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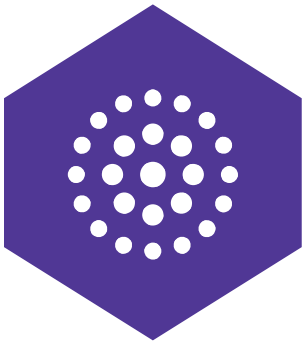

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Assessing Student Perceptions of Indigenous Science Co-Educators, Interest in STEM, and Identity as a Scientist:
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Assessing Student Perceptions of Indigenous Science Co-educators, Interest in STEM, and Identity as a Scientist: A Pilot Study

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Abstract: Minorities are underrepresented in the science, technology, engineering, and mathematics (STEM) workforce, post-secondary STEM education, and show high academic attrition rates. Academic performance and retention improve when culturally relevant support is provided. The interface of Western science and Indigenous science provides an opportunity for bridging this divide. We hypothesized that there would be regional (U.S.A. vs. Canada) differences amongst post-secondary students regarding these variables: perceptions of traditional Elders as STEM co-educators; interest in STEM; and self-identity as a scientist. We conducted a short-term longitudinal pilot study of an interdisciplinary, multi-institutional, and cross-cultural STEM course in the spring of 2013. This online STEM course was concurrently offered at mainstream and tribal universities in the U.S.A. and Canada. Pre- and post-course surveys were administered to participants (n=11). The outcome measures of interest were assessed, and group differences were tested by ANOVA (SPSS 21 software). Due to the limited sample size, the statistical power was low. We found no statistically significant results upon data analysis. In regards to region, however, we found that Canadian students showed a stronger trend to believe that traditional Elders are appropriate as post-secondary STEM co-educators as compared to U.S. students (p=.31). Students from the U.S. 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). In regards to race/ethnicity, we found that non-White students tended to consider traditional Elders appropriate post-secondary STEM co-educators (p=0.45); that White students tended to be more interested in STEM fields than non-White students (p=0.80); and that non-White students tended to self-identify as a scientist more so than White students (p=0.31). Despite the lack of statistically significant results from this pilot study, the observed trends suggest a need for more research. Do Indigenous science Elder educators merit involvement in novel pedagogical approaches and delivery modalities to reach minority students and to increase students' interest in STEM? Next, we will conduct a quasi-experiment with a larger sample of university students, to assess the impact of traditional Elders as STEM co-educators in an online STEM course at tribal and mainstream universities in the U.S.A. and Canada.

Keywords: Indigenous Science, Western Science, STEM, post-secondary education, Aboriginal, Native

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 aged 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). 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 comprised 2% of the U.S. population in 2012 (National Center for

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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 Aboriginal population increased 20.1% between 2006 and 2011, compared with 5.2% for the non-Aboriginal population (National Household Survey 2013). In this paper, the terms Native, Native American, and Aboriginal refer to the indigenous peoples of the U.S. and Canada.

In the U.S., URMs are less likely to enrol in programs of higher education (Swail et al. 2003). In 2012, for every six U.S. students who earn a bachelor degree or higher, one student was considered an 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. Compared to White students, minorities are also less likely to complete their courses (Thomas and Richardson 2012). In 2010, only 16% of all high school seniors choose STEM fields for their careers at the post-secondary level over other majors in the U.S. (U.S. Department of Education 2010). 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). In academia, the Native/Aboriginal group is the least characterized underrepresented minority (National Science Board 2012).

Native/Aboriginal students are the least represented 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 were reported, with no significant change in Native/Aboriginal student 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 perceived conflicts between Western science and Native/Aboriginal traditional knowledge. Another factor is students' 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 whilst maintaining their culture are more likely to succeed in academia than are other Native/Aboriginal students. Aikenhead (2006) discusses major factors leading to educational failure in science at mainstream schools amongst students who belong to certain cultures, such as Aboriginal/Native. One contributing factor that weakens participation of Aboriginal/Native students in science-related fields is the perception that science is not part of their culture (Aikenhead 2006).

Culturally relevant education is linked to improved academic performance by Native/Aboriginal students (Demmert and Towner 2003). To provide better learning experiences and support for Native/Aboriginal students in STEM courses (online and live), it is important to include culturally relevant concepts in 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. Through acknowledgment of language and culture, TCUs provide a support system for students. In addition to Indigenous science, they also offer STEM-related courses and research opportunities. Many of these aspects help Native/Aboriginal students to be more engaged in their academic programs (National Clearinghouse for English Language 2011).

In a recently published study, students (n=963) were surveyed at both 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 natural health products 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.

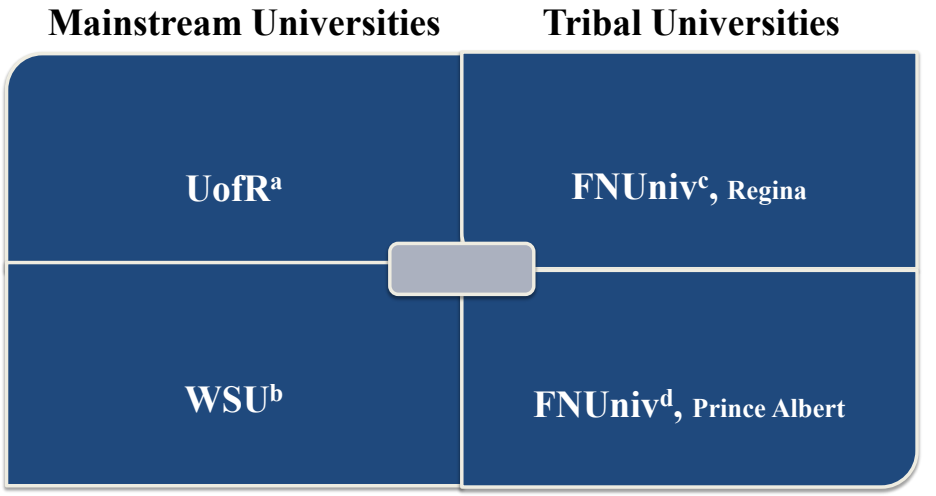
Perhaps due to cultural factors, Native/Aboriginal students are less likely to join online courses or programs compared to other students (Newell and Adesope 2011). These cultural issues could be due in part to difficulty in accessing computer-related technology. Traditional Native/Aboriginal students may also have concerns about engagement with Western science and harbour a 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 may increase student 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 was to determine regional and racial/ethnic differences in post-secondary student perceptions regarding these variables in regards to a STEM course: 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 do 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 concurrently at four universities (Figure 1). Two were TCUs (First Nations University of Canada (FNUniv), Regina, Saskatchewan, 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.). Students from all institutions received the same online course, which was delivered by the same STEM course professors. The course professors were: a Nutrition assistant professor from WSU (MPF), a Biochemistry full professor from UofR (TD), and a Biology associate professor from FNUniv (FG). The course content covered native plants from the North American Great Lakes and Great Plains bioregions, used as functional foods, medicines, and/or natural health products in mainstream and indigenous cultures. Non-PhD indigenous Elders were guest lecturers delivering online presentations to explain cultural uses of the plants. The three PhD professors used a Western scientific approach to deliver their course materials, whereas the Elders delivered the cultural aspects of the plants, consistent with Indigenous science approaches.



[a]University of Regina
[b]Wayne State University
[c]First Nations University of Canada, Regina
[d]First Nations University of Canada, Prince Albert

Figure 1: Study Design Diagram

Regions

Regina is the capital city of the Canadian prairie province of Saskatchewan and home of UofR, a liberal arts institution with research and teaching priorities. 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, formerly the Saskatchewan Indian Federated College founded in 1976 in partnership with the UofR, is not an independent degree-granting institution. The mission of FNUniv is to improve the quality of life, and to preserve, protect, and interpret the history, language, culture, and artistic tradition of Native/Aboriginal people (History of First Nations University of Canada 2013). In winter 2013, 667 students were enrolled at FNUniv (Annual Report First Nations 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 and teaching 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 of 2012, there were 705 Canadian students out of 2,330 students newly enrolled (Canadian Students Wayne State University 2012).

Participants

A total of eleven 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)*; Table 1. Due to the low number of Aboriginal participants we re-framed our hypotheses *a posteriori* to compare White vs. 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 1: 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 Latino	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 designed to assess the regional (U.S. vs. Canada) and racial (White vs. non-White) differences in post-secondary students' perceptions regarding: 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), and the

second section asking about student 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 a scientist, 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 selections of 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. However, the following observed trends do suggest the need for future research.

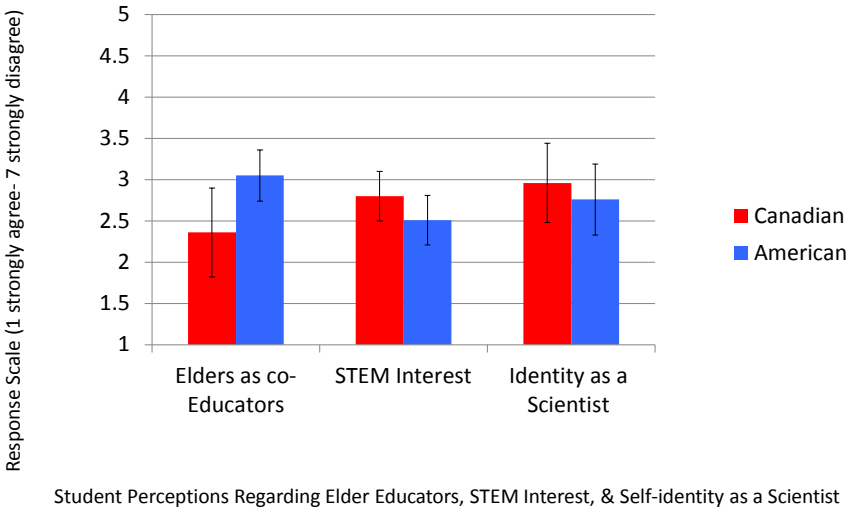


Figure 2: Regional (U.S. vs. Canada) Student Perceptions Regarding: Elder Co-educators, Interest in STEM, and Self-identity as a Scientist

Results from one-way ANOVA analyses in Figure 2 show Canadian and U.S. students' perceptions about: Elder co-educators, interest in STEM, and self-identity as a scientist. Figure 2 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)*.

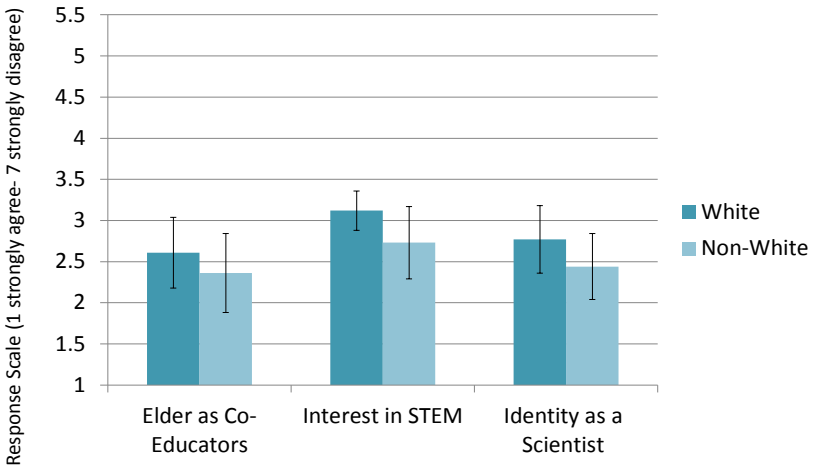


Figure 3: Racial (White vs. non-White) Student Perceptions Regarding: Elder Co-educators, Interest in STEM, and Self-identity as a Scientist

Results from one-way ANOVA analyses in Figure 3 show White and non-White student perceptions regarding: Elder co-educators, interest in STEM, and self-identity as a scientist. Figure 3 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).

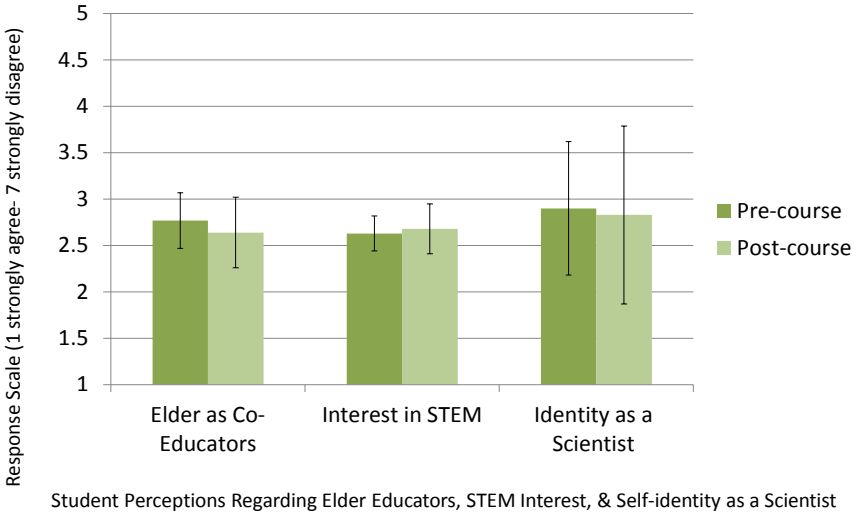


Figure 4: Pooled Student Perceptions (pre- & post-course) Regarding: Elder Co-educators, Interest in STEM, and Self-identity as a Scientist

A t-test was used to analyze the data in Figure 4 that shows pooled student perceptions (pre- & post-course) about: Elder co-educators, interest in STEM, and self-identity as a scientist. The findings suggest no trends for students' perceptions (pre- vs. 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 was to set the stage towards 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. There are no statistically significant regional or racial differences in student perceptions regarding Elder co-educators at the interface of Indigenous science and Western science in a distance-learning course. However, we find that Canadian students show a trend towards believing that traditional Elders are more appropriate as post-secondary STEM co-educators when compared to U.S. students. We had hypothesized that non-White students would consider traditional Elders as appropriate post-secondary STEM co-educators more so than 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 towards being more interested in STEM fields as compared to non-White students. Finally, while we hypothesized that White students would self-identify as a scientist more so than non-White students, there was a weak trend suggesting the reverse. However, there were no statistically significant differences.

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). In this pilot study of an online STEM course, we set out to assess student perceptions of Indigenous science co-educators, student interest in STEM, and student self-identity as a scientist. Involvement of traditional Elders in novel pedagogical approaches and delivery modalities to reach minority students—especially Native/Aboriginal—may facilitate their interest and retention in STEM courses (Michell 2011).

Study Limitations

The low number of study participants limited the statistical power of this study. The lack of Native/Aboriginal participants in the study prevented us from determining the effect of the course upon Native/Aboriginal students specifically. This course had been offered for the first time at FNUniv and UofR at the time, and the ethics approval came late. Thus, we did not have adequate time to advertise the course widely at these participating universities. This led us to modify our purpose and hypotheses *a posteriori.*

Implications for Future Directions

We will next conduct a quasi-experimental pedagogical study in the spring of 2014 to test our hypotheses regarding the impact of the presence or absence of Elder co-educators in the (otherwise) 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 a quasi-factorial 2 X 2 design. The experimental group will engage with traditional Elder co-educators at UofR and FNUniv–Regina (e.g., online medicine walks, online lectures, other online interactions), whilst the control group will have STEM-trained

ethno/botanists as co-educators at FNUniv–Other and WSU (e.g., online botanical garden tours, online lectures, other online interactions). 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 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. Power analysis for the upcoming study determines 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). We strive to uncover strategies to improve post-secondary STEM pedagogy, through innovative research aimed to enhance underrepresented minority students' inspiration through science, both Indigenous and Western.

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