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A HUMAN RIGHTS CENTRED HISTORICAL APPROACH TO TEACHING SCIENCE FOR SOCIAL CHANGE

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Abstract

The COVID-19 pandemic brought to light uncomfortable realizations for science educators; it has become patently obvious how much confusion and misunderstanding there exist about basic scientific facts that could help one make informed decisions, from individual choices to policy making at all levels of government. The extreme polarity in public and private discourses related to COVID-19 might be augmented by political views, economic interests and social media algorithms, but at the bottom of it all there is a lack of understanding of scientific concepts and of the nature of science, as well as its sociocultural and historical contexts. There is also a lot of skepticism about science and scientists. This skepticism is not completely out of place; historically, there are embarrassing large numbers of cases in which human rights were infringed in the name of advancements of scientific knowledge. There are also incredible contributions of science to upholding and improving human rights. Whereas scientific discoveries are presented by the media as noteworthy and celebrated, there is a lack of intentional exploration and meaningful discussion of the "ups and downs" of science throughout its history and across cultures in the context of its relationship with human rights. To address this issue, I developed and implemented two courses designed for pre-service and in-service teachers, exploring the rather turbulent history of science and human rights from ancient times to the present day, from a perspective that considers both science and human rights within social, cultural and historical contexts, and highlights the contributions of science to human rights causes, from both negative and positive cases. Rather than promoting a naïve view of science as an a-cultural practice, detached from its sociocultural and historical context, and uncritical of the hegemonic Western, Judeo-Christian, White, male, heteronormative and colonial grounds on which rests the mainstream science presented in grade school textbooks, the courses pushed the boundaries of the very definition of science and its role in human rights causes, challenging students to consider the many implications of how we define, present and study science in schools, as well as how we promote and use scientific knowledge in our lives. Students in the courses were challenged to (re)envision science and human rights as they critically analyzed predominant Discourses from an eco-pedagogical social-cultural and historical perspective. A description of the courses and results evidencing the impact of the courses on students' conceptualizations of science education for social change are reported in this conference presentation.

Keywords: *Science education, human rights, teacher education, sociocultural and historical context, equity.*

1. Introduction

The Faculty of Education at the University of Manitoba offers four programs: a Bachelor of Education (BEd); a Post-Baccalaureate Degree in Education (PBDE); a Master of Education (MEd); and a Doctor of Philosophy in Education (PhD). The BEd program is a post-degree, two-year teacher preparation program, catering primarily to provincial students. Students apply for one of three possible streams: Senior Years (focused on curriculum, teaching and learning in high school, that is, from grades 9 to 12 in the province of Manitoba); Middle Years (focused on grades 5 to 8); and Early Years (focused on Kindergarten to grade 4). Students admitted into the Senior Years Stream must hold minimum course credit hours on two specific teachable areas, which become their major and minor teachable disciplines in the BEd program. The BEd program encompasses 60 credit hours, distributed among 20 courses (5 per term, including a practicum in K-12 schools). Senior Years Stream students have the option to choose one out of three *Themes* courses during their last term in the program, which fulfils one of the five electives in their program. One of the courses I describe and discuss in this conference presentation is a *Themes* course for Senior Years Stream students in the BEd program.

The second course I describe and discuss in this presentation was offered at the PBDE level, also open for registration to graduate students. The PBDE program is a post-undergraduate program

encompassing 30 credit hours of coursework. Unless students are seeking specific certification, there are no required courses in this program. The vast majority of PBDE students are in-service teachers taking the program as professional development and/or for upward salary scale placement. The MEd program requires 18 credit hours of coursework and a thesis, or 30 credit hours of coursework and a comprehensive paper. MEd students must take a combination of core courses (mandatory courses), concentration courses (focusing on a specific educational field of their choice), and research methods courses (at least one for the comprehensive route and two for the thesis route). The comprehensive route also allows students to take elective courses to complete the required 30 credit hours of their MEd program. The course I report on in this presentation is commonly referred to as a *Topics* course, which are newly developed courses offered no more than three times in any one of the post-undergraduate level programs at the Faculty of Education, and which typically encompass recent developments, current perspectives, or innovations in curriculum, teaching and learning, reflecting the expertise of faculty members and student demands, and responding to the need for new courses to be developed and offered from time to time, without becoming permanent offers in the course calendar for each program[1]. Thus, the *Topics* courses are excellent opportunity to pilot new courses and to respond to time sensitive issues (for example, the many implications of the COVID-19 pandemic restrictions on teaching and learning). The course I developed and taught as a *Topics* course worked as a pilot for a new MEd specialization currently being planned for our MEd program, which is being proposed on the basis of a strong sociocultural and critical stance for Mathematics Education and Science Education, and also as an opportunity to better align the courses offered in our PBDE and graduate programs in science education to the strategic plan and vision of the Faculty of Education and of the university, particularly regarding equity and inclusion initiatives. My desire to design and implement such a course also stemmed from my teaching philosophy for science education and my perception of the immediate need for change in how we conceive of science and the purpose of science education in K-12 schools, as well as our role as science educators in society given the many challenges we face in the Anthropocene. The public debates raging on social and traditional media outlets during the COVID-19 pandemic fueled the urgency for a provocation that could and hopefully would stir pre-service and in-service teachers towards critically appraising their roles and responsibilities as science educators and re-imagining possibilities for action and social change through science education.

In the next sections, I describe the two courses and, subsequently, I discuss the impact of the courses on students, inferred from students' course work, discussions, and final assignment submissions. Finally, I propose next steps for us, science educators and teachers of a new generation of citizens who are tasked with furthering the pro-equity, pro-inclusion and pro-sustainable future agendas to overcome the challenges of our times.

2. Course descriptions

Both courses were offered during the Winter 2022 term (January–April). The BEd Themes course was titled *Teaching Science as Cultural Activity: A Human-Centered Approach*. There were 29 students enrolled, all of them in their last term of the program. Students' major teachable areas included Biology (10), Chemistry (1), English (2), General Science Education (1), Geography (1), Heritage/Aboriginal/World Languages (2), History (1), Music (1), Mathematics (1), Physical Education (7), and Physics (2). I have previously taught most of these students (22) during their BEd program. The PBDE Topics course was titled *Teaching Science for Social Change: The People and the Stories that Changed the World.* It had 18 students enrolled, 10 of which were MEd students at various stages in their programs. Previously, I have taught four of the students in this course and I had professional interactions with several others. Knowing many of the students facilitated rapport and the establishment of a safe space where sensitive and, at times, uncomfortable topics were discussed as part of these courses. We met twice a week for 9 weeks for the BEd course (total of 32 contact hours), and once a week for 12 weeks for the PBDE course (total of 34 contact hours). Both courses were delivered remotely and synchronously, via Zoom©, due to the university COVID-19 pandemic restrictions to in-person meetings.

The stated purpose of the BEd course was to explore "historical and contemporary stories of scientists to illustrate an approach to school science that moves away from a focus on the body of scientific knowledge or preparation for employment in the high-tech, knowledge-based global economy and illuminates the interdependence of science and society and science and the humanities" (McMillan, Pozzer, & Hechter, 2017) by "follow[ing] the trajectory of science as a discipline through sociocultural lens," making explicit "the connections of science and society, the cultural and normative grounds of scientific thought, Discourses and practices, as well as the multicultural and interdisciplinary nature of early scientific endeavors" (Pozzer, 2022a). Hence, a major focus of the course content was on

[1]Such courses can become permanent, but only after submission of a proposal justifying the demand for and benefits of the course for the program, which involves approval at various levels within the university.

non-Western history of science and the inclusion of scientists' profiles and contributions from diverse ethnicities, nationalities, cultures and genders. The *Encyclopaedia of the History of Science, Technology and Medicine in Non-Western Cultures* (Selin, 2020) became a foundational reference source for course development, given that many of the sources consulted focused exclusively or primarily on Western history of science and scientists (e.g., Bauer, 2015; Fara, 2009; Gribbin, 2004; Wooton, 2015). In addition to personal and contextualized stories of scientists, which humanized them and demystified the "hero" and "genius" character commonly associated with famous scientists, the content in the course was presented following a chronological trajectory that emphasized the intimate connections of scientific pursuits and advancements to the social and cultural values and norms of the times (Bauer, 2015; Dewitt, 2018; Ede & Cormack, 2017; Wooton, 2015). Teaching and learning strategies included multimodal lectures, whole-class discussions, small group discussions (through Zoom© breakrooms), key readings that students collaboratively summarized and presented in class as multimodal posters (using Mural©), student-led multimodal presentations on specific topics, and guest speakers presenting on the intersections of Western mainstream science and Indigenous Science in Canada.

The PBDE course stated purpose was to explore "the sociocultural and historical context of scientific breakthroughs that changed the world and contributed to human rights causes," familiarizing students with "sociocultural and eco-pedagogical perspectives on history of science and scientific literacy" (Pozzer, 2022b). From the very first day, students were introduced to the works of Freire (2005), Misiaszek (2018), and Martusewics, Edmundson and Lupinacci (2011) on ecopedagogy. Selected concepts from the works of Chomsky (1999), Gee (2007), and Bourdieu (1991) were used as framework for analysing hegemonic Discourses in mainstream Western Modern Science (WMS, an acronym also sarcastically referred to as White Male Science). The course included an extensive bibliography on science education for equity and social justice, ecojustice education, ecopedagogy, science and human rights, and decolonization of science, curriculum, teaching and learning. Every class, students were introduced to a short story of the trajectory of human scientific knowledge on a specific topic, including contributions from non-Western cultures and the social and cultural contexts of the times of major contributions and advancements in that field. Then, a discussion ensued regarding the uses and misuses of scientific knowledge and its products, which was based on the materials students were required to read/watch/listen to in preparation for class. The themes of these classes were: The universe; The invisible world; Physics & Medicine; Evolutionary Theory; Transportation; Genetic Engineering; Communication; and Eco-centric ecological perspectives & Indigenous Science. The materials students accessed in preparation for class included academic writings (articles and book chapters), movies and documentaries, podcasts, fictional short stories, webpages and songs. During class, students were also shown artwork and listened to songs, which they were then invited to analyze or otherwise respond to during class discussions.

In both courses, one of the major assignments required students to research the story of a scientist of their choice, including the sociocultural historical context and emphasizing particular issues identifiable in this story, such as, for example, gender or sexual bias, cultural or ethnic bias, nature of science, normative nature of scientific Discourses, ethical issues, or societal in/equity issues. Students should also situate the major contributions of this scientist into our current understanding of the physical world, within a narrative of our trajectory as humans to develop scientific knowledge of this concept, i.e., how this scientist's contribution gave continuation or challenged/changed our understanding of a particular aspect of the physical world and the social consequences of this. In the BEd course, students completed five profiles, and they were asked to showcase diversity in the scientists they have chosen to profile. In the PBDE course, students completed 3 profiles, and these should be connected to human rights causes. In both courses students were encouraged to vary the format in which they submitted the stories, ensuring their presentations were informative, engaging and multimodal.

The final assignment for the PBDE students was a short story, fictional or historical fiction, in which they elaborated on how science has contributed to the advancement of human rights and eco-social justice causes. Students were encouraged to write in any format they prefer (e.g., essay, comic strip, photo-novella, fable, fairy tale, poetry, etc.). During the last two meetings in the course, students read their stories aloud to the class. Allowing students to share their stories orally was intentionally designed to resonate with the many cultures around the world where the telling of stories is a quintessential aspect of their cultural traditions.

Through sharing all their assignments with the class, a repository was created of a very diverse group of scientists, from ancient to current times and from all fields of science, whose contributions have or are changing the world. During classes, students were exposed to examples of different ways of delivering content, different presentation formats, as well as critical sociocultural analysis of curriculum content and historical narratives in science. In the PBDE course, students read *Octavia's Brood* (Imarisha, Brown, & Thomas, 2015), a collection of short science fiction stories, and they completed two exercises designed to help them develop a plot for the short stories they were required to write as a final course assignment.

3. Students' work and responses to the courses

Overall, student reception of course content was positive, albeit students recognized the many challenges some of the course content posed to them, both personally and as educators. Among these challenges, students recognized the need for changing practices in their lifestyles and in their pedagogy. They also came to the realization that science is not neutral and therefore their science teaching is not and cannot be politically and culturally neutral either. In the BEd course, the first few weeks of class were spent on helping students understand the meaning of sociocultural context and how to recognize Discourses in the provincial science curriculum and in the history of science materials we explored in the course. Student achievement varied greatly in these two items, but significant progress was evident among the work of most students, from the first to the fifth submission of their course assignments. Two common issues students focused on in their assignments were racial discrimination against Black people and gender bias against women. The scientists students selected to profile were very diverse in ethnicity, nationality, and cultural backgrounds. Chinese and Islamic scientists from ancient times predominated, while immigrants, Blacks and Indigenous peoples were well represented among more modern (1960's onwards) contributions to science. Women scientists were selected in ¾ of the assignments submitted. Whereas most of the scientists profiled contributed to the fields of medicine, epidemiology, or genetics, a great many other fields of science were also represented in students' work, including astronomy and space exploration, geology, computer science, mathematics, engineering, physics, chemistry, paleontology, environmental sciences, botany and agriculture, kinesiology and sports science, psychology, animal behavior, and nutritional studies, among others.

Both BEd and PBDE/MEd students fully embraced the call for presenting content in different formats, producing podcasts, narrated posters, interactive presentations, animations, short movies, blog posts, and fictional news articles to tell the stories of the scientists they have chosen to profile. In their assignments, they suggested ways in which the stories of these scientists could be embedded into the science curriculum for different grade levels and provided many resources to deepen our knowledge of these people and/or their fields of studies. BEd students whose teachable major was not science performed equally well in the course, although some of them referred to the need to learn the "science" while learning about the story of the scientists. This issue was not raised among students in the PBDE course, possibly because they were given the choice to select social scientists for their profile presentations. Indeed, in the PBDE course, students included an educator, a sociologist, a philosopher, two political scientists and a historian; all other scientists represented field within the natural sciences, mathematics and computer sciences, with 30% of these representing health sciences. In this course, students' choice of scientists was not as culturally and ethnically diverse, with only one fifth of the scientists profiled representing non-Western cultures. Only two of the scientists profiled lived and worked before the 19th century, and close to 41% were females. Not only students in the PBDE course chose more "traditional" scientists (that is, males, Westerners, and famous), but also their discussion of how the work of these scientists connected to human rights issues and social change was always portrayed as positive. Some students commented on discrimination and other challenges the scientists faced, but the overall message in their presentations was that of how science contributed to positive social change and advancements in human rights.

In the PBDE course, students' reactions to some of the materials shared in class or assigned for them as homework were very emotional, including feelings of powerlessness, impotence, rage, and anxiety. Many students referred to the course materials as depressing. Students found particularly challenging to understand how our ancestors accepted and reproduced dehumanizing practices targeted at Blacks and Indigenous populations, as well as discriminatory and inhumane treatment of special needs people and women. However, when asked to consider some of the contemporary issues of exploitation of humans and non-human animals, such as, for example, the cruel treatment of animals for research and in animal industrial farms, the corporate exploitation of cheap labour in poor countries, the devastating environmental impacts of unsustainable lifestyles in Canada and other developed countries, or the systemic racism against Indigenous populations in Canada and against Blacks and Latinxs in the US, students struggled to perceive the similarities in the sociocultural contexts that created the possibilities for practices to be produced and sustained.

Despite or because of the discomfort students felt with some of the PBDE course materials and discussions, students reported that the course definitely promoted changes in the way they think about science and their role and responsibilities as science educators. One student mentioned that it is not possible to unsee what one has seen and that they can no longer ignore the knowledge they now possess about social and ecological injustices and inequities in society. Several students also admitted they have never heard of some of the events related in the course and the various cases of human rights infringements performed in the name of scientific advancement. Some students mentioned they felt overwhelmed with the magnitude of the task they envision for themselves as educators, now that they are in possession of such knowledge. Many students admitted being daunted by the prospect of writing a

short story and reading it aloud to the class, but, afterwards, they reported on the feeling of community the sharing of the stories created, and the powerful reflection this exercise entailed, especially when writing their stories. Only two of the fictional short stories were targeted at children. Many of the stories described dystopian futures where current practices and societal structures were extrapolated to create fictional scenarios that are possible and even probable. Listening to these stories provoked strong emotional reactions and deep introspective reflection.

On the flip side of feelings of powerlessness and impotence, several students in the PBDE course reported being inspired to make changes, in their private life and as educators, and many plan to share their short stories in their own classrooms. Likewise, many BEd students vowed to include the stories of the scientists they researched in their teaching in schools, as a way of promoting students' identification with science by sharing stories of scientists that "look like them" and represent cultural, gender and ethnical diverse groups.

Undoubtedly, it takes more than one course to create the conditions necessary for meaningful change to occur, especially when these are deeply ingrained ways of knowing, thinking and doing that are produced and reproduced as intrinsic to science. However, the original aim of stirring teachers into action that propelled the development of these courses was achieved. As one PDBE student mentioned during our last class, she finally understood what I meant when I told them all possible futures are fictional – when we create and share stories we are imagining possibilities, we are creating possible futures; which stories we choose to tell and how we tell them makes all the difference when it comes to transforming the fiction into reality.

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