority and non-minority students' scientific appreciation. Elders are a valuable source of Indigenous science knowledge for many reasons. For example, Elders add value to traditional Western teaching methods, help students explore and explain the natural world, and model as Indigenous scientists for all students.

Future Implications

Elders can play beneficial roles during the convergence of Indigenous and Western science in postsecondary education by assisting in the design of course curricula, lending their teaching and research skills, and providing many other services when they serve as co-educators and co-researchers in educational institutions (Michell, 2011). Above all, the presence of respected Elders adds an invaluable meaning of community and overall solidity to the classroom environment for Native/Aboriginal students, and benefits both minority and non-minority STEM students by expanding their scientific knowledge, their definition of science, and their identity as a scientist, as shown by this project and the published literature. However, Native American/Aboriginal students were severely underrepresented in this research as participants, despite the original goal of targeting this group; this highlights the need for greater participation

by Native students in such future research to improve the generalizability of study findings to this group in particular. Nevertheless, we encourage the exposure of all students to Indigenous science, to increase science literacy regarding the accepted definition of ‘science’. Elders’ presence at post-secondary institutions, as Campus Elders, can facilitate exposure to Indigenous science, through research, teaching, and serving as co-educators in STEM. In order to demonstrate the value of converging Indigenous and Western science, additional quantitative and qualitative research in this area should be undertaken.

APPENDIX A

The pre- and post-course survey used in chapters (phase) 2 and 3

Part 1:

1) Do you want to continue to take the short survey?

a. Yes

b. No

2) You are taking this course from which university?

a. Wayne State University

b. University of Regina (including Luther College and Campion College)

c. First Nations University of Canada- Regina

d. First Nation University of Canada- other campus

3) Tell us which survey you are taking now?

a. At the beginning of the semester (pre-survey).

b. At the end of the semester (post-survey).

4) Demography:

A) Grade level (at university):

a. 1st Year

b. 2nd Year

c. 3rd Year

d. 4th Year or More

e. Graduate

B) Biological sex:

a. Female

b. Male

C) Age in years:

a. 18-19

b. 20-21

c. 22-23

d. 24-25

e. 26-30

f. 31-40

g. 41+

D) Race/Ethnicity:

a. White

b. Black

c. First Nation, Metis or Inuit

(American Indian, Alaskan Native, or Native Hawaiian)

d. Asian

e. Hispanic or Latino

f. Pacific Islander

g. Other: _____

Part 2:

1. I believe traditional Elders are appropriate for co-teaching science course content and activities.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

2. I believe having traditional Elders co-teaching a science course will make the class more culturally relevant for me.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

3. I believe having traditional Elders co-teaching a science course is effective in helping me understand the material.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

4. I believe having traditional Elder co-teachers is useful for problem solving.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

5. I believe this course that blends Indigenous and Western science is culturally relevant to me.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

6. I believe having traditional Elders co-teaching a science course provides a viable alternative to a one-instructor model.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

7. I believe having traditional Elders co-teaching uses the expertise of all instructors involved.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

8. I believe having traditional Elders co-teaching demonstrates pre-planning by the course instructors.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

9. I believe having traditional Elders co-teaching is more integrative than a single instructor.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

10. I believe the co-teaching traditional Elders appear to be involved with other instructors.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

11. I believe having traditional Elders co-teaching helps me gain a better understanding of the material.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

12. I believe having traditional Elders co-teaching demonstrates the blending of Indigenous and Western ways of knowing.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

13. I believe having traditional Elders co-teaching demonstrates best practices in team teaching and collaboration.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

14. I believe in general, science courses can be relevant to my culture and tradition.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

15. I believe having traditional Elders co-teaching allows for more opinions or points of view (e.g., a more holistic point of view).

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

16. I believe this course helps to improve or develop my professional knowledge about culturally relevant science.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

5) What do you/did you like best about multidisciplinary team teaching?
    a. Learning many science perspectives
    b. Exposure to more opinions or points of view
    c. Communication with instructors
    d. Convinced Indigenous science is compatible with Western science
6) What do/did you like least about multidisciplinary team teaching?
    a. Learning many science perspectives
    b. Exposure to more opinions or points of view
    a. Communication with instructors
    b. Convinced Indigenous science is compatible with Western science

8) Do you think you learn more or less with multidisciplinary team teaching than with regular teaching (one professor)?

    a. Less
    b. More

9) Is there something else you would like to add about your experience in a multidisciplinary team teaching class (with or without Elders)?

Part 3:

A) To me, SCIENCE (e.g., Biochemistry, Biology, Nutrition …) is:

1.	Fascinating	①	②	③	④	⑤	⑥	⑦	Mundane
2.	Appealing	①	②	③	④	⑤	⑥	⑦	Unappealing
3.	Exciting	①	②	③	④	⑤	⑥	⑦	Unexciting
4.	Means nothing	①	②	③	④	⑤	⑥	⑦	Means a lot
5.	Boring	①	②	③	④	⑤	⑥	⑦	Interesting

B) To me, MATH is:

1.	Fascinating	①	②	③	④	⑤	⑥	⑦	Mundane
2.	Appealing	①	②	③	④	⑤	⑥	⑦	Unappealing
3.	Exciting	①	②	③	④	⑤	⑥	⑦	Unexciting
4.	Means nothing	①	②	③	④	⑤	⑥	⑦	Means a lot
5.	Boring	①	②	③	④	⑤	⑥	⑦	Interesting

C) To me, ENGINEERING is:

1.	Fascinating	①	②	③	④	⑤	⑥	⑦	Mundane
2.	Appealing	①	②	③	④	⑤	⑥	⑦	Unappealing
3.	Exciting	①	②	③	④	⑤	⑥	⑦	Unexciting
4.	Means nothing	①	②	③	④	⑤	⑥	⑦	Means a lot
5.	Boring	①	②	③	④	⑤	⑥	⑦	Interesting

D) To me, TECHNOLOGY is:

1.	Fascinating	①	②	③	④	⑤	⑥	⑦	Mundane
2.	Appealing	①	②	③	④	⑤	⑥	⑦	Unappealing
3.	Exciting	①	②	③	④	⑤	⑥	⑦	Unexciting
4.	Means nothing	①	②	③	④	⑤	⑥	⑦	Means a lot
5.	Boring	①	②	③	④	⑤	⑥	⑦	Interesting

E) To me, a CAREER in Science, Technology, Engineering, or Mathematics (is):

1.	Fascinating	①	②	③	④	⑤	⑥	⑦	Mundane
2.	Appealing	①	②	③	④	⑤	⑥	⑦	Unappealing
3.	Exciting	①	②	③	④	⑤	⑥	⑦	Unexciting
4.	Means nothing	①	②	③	④	⑤	⑥	⑦	Means a lot
5.	Boring	①	②	③	④	⑤	⑥	⑦	Interesting

Part 4:

Identity as a Scientist:

1. In general, being a scientist is an important part of my self-image.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

2. I have a strong sense of belonging to the community of scientists.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

3. Being a scientist is an important reflection of who I am.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

4. I have come to think of myself as a "scientist."

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

5. I feel like I belong in the field of science.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

6. I am a scientist.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

7. My ethnic identity is an important part of who I am.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

8. My ethnic identity is an important part of my being a scientist.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

9. I think of myself as a _____ scientist (fill in the blank with your ethnic identity – for instance, a Native scientist).

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

10. Thinking of myself as a scientist is compatible with other aspects of my background.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

11. Having more people with my ethnic background in my field makes me feel more like a scientist.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

Part 5:

Commitment to A Science Career:

1. I intend to work in a job related to science.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

2. I see the next steps in the field of science, and I intend to take them.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

3. I will work as hard as necessary to achieve a career in science.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

4. I expect a career in this field will be very satisfying.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

5. I feel that I am on a definite career path in science.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

6. I definitely want a career for myself in science.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly disagree

7. Science is the ideal field of study for my life.

I strongly agree	①	②	③	④	⑤	⑥	⑦	Strongly

								disagree

Thank you for participating in this survey.

APPENDIX B

Permissions from the publishers to use published (Chapter 1) and *in press* (Chapter 2) papers:

1- An article*, Aboriginal and Non-Aboriginal Students Learn about Natural Health Products from Different Information Sources,* of which I am first author, and which is published in the journal *Pimatisiwin: A Journal of Aboriginal and Indigenous Community Health* reports an essential part of my *(dissertation)* research. I received permission by email on March 09, 2015 from the journal editor Dr. Patti LaBoucane-Benson, Email: patti-laboucane@ncsa.ca.

Alkholy, S., Alqahtani, S., Cochrane, A., Ferreira, M. P., & Gendron, F. (2013). Aboriginal and non-Aboriginal students learn about natural health products from different sources. *Pimatisiwin: A Journal of Aboriginal and Indigenous Community Health* 11(1), 99-112.

2- An article*, Assessing the impact of Western science and Indigenous science educators in an online STEM course: A pilot study,* of which I am first author, and which is accepted (*in press*) in the journal *The International Journal of Health, Wellness and Society* reports an essential part of my *(dissertation)* research. I received permission by email on February 24, 2015 from the journal editor Mr. Blake Williamson, Email: support@rt.commongroundpublishing.com

Alkholy, S., Gendron, F., Dahms, T. E., & Ferreira, M. P. (Accepted 2014). Assessing the impact of Western science and Indigenous science educators in an online STEM course: A pilot study. *The International Journal of Health, Wellness and Society, in press 2015*.

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ABSTRACT

ASSESSING THE IMPACT OF NATIVE AMERICAN ELDERS AS CO-EDUCATORS FOR UNIVERSITY STUDENTS IN STEM

by

SARAH ALKHOLY

May 2015

Advisor: Maria Pontes Ferreira, PhD, RD

Major: Nutrition and Food Science

Degree: Doctor of Philosophy

Introduction: Minorities are underrepresented in the science, technology, engineering, and mathematics (STEM) workforce, post-secondary STEM education, and they show high academic attrition rates. Academic performance and retention improve when culturally relevant support is provided. The interface of Western and Indigenous Science provides an opportunity for bridging this divide. This three phase doctoral project is based upon a community-based participatory research (CBPR) orientation that aims to support academic institutions to serve minority students in STEM, and implement educational components (pedagogy) to serve the needs of the underrepresented community. **Method:** Phase 1: was a cross-sectional study whereby a survey was given to participants to assess prevalence of natural health products use by students, and to determine how students learn about NHPs. Phase 2: was a longitudinal survey pilot study based upon an online STEM course offered concurrently at four universities to determine the differences between U.S. and Canadian, minority and non-minority university students regarding their perceptions of traditional Elders as STEM co-educators, student interest in STEM, and science identity, through the use of a pre-and post- course survey. Part 3: was a pedagogical quasi-experiment based upon an online STEM course offered concurrently at four

universities (Elder intervention; Botanist control) to assess the impact of the intervention on student perceptions of: Elders as STEM co-educators; student interest in STEM; identity as a scientist; learning outcomes. **Result:** We found that Aboriginal students learn information about natural health products from traditional Elders significantly more so than non-Aboriginal students. There were no statistically significant results from the pilot study (no difference between USA and Canada). Findings from the quasi-experiment show that students taught with Indigenous science Elder co-educators have significantly greater interest in STEM than students not exposed to Elders' teachings. Minority students reported significantly less self-identification as a scientist than did White students at pre-course, but report similar identity as a scientist to White students post-course. **Discussion:** Future work should investigate the role of Elder traditional educators to convey NHPs information directed specifically to Aboriginal university students. Although there were no statistically significant results from the pilot study, we know that the same course delivered to U.S. and Canadian students concurrently reveals no differences between these groups, itself an important finding. Further, the observed trends suggest a need for more work to demonstrate if Indigenous science Elder educators merit involvement in novel pedagogical approaches and delivery modalities to reach minority students and to increase students' interest in STEM. From the quasi-experiment we attribute the findings to the impact of Elders and culturally competent course content upon students, in a post-secondary STEM class. However, low power in Phase 2 and 3 studies, as well as no/low participation by Native students weakened the study design and led to *a posteriori* hypothesis testing. This precludes generalizability of the findings to Aboriginal students; greater participation from this group is needed for full representation. While this project establishes the need for convergence of Indigenous and Western Science in academia, further work is warranted.

AUTOBIOGRAPHICAL STATEMENT

I was born in 1983 in New Orleans, Louisiana, U.S.A., from Saudi parents while my father was earning his PhD in law. I went back to Saudi Arabia when I was 3 years old; there, I grew up and completed all my primary schooling until I graduated from King Abdul-Aziz University (KAU) Jeddah, Saudi Arabia with a bachelor's degree. Once I earned my bachelor's degree, I had the opportunity to apply for scholarship to continue my graduate education to earn master's and PhD degrees. Even though my first language is Arabic and my English was poor, as an American citizen, U.S.A. was my first choice to continue my higher education. In 2007, I received my scholarship and moved to U.S.A.

I currently hold a bachelor's degree in the field of nutrition and food science from KAU Department of Home Economic Science, earned in 2006. In 2010, I graduated from Western Michigan University in Kalamazoo, Michigan, where I earned a master's degree in Family and Consumer Science in the College of Education and Human Development. In 2013, I received my second master's degree from Wayne State University in Detroit, Michigan, and I am now in my fifth year in the doctoral program in the Department of Nutrition and Food Science.

Currently, I am a doctoral candidate in the Department of Nutrition & Food Science at Wayne State. My research interests are in ethnonutrition. Specifically, I am doing community-based participatory research with Native/Aboriginal students and Elders. After I earn my PhD degree, I am planning to return to Saudi Arabia to work as a professor at Umm Al-Qura University in the Nutrition department, in order to serve and transfer all the education that I learned in the United States to Saudi students. Five years from now, I see myself living between Saudi Arabia and U.S.A. I am looking for an opportunity for a postdoctoral fellowship and for collaborative research between universities in Saudi Arabia and U.S.A. I really appreciate the fact that I am Arab-American working in multicultural communities.