A Review of Themes and Promising Practices in STEM-based Work in Equity, Diversity, and Inclusion

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Introduction

STEM disciplines face unique challenges in recruiting and retaining women, Indigenous, Black, racialized, and 2SLGBTQIA+ students. This review presents themes and promising practices that emerged from a review of current conversations in the literature about the state of EDI work in STEM fields. These themes and promising practices represent the building blocks of a successful systemic approach to advance EDI in Science Faculties and programs in North American institutions. This literature review supports ongoing work being done by UBC Science in partnership with the Student Diversity Initiative at the UBC Equity and Inclusion Office towards advancing EDI goals. It aims to help to build capacity for departments to develop comprehensive approaches that address diversity, equity, and inclusion in science education by providing promising practices for implementation.

The framing concept for this review, and for EDI work undertaken by UBC Science is Inclusive Excellence. Inclusive Excellence (IE) is a framework that asserts that true excellence in an academic institution is unattainable without inclusion, and conversely that diversity and inclusion are fundamental to institutional excellence. Instead of understanding diversity and inclusion in terms of recruitment numbers or visible representation, IE presents a multi-level framework for understanding how the institution engenders excellence by creating a vibrant community, and embedding diversity throughout the institution at every level. The IE framework adopted by UBC has five principles that undergird the universities Inclusion Action Plan (IAP):

1. The cultural and social differences of learners enrich and enhance the University
2. Excellence cannot be achieved without inclusion
3. Inclusion is more than just numbers
4. Systems-change must be prioritized
5. Collaboration and partnerships are key to success

EDI efforts at UBC are currently guided by the UBC Inclusion Action Plan, titled *Shaping UBC's Next Century: Strategic Plan 2018 - 2028*, which highlights three key themes to guide the future of the University: Inclusion, Collaboration, and Innovation. The 2018 Inclusion Action Plan operationalizes the theme of inclusion, and gives UBC community members a framework and actions they can pursue to support inclusion at the unit-level. This review connects promising practices from the literature to actions from UBC's Inclusion Action Plan to help support UBC Faculty, staff, and students.

This review was developed following an eight-part guideline for systematic reviews, understanding systematic reviews as part of a continuum of reviews of literature in a research context (Okoli et al, 2010). For this work, prior literature review studies were screened to isolate key search databases. Five databases were chosen based on their prevalence, and systematically reviewed for relevant citation results (n=327). For details around the search strategies and review process, see Appendix 3. The results were then screened for inclusion following a pre-established protocol (see Appendix 2), and then appraised for quality and relevance. As the process continued, it became apparent the level of rigor being applied exceeded the scope of the review. The results of the database search were then reviewed for relevant practices, and key themes until a point of saturation was reached (n=52). Additional searches utilizing citation chaining from key articles included in the review were then used to expand on key concepts (n=61).

The papers reviewed all focus on a North American academic context, with the majority focusing on examples from Universities and Community Colleges in the USA. This review includes papers from the following fields:

- History and Philosophy of Science
- African American Education
- Ecology
- Evolutionary Science
- Psychology of Women
- Translational Medicine
- Biology
- Educational Economics
- Sociology
- LGBT/Queer Studies
- Social Research Methodology
- First Nations Education
- Ocean Science
- Social Psychology
- Career Development
- Science Education
- Psychology

This review surveys key themes and promising practices from the current academic literature on EDI in STEM. In general, current scholarship underscores the many ways in which undrepresented minority (URM) students still face systematic barriers to recruitment, retention, and career progression within STEM, despite demographic shifts in some STEM fields. A key concept that emerged from the literature was **how the quality and strength of a student's science identity are key indicators of the future academic success and retention of that student**. Science identity can be meaningfully addressed at the program, department, and course level, including through mentorship, the creation of peer groups, the facilitation of undergraduate research experiences, and other specific practices.

Ultimately, the goal of EDI work in STEM fields should be to rectify the historic and systemic inequities faced by URM students by helping them to develop the sense that they are a "scientist", following whatever definition that may be in a given field. The ability of students to see themselves in the field, and to feel competent and recognized for their contribution to that field, is the most important factor in improving outcomes for URM students. In a survey of 413 chairs and department heads of STEM faculties at many of the top 200 US research institutions, while 70% of those surveyed reported that URM students faced systematic barriers to recruitment and retention in their faculties, only 33% reported having a comprehensive plan in place to address these issues (Bayer Corporation, 2012). It is hoped that this review can help readers in developing a comprehensive plan to improve outcomes for underrepresented students in UBC Science, building from the current state of EDI literature in STEM fields at large. For faculty members looking for interventions that may be useful in their work in the classroom, please consult Promising Practices 3 and 4 (pages 11-14), which outline ways in which faculty can meaningfully help their students improve their sense of science Identity.

Definitions

- The UBC Strategic Plan defines **inclusion** as "a commitment to access, success, and representation of historically underserved, marginalized, or excluded populations". (IAP, 2018)
- **Underrepresented Minority** (URM) students refers to student demographic groups that are currently underrepresented in STEM fields in higher education. While the demographic groups that this term describes can differ by the context that is being studied, in general this term refers to female-identified students, Indigenous students, Black-identified students, Racialized students, disabled students, 2SLGBTQIA+ students, first generation scholars, and other intersectional identities within Science faculties (Nealy & Orgill, 2019).
- **Science Identity** is defined as the extent to which a student self identifies with the identity traits, attributes, and qualities that are commonly associated with what it means to "be a scientist" (Osueguera et al., 2019).
- **Inclusive Excellence** is a system-wide approach to diversity and inclusion in higher education. The framework of Inclusive Excellence asserts that academic excellence is unattainable without excellence in diversity and inclusion. It is guided by five principles: 1) the cultural and social differences of learners enrich and enhance the University; 2) excellence cannot be achieved without inclusion; 3) inclusion is more than just numbers; 4) systems-change must be prioritized; and 5) collaboration and partnerships are key to success.
- **Imposter Phenomenon** (or Imposter Syndrome) refers to an internal feeling of intellectual phoniness or lack of belonging that is often experienced by high achievers and also occurs among underrepresented minority students (Peteet et al., 2015).
- **Solidarity** is an active expression or demonstration of support and aid between people who are mutually aligned in experience, goals, or understanding.
- **Microaggressions** are everyday slights, indignities, put downs and insults individuals from marginalized groups experience, based on their perceived or actual membership in social identity groups. Microaggressions take a psychological toll on recipients, leading to higher rates of depression, anger, avoidance, and a compromised sense of belonging.
- **Oppression** is the systematic devaluing, undermining, marginalizing, and disadvantaging of individuals and groups based on their perceived or actual membership in social identity groups. These groups are often socially constructed categories, including race, gender, sexual orientation, and ability, and are always understood in reference to a pervasive, privileged normal group.

Key Themes

A. The concept of "URM Students" is highly context dependent.

Before examining the nature of the current state of URM students in STEM, we need to note that the definition of URM groups varies significantly within the literature. Some scholars include only racial and gender groups and often do not consider the intersectionality of these groups. While most definitions of URM include cis-gendered women, Black, and other racialized students, many definitions of URM exclude East Asian students, and don't account for differing ability, sexual orientation, gender identity or expression. In addition, Indigenous students are also excluded from most definitions of URM students as they often make up too small a portion of STEM faculties to be statistically relevant; this points to a weakness of relying on quantitative measures, and of the bias towards quantitative measures in the literature more generally. The lack of scholarship around Indigenous, Trans, and 2SLGBQT+ students can only help to further marginalize these groups. Further, recent scholarship has argued that race-based census data is a poor indicator of URM status within universities, instead arguing that factors such as place of birth, parents' country of origin, and parent's educational achievement are more crucial factors to measuring diversity within STEM departments (Mukherji et al, 2017). Regardless, we can generally conclude that when scholarship on EDI uses the term "URM", it typically refers to cis-gendered women, Black, Hispanic and East Asian students, and may or may not refer to differently abled, neurodivergent, 2SLGBTQIA+, or Indigenous students.

This definition of URM is understood to vary within different contexts. Firstly, who constitutes a URM student varies within the particular STEM field and the historical context of time and STEM field. While the representation of cis-gendered women in STEM is understood to be improving in the last decade in the biological and biomedical sciences (Wang & Degol, 2017), there still exists an underrepresentation of cis-gendered women in other STEM fields such as Computer Science and Engineering within the USA (US Department of Education, 2012). The term URM is also often relative to the level of analysis undertaken within a given study. While almost 60% of Bachelor's degrees are awarded to women nationally in the USA and Canada, that number may differ radically at the institutional, departmental, or classroom level.

It is also important to understand the levels of representation of "URM" students' intersectionality, and to keep in mind that most studies reviewed treat categories such as "women" and "Black" as separate categories. For example, within one of the articles, several STEM department heads within the USA feel that women are better represented in their institutions than racialized students, but the study does not mention whether female identified racialized students were well represented (Bayer Corporation, 2012). While important to contextualize, the studies under review give a thorough picture of common issues that URM students face within STEM fields in North America, and have the potential to positively inform EDI work at UBC Science.

B. Students from minority groups are still underrepresented in STEM and face systemic barriers to retention and recruitment.

Research related to URM students reveals they frequently experience hostile school environments, which can eventually force them out of STEM fields. For instance, within STEM classrooms, Black students experience isolation, tokenization and microaggressions that create an abrasive environment. This environment signals that Black students do not belong, as they do not fit in with the norms of the particular discipline early in their undergraduate studies (Blosser, 2019, Basile & Black, 2019, Ortiz et al., 2019, Morton et al., 2020). In addition, First Generation Native Hawaiian college students in STEM also report a lack of support, isolation, tokenization, and feeling like an imposter in their studies and later professions (Allaire, 2019). This experience of isolation and tokenization often begins in interactions with mentors, faculty and advisors. Black men experience racial microaggressions and insults from their advisors, forcing them to deal with the additional task of coping with microaggressions from a key source in an academic context (Burt et al., 2019). A study of womxn (defined as persons that identify as women regardless of assigned gender at birth) STEM students took this observation a step further. When monitored for distinct psychophysiological responses to microaggressions, researchers found that students responded differently to situations of tokenism in mentoring relationships, based on the intersections of their identities (Villaneuva et al. 2019). This cumulative experience of URM students (including indigenous students) can be understood to be responsible for the low retention rates within STEM faculties. At a demographic level, female identified, 2SLGBTQIA+, Black, Indigenous, Racialized, and differently abled first generation university students are still underrepresented within the STEM disciplines at large. While some argue that this is due to demographic inertia, it has been shown that, at least within engineering departments in the USA, this underrepresentation is due to systematic barriers and practices in recruitment, retention, and career progression (Thomas et al., 2015).

In addition, while this review uses the term URM extensively, it is also worth considering the extent to which the underrepresentation of certain demographic groups is meaningfully related to the overperistence of other groups. Within the literature, overpersistence refers to instances in which a group or groups continue within a given field. The term intentionally shifts critical scholarship about EDI within STEM away from groups who the field is poor at retaining, and moves towards groups that are more easily retained and who predominantly compose the discipline under examination. Within research groups in the physical sciences, men still overwhelmingly dominate research roles, and often choose to supervise same-gender students leading to differing opportunities for advancement by gender (Start & McCauley, 2020). In one study, cultural stereotypes of male superiority in mathematics were shown to lead men to be more confident in and identify more with mathematics, which lead them to overpersist in STEM fields, even in situations where it leads to less academic success (Penner & Willer, 2019). This overconfidence helps explain why students from overrepresented demographic groups comprise a majority at the undergraduate level. This phenomenon, defined elsewhere as the psychological prototypicality of men, is also understood as a psychological barrier to greater diversity.

Within the literature, prototypicality is defined as the belief that one's own identity defines, or best represents a certain group (Danbold & Huo, 2016). This effect leads men to believe that they are prototypical within STEM fields, and that this prototypicality is legitimate. Within one study, men who believe they are prototypical have been shown to report higher levels of psychological threat when informed that diversity initiatives were successful, and more women are entering their departments. This prototypicality threat also predicted desires for women to conform to STEM standards (as defined by prototypical men), and to individually oppose gender diversity initiatives and exclusionary intentions. As such, it is worth considering the extent to which the stereotypes and assumptions which limit the participation of URM groups do so through the active enforcement of and exclusion upon those stereotypes by those who most exemplify them, namely white cis-gendered men (Danbold & Huo, 2016).

Furthermore, minority groups are still underrepresented within other indicators of career success and prestigious roles within the STEM fields, and generally less recognized for their work. For example, in a review of awards given out by 13 STEM disciplinary societies between 1991 and 2010, women recipients of scientific awards and prizes almost doubled, but the awards won were overwhelmingly for service or teaching rather than the more prestigious research awards. Conversely, men were more likely to win awards for their research, despite being less likely to be nominated for those awards (Lincoln et al., 2012). Within another study of 30 different scientific societies within Astronomy, Ecology, Mathematics, and Statistics, it was shown that women were underrepresented within more prestigious, late-career awards, while they were equally represented in less prestigious, early-career awards (James et al., 2019). This phenomenon aligns with the narrative of the "leaky pipeline" in STEM, by which fewer URM scholars progress to higher levels of education and status within STEM fields (Cheryan et al., 2012). However it is important to not conflate the lack of official recognition with a lack of scientific impact.

This issue is further demonstrated within an analysis of the quality and amount of scholarly publications produced by female identified scholars, a key factor related to the retention and career progression in STEM fields. In a survey through Google Scholar of 34,918,955 citations from the "top" 480 scholars in STEM fields on the platform, publications by women scholars made up just 7.3% of citations, and scholars from visible minority groups made up just 6.3%. In addition, the more highly ranked the institution was on Google Scholar, the lower the total number of citations by women attributed to that institution on the platform. Of the "top" 480 scholars used in this survey, only one publicly identified as 2LGBTQIA+, and no scholars identified as Black or Indigenous (Jozaghi, 2019). In a review of 30 years of publications in the Ecology and Evolutionary Biology field, while the total number of female authors has increased, the proportion of female authors is significantly lower than the proportion of female PhD graduates. It also showed that men are more likely to co-author papers with other men in the field (Frances et al., 2020).

Despite all of the barriers faced by URM STEM students at the undergraduate level, their low levels of recruitment and retention, and the low level of representation of URM scholars within scientific publications, the research URM scholars produce tends to have an outsized impact. In a review of nine million papers and six million scientists, diversity was shown to correlate most directly with scientific impact, measured as citations up to five years after publication. Increased ethnic, gender, and national diversity of co-authors papers resulted in a 10.63% impact gain per paper and 47.67% impact gain for scientists. Indeed, just the increased ethnic diversity with a group of authors was more directly correlated with a paper's impact than the institutions or nationalities of the authors (Alshebli et al., 2018). This indicates that while ethnic diversity may be a lacking feature in STEM departments, in instances where URM undergraduate students do pursue academic careers and publish, they have the potential to greatly increase the impact of research being conducted in their field.

C. The development of Science Identity is essential to the retention of Underrepresented Minority students (URM) within STEM.

The literature amply demonstrates that the development of a robust science identity for URM students within STEM faculties is an essential and missing factor in their retention and academic success. Science identity is defined as the extent to which a student self identifies with the identity traits, attributes, and qualities that are commonly associated with what it means to "be a scientist" (Osueguera et al., 2019). Science identity is both facilitated and augmented by a set of different factors, including a student's sense of belonging within a discipline, their sense of self-efficacy, the quality of their social relationships, and by being recognized and affirmed to be competent within the norms, skills, and values of a particular discipline. This set of factors can be understood as tools for both the analysis of and intervention upon the science identity of URM STEM students. However, the exact relationship between these factors differs among scholars across different disciplines and theoretical backgrounds. Regardless of the background of the work, the literature reviewed states unequivocally that students from URM groups are much more likely to have a lower sense of science identity than other STEM students (Hazari et al. 2013; Kim et al. 2018; Kobulnicky & Dale, 2016; Lane, 2016; Marrero et al., 2017; Nealy & Orgill, 2019; Osueguera et al., 2019; Rainey et al., 2018; Richardson et al., 2019; Schultz et al., 2011; Starr, 2018).

The strength of a student's science identity is a key indicator of whether or not individuals stay or leave STEM majors (Rainey et al. 2018). The low science identity of URM students can be attributed to a combination of factors relating to the intersection of systemic disadvantages that URM students face on the basis of their identities (Osueguera et al., 2019; Richardson et al., 2019). As an example, URM students from poor or racialized families may have had less exposure to science, or access to quality math education in elementary and high schools, key indicators of future enrollment in STEM programs (Dooley et al, 2017). Stereotype threat effects, in which stereotypes of what kind of personality traits (e.g. "nerd", "genius") or skills are understood to comprise what a scientist "should be" in a particular field can also act as a barrier for URM students who do not self-identify with those traits (Starr, 2018). Further, there is evidence that this effect is more prevalent within URM groups, who are often not represented in either the classroom or faculty of STEM departments (Ahlqvist et al., 2013; Rainey et. al., 2018) and for students with intersecting URM identities (e.g. Black/Hispanic & Female) (Hazari et al., 2013).

Within the literature, the improvement of science identity is either understood as a meaningful target or a desired secondary objective of EDI work at the classroom, program, Faculty, and institutional level. Across the literature, science identity is understood to be broadly improved by increasing a person's sense of belonging, self-efficacy, social relationships with peers and mentors, and/or recognition for their skills (Hazari et al. 2013; Kim et al. 2018; Kobulnicky & Dale, 2016; Lane, 2016; Marrero et al., 2017; Nealy & Orgill, 2019; Osueguera et al., 2019; Rainey et al., 2018; Richardson et al., 2019; Schultz et al., 2011; Starr, 2018). These initiatives break into several broad categories:

1. The **creation of community spaces for students** from URM groups that enable validation and growth (Allaire, 2019; Case & Hunter, 2012; Cheryan et al. 2015; Ong et al., 2018; Russell, 2017; Solorzano et al., 2000).
2. Presenting URM students with **opportunities for meaningful undergraduate research experiences**, in which they can learn, perform and be recognized for having the skills of "scientist" (Kobulnicky & Dale, 2016; Lane, 2016; Marrero et al., 2017; Schultz et al., 2011).
3. Creating **opportunities for authentic and responsive mentorship opportunities with faculty and peers** (Ferrara et al., 2018; Huston et al., 2019; Johnson et al., 2016; Kobulnicky & Dale, 2016).
4. Specific **interventions targeting either systematic disadvantages faced by URM students or unconscious biases of faculty** (Beltran et al., 2020; Burnette et al., 2020; Cadenas et al., 2020; Carnes et al., 2015; Ferrara et al., 2018; Smith et al., 2017; Sorkness et. al., 2020).

Notably, these categories are components of existing retention programs in STEM departments across the USA. In a 2012 survey of 413 STEM chairs and departments heads from among the top 200 research institutions in the USA, schools with retention programs in place for URM students reported incorporating faculty mentorship (78%), academic support including tutors and study groups (74%), peer support networks (74%), and undergraduate research experiences (73%) (Bayer Corporation, 2012). The aforementioned four categories will be explored in more depth in the following section on Promising Practices.

Promising Practices

1. Develop spaces within Science departments where URM students can meet and develop a sense of community, belonging, and solidarity.

IAP Goal 1.D - Inclusive Spaces and Initiatives

The development of community and social relationships between URM students can help to build a sense of belonging within STEM fields, and is a key enabler of academic and career success. Within these often unwelcoming environments, URM students can be isolated, experience lower levels of belonging, and be exposed to microaggressions and systemic barriers which can limit their persistence in STEM fields (Ong et al. 2018; Rainey et al. 2018). In studies involving STEM students who are First Generation Native Hawaiian, white women, women of colour, and black women, students report the need to build solidarity in spaces away from potentially harmful "mainstream" science environments (Allaire, 2019; Cheryan et al., 2015; Ong et al., 2018; Russell, 2017).

Community and solidarity are meaningfully developed in self-defined community spaces. We can define this as transformative spaces for URM students, where the intersecting forms or oppression that students experience can be challenged (including classism, racism, sexism, homophobia, and ableism among others), the experiences of students can be validated, students are able to vent and be heard, and individual learning can be pursued in a safer, more understanding space (Case & Hunter, 2012; Solorzano et al., 2000). Community spaces exist within and outside of academic environments, and include spaces like student groups, diversity conferences, peer-to-peer relationships, and mentorship relationships (Ong et al., 2018). Another example of a community space is online forums, where female STEM practitioners can find crucial mentorship, information, and community from same-gender academics (Murthy et al., 2013). Other work indicates that undergraduate research can function as a community space, and that increase belonging positively impacts the development of science identity, which also positively correlates with persistence in STEM fields for URM students (Lane, 2016). In some cases, Science departments themselves can serve as community spaces, when students feel fully able to share and belong in departmentally organized groups. In these situations, the development of community spaces has the potential to disrupt patterns of privilege and marginalization by indicating a fundamental shift in culture (Ong et al. 2018). Community spaces create networks among URM students, and help to create a space where students can develop their science identities with the help and guidance of peers and mentors who can speak to and challenge the dominant stereotypes within their fields. These aspects ultimately allow URM students to create space to see themselves within their disciplines (Blosser et al., 2019; Case & Hunter, 2012; Ong et al., 2018; Solorzano et al., 2000).

2. Undergraduate research experiences improve the experience and retention of URM students by increasing their sense of science identity, challenging stereotypes about science and scientists, and increasing their sense of self efficacy.

IAP Goal 4.B - Inclusive Teaching and Learning

As mentioned above, URM students often feel alienated, devalue their own skills, and experience microaggressions that indicate that they do not belong in their chosen major (Basile & Black, 2019; Blosser, 2019; Morton et al., 2020; Ortiz et al., 2019). In addition, URM students experience stereotype threat, a psychological phenomenon in which individuals feel that they are limited by the stereotypes that they perceive a STEM field has about them, and of what success or belonging in that field looks like (Borum & Walker, 2012; Cheryan et al., 2012; Danbold & Huo, 2016). Undergraduate research experiences are one way to help students to challenge and shift their stereotypes about what "doing science is" and who "is a scientist", creating a greater sense that they belong in their chosen field (Marrero et al., 2017). In multiple cases, undergraduate research experiences are also cited as a central reason for the retention and academic success of URM students, and particularly for Black students dealing with stereotype threat (Borum & Walker, 2012; Goonewardene et al., 2016; Jackson et al., 2013; Lane, 2016).

Undergraduate research experiences are one way to help URM and non-URM students develop a greater sense of science identity and belonging which can lead to increased retention rates and better prepare students for graduate study (Kobulnicky & Dale, 2016; Lane, 2016; Marrero et al., 2017; Schultz et al., 2011). Undergraduate research experiences allow students to increase their self-efficacy while developing their competence in core research skills, expanding domain knowledge, and gaining the recognition of peers and mentors (Anthony et al., 2017; Heilbronner, 2011). It is also important to recognize that lab settings represent a microculture where URM students learn about science norms and values that can influence their motivations (Thoman et al., 2017). Research experiences allow students to connect to the value of their learning directly, and move learning out of the classroom into a "real world" application to create a sense of the larger mission and value of their work. Mentorship is a key enabling factor for undergraduate research, either through "apprentice-style" mentoring in a private or classroom setting, or community mentoring on a project basis (Goonewardene et al., 2016; Kobulnicky & Dale, 2016). In one case, mentored undergraduate experiences have been shown to lead to an increase in the GPA of URM students, average number of credits completed per semester, and placements in graduate schools (Goonewardene et al., 2016).

It is important however, to not only create opportunities for URM students to engage in undergraduate research, but for them to be able to have community spaces within which to present and develop that research through forums like URM-focused undergraduate conferences. The benefits of attending these types of conferences go above and beyond the benefits of engaging in undergraduate research. In one study, increased attendance of URM students and URM women students' at conferences was positively linked to increases in reports of self-efficacy, sense of belonging within Science, and the intention to pursue a graduate research degree. These measures were even more positive for URM students who presented their research or received an award at a conference (Casad et al., 2016).

3. The development of quality mentorship experiences is a key enabler of success for URM students. Future programs should further explore how to develop quality mentorship opportunities.

IAP Goal 1.D - Inclusive Spaces and Initiatives
IAP Goal 4.E - Equitable Community Relationships.

Another key aspect of retention for URM students is the opportunity to participate in mentorship relationships with other students, researchers, and professors. Mentorship here is defined following O'Neil & Wrightsman's (2001) work:

> When a professional person serves as a resource, sponsor, and transitional figure for another person… who is entering that same profession. Effective mentors provide mentees with knowledge, advice, challenge, and support as mentees pursue the acquisition of professional competence and identity. The mentor welcomes the less experienced person into the profession and represents the values, skills, and success that the neophyte professional person intends to acquire someday. (p. 114)

As mentioned above, undergraduate research opportunities have a variety of benefits which disproportionately benefit URM STEM students, including increased interest in their discipline, an increased sense of belonging, increased science identity, and higher retention rates (Kobulnicky & Dale, 2016; Marrero et al., 2016). The support offered through mentorship helps to address the potential lack of support from other familial or societal sources, particularly for students who are first-generation scholars. Importantly, mentorship shouldn't be thought of as necessarily a one-way relationship between faculty and students. Instead, research shows that creating opportunities for undergraduate students to act as mentors to high school STEM clubs not only develops undergraduate URM students' identities as future scientists and their content knowledge, but it also helps to generate interest for high school students in further STEM education (Ferrara et al., 2018).

Importantly, URM students often seek out mentoring (Johnson et al., 2016) and tend to commit more than non-URM students. In one study, Black women Mathematics doctoral recipients cited mentorship as a key factor in their persistence and retention within the field (Osueguera et al., 2019). In another study, Black women in a STEM Scholar program at a Mid-Atlantic university in the USA were much more likely to take advantage of mentorship, training, and research experience opportunities, and to commit more fully to them, than male students. It's worth noting that within this intervention, Black students were retained at the same rates as non-URM students, indicating that research experience and mentorship, as well as the culturally-specific climate created can make a real difference to URM student retention in STEM fields. Understandably then, mentorship programs are most effective when factors such as cultural context and cultural relevance are considered in the design of such programs (Johnson et al., 2016).

However, it isn't just the presence of a mentor that increases the retention of URM students, but the quality of the relationship matters too. In a multisite, longitudinal, quasi-experimental of 469 biomedical science students at 24 institutions within a NIH-funded RISE program, students from 2005 to 2011 were surveyed biannually on their interests, achievement, and aspirations within their STEM field. While in general it was shown that interest in STEM careers decreases for all students over their four-year degrees, the RISE program mitigated this effect for URM students. However, it was shown that having a mentor did not affect student intentions to pursue a STEM career, while undergraduate research experiences, which included mentorship, did. This indicates that mentorship alone is not sufficient to guarantee interest in a field, and that "some mentorship relationships are better than others" (Schultz et al., 2011, p. 110).

While mentorship is a positive factor in URM student retention, systemic barriers to mentorship exist within the academy that lead to this important practice being difficult for faculty to provide. Ultimately, faculty often act as mentors in addition to other expectations such as teaching and publishing, and are often not rewarded professionally for mentoring. In addition, basic assumptions about mentorship pervasive in STEM culture ultimately lead to an impoverished experience for students (Johnson et al., 2016; Kobulnicky & Dale, 2016). There are many suggestions to remedy these issues by supporting faculty in mentoring URM students. Two of the most promising approaches for this are sponsorship and community mentorship.

Sponsorship, an approach drawn from the corporate sector, is distinguished from mentorship as a proactive and instrumental orientation on behalf of the "mentor", rather than the expectation that the "mentee" must be proactive in taking advantage of the relationship (Huston et al., 2019). Ideally, a sponsorship program would support and match students who show potential and willingness to participate and engage with STEM programs with faculty who are senior, have social capital, and are aware of ways they can actively benefit and progress the student's career. An example of this would be a faculty member deliberately using their social capital for the student with professionals in the field, and the faculty member taking opportunities to identify and recommend the protégé and their achievements when they are not present. This active approach serves to help address the barriers URM students face on the basis of their intersectional identities.

Within the context of undergraduate research, community mentorship seeks to address the strain on faculty time that research mentorship presents by situating the "mentee" within a network of practitioners in a scientific community. The community mentorship model treats undergraduate students as peer mentors, and pairs them with multiple faculty members on a group research project. During the research project, students gain competence with research methods, while undertaking training with different faculty and working collaboratively with both faculty and peers. The resulting network of practice supports a research experience characterized by a greater sense of community, student interest in the material, and self-efficacy (Kobulnicky & Dale, 2016).

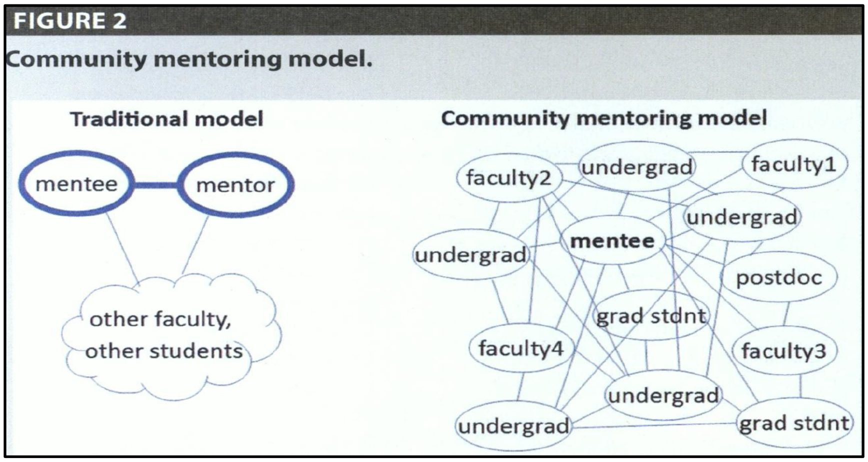

FIGURE 2
Community mentoring model.

(Kobulnicky & Dale, 2016)

Further information on how to pursue mentoring for STEM students, faculty, and directors can be found here.

4. Initiate and habituate equity-focused practices that recognize the barriers URM students face.

IAP Goal 3.A - EDI Education and Training Programs
IAP Goal 1.D - Inclusive Spaces and Initiatives
IAP Goal 4.B - Inclusive Teaching and Learning

In general, targeted practices for students that recognize the barriers URM students can face have a noticeable benefit to URM student retention and success. It is worth noting however that one-time interventions, like bringing in EDI-related speakers, by themselves do not significantly increase the likelihood of students to pursue a STEM degree (Burnette et al., 2020). The following examples are best understood as practices that could be habituated by UBC Science in its efforts to improve outcomes for URM students within its departments and programs. By and large, practices are successful when they explicitly address issues faced by first generation and URM students, including lack of family support, the "hidden curriculum", and key professional academic skills (Burnette et al., 2020). This is something that institutions like the National Institute for Health in the USA recognizes. Their KL2 program, which focuses on early career URM faculty, offers a suite of practices to recipients, including training programs in grant and scientific writing, entrepreneurship, leadership, community engagement, health disparities research, and evidence-based research as well as offering mentor and mentee training. This program has been shown to greatly increase the retention or URM faculty within the field (Sorkness et. al., 2020).

Potential practices include:

- **Grant writing workshops**, which have been shown to increase the number of grants submitted, number of proposals led as a primary investigator, and amount of external funding dollars awarded to women in STEM (Smith et al., 2017).
- **Psychology-based interventions**. In one study, a growth mindset intervention, in which the ability of an individual to change and gain new skills despite limiting beliefs, was shown to improve interest in the subject materials within Computer Science classrooms (Burnette et al., 2020).
- **Intensives** and **field courses.** In one study of Poder programs at community colleges, (a form of social-focused entrepreneurship program for STEM students), completing a five week-intensive focused on developing a socially-focused technology entrepreneurship project that increased levels of entrepreneurship, self-efficacy, skill, critical behavior, and technology readiness among URM community college students (Cadenas et al., 2020). Within the Ecology and Evolutionary Biology field, field courses are associated with higher self-efficacy gains, higher college graduation rates, higher retention, and higher GPAs at graduation in URM students. This suggests that field courses could be a useful tool to increase retention of URM students and diversity in STEM (Beltran et al., 2020).
- Placement of undergraduate STEM students as **mentors** to high school STEM clubs. Mentorship experiences have been shown to greatly increase the science identity, metacognition, and self-efficacy of undergraduate STEM students (Ferrara et al., 2018).

The development of active equity practices may be one potential avenue for faculty members to explore. The development of equity-focused practices by faculty is an important component of achieving EDI goals, and creating a welcoming culture of inclusive excellence. It's also worth noting again that psychology-based interventions work best when the learnings from them are habituated into lived practices. For instance, a gender-based intervention in STEM departments at the University of Wisconsin-Madison, revealed the importance for interventions that help people work through their implicit biases, that increase awareness to the pervasiveness of stereotype threat, and provide evidence and strategies for how gender equity can advance the field of STEM. Faculty in this intervention reported higher levels of self-efficacy for engaging in gender-equity promoting behaviors and higher levels of requisites of behavioral change, including internal motivation and improved perception of the benefits for equity-promoting behaviors. Post-intervention, faculty reported the development of equity-based practices, including changes in faculty culture, including greater perceptions of fit, valuing their research, and comfort in raising personal and professional conflicts (Carnes et al., 2015). Similarly, another study in the Life Sciences showed that a gender-bias workshop intervention resulted in more willingness to engage in action to reduce gender bias and rectify diversity issues (Moss-Racusin et al., 2016). Importantly, in the University of Wisconsin-Madison intervention, this effect increased significantly after three months when a quarter or more of faculty attended the workshop. This finding indicates the value of widespread faculty buy-in for achieving inclusive excellence and EDI goals.

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Appendix 1 - Brief Summaries of Literature Reviewed

Key Themes 1 & 2 - URM Context and Systemic Barriers

A. There is a strong argument presented in the paper for disaggregating racial data used to categorize URM students to include variables including the place of birth of the student, the parents' country of origin, and parental educational achievement rather than traditional racial and ethnic categories to have a more accurate measure of diversity. (Mukherji et al, 2017)

B. Black women engineering students experience isolation, hypervisibility, difficulty forming study groups, and exposure to microaggressions. (Blosser, 2019)

C. Black Students face the experiences of their racial identity having narrow value on paper when applying to STEM programs, a weeding out process whereby they receive coded and overt messages that they don't belong, and messages that they are unique and special because of their racial identity later in their studies, forcing them to conform and assimilate with white, normative ideals.(Basile & Black, 2019)

D. First Generation Native Hawaiian college students in STEM report a lack of support from pre-university teachers, isolation, and being tokenized. (Allaire, 2019)

E. Minority groups are underrepresented in the Natural Sciences. Factors including exposure to nature, self efficacy, social discrimination, mentorship, institutional diversity, and retention were seen to influence this underrepresentation. These categories are then organized using Social Cognitive Career Theory. (Haynes et al., 2011)

F. Low reported levels of psychological well-being, and a lack of ethnic identity are potential indicators of imposter phenomenon. (Peteet et al., 2015)

G. Black men entering Graduate school as Engineers experience racial microaggressions and racial insults from their advisors, forcing them to engage in an additional task of coping with microaggressions from a key source of socialization within an academic context. This likely dissuades many Black identified men from pursuing teaching. (Burt et al., 2019)

H. Professors need to examine their biases and microaggressive actions in order to create a better environment for Black identified graduate students, and to encourage the retention of Black identified academic talent. (Burt et al., 2019)

I. Womxn STEM students experience both conscious and unconscious psychophysiological effects within their relationships with their mentors. (Villaneuva et al. 2019)

J. Using Google Scholar to track citations, among top-ranking universities in which the majority of the population is Caucasian, women make up 7.3% of citations and minorities make up 6.4% of citations, respectively. (Jozaghi, 2019) Between 1991 and 2010, women's representation as recipients of scientific awards and prizes almost doubled. However, women won a significantly smaller proportion of awards for research than for service or teaching. This indicates that the 'Matilda Effect' whereby women are less recognized for their work than men, holds for women in science research. (Lincoln et al., 2012)

K. Men overwhelmingly make up research groups in the physical sciences. Where women lead research groups, they often supervise, and receive applications from same-gender students, resulting in a barrier to advancement through research and publication for female-identified researchers across several STEM disciplines. (Dennon & Shannon, 2020)
L. In Ecology and Evolutionary Biology (EEB) publications, men are more likely to co-author papers with other men. The number of female co-authors remains below of the number of female PhD's in EEB. (Frances et al., 2020)
M. Within the sciences (as represented by Astronomy, Ecology, Economics, Mathematics, and Statistics) women are underrepresented in higher status roles and awards administered by scientific societies, and equally represented with men in lower status roles and less prestigious awards. (James et al., 2019)
N. The gender gap in science in engineering is not the result of demographic inertia. Instead, systemic barriers and practices in recruitment, retention and career progression of female faculty are to blame, and preclude gender parity. These issues need to be fundamentally changed to achieve parity. (Thomas et al., 2015)
O. Men who believe their prototypicality in STEM is legitimate report higher levels of prototypicality threat when informed that women in STEM initiatives were successful in bringing more women into STEM. Experiences of prototypicality threat predicted desires for women to conform to STEM standards as defined by men, opposition to gender diversity initiatives and exclusionary intentions. This defense may limit the participation of women in STEM in the long term. (Danbold & Huo, 2016)
P. On one model, cultural stereotypes of male superiority in mathematics lead men to be more confident in and identify more with mathematics, which leads men to overpersist even in situations where it leads to less success. Researchers should characterize gender difference in STEM fields not only in terms of female under persistence, but also in term of male overpersistence. (Penner & Willer, 2019)
Q. Stereotypes about the people, work involved, and values of the field act as gatekeepers for women in Computer science. The stereotypes operate within interpersonal relations, culture, and media. They can be successfully changed with interventions in these spaces. (Cheryan et al., 2012)
R. Across STEM fields, in a review of nine million papers and 6 million scientists, diversity was shown to correlate most directly with scientific impact. Ethnic, gender, and national diversity of co-authors papers results in a 10.63% impact gain for paper and 47.67% impact gain for scientists. (Alshebli et al., 2018)

Key Theme 3 - Science Identity

A. Gender-STEM compatibility is more variable for women with a higher tendency to perceive social-identity threat. This variability predicted impaired outcomes, including lower engagement and grades in STEM classes. (Ahlqvist et al. 2013)

B. Science identity is a key indicator of whether or not individuals stay or leave STEM majors, and science identity is less present among underrepresented demographic groups in STEM. (Rainey et al. 2018)
C. While all STEM students are likely to report low identification with their disciplines, Black and hispanic women in Chemistry and Physics disciplines report markedly lower levels of science identity. (Hazari et al. 2013)
D. Science identity is a combination of social identity (identification with a group) and personal identity (who one is as an individual). Social identity is meaningfully related to the development of a sense of belonging, and a perception of acceptance by the larger social group. Science identity is influenced by practices, relationships, and environmental factors that indicate the presence of stereotypes to which students feel they either do or do not conform with. (Kim et al. 2018)
E. For URM students, science identity is made up of inherent identity characteristics, group practices, and ways of speaking and defining their subjects. (Nealy & Orgill, 2019)
F. There is a negative relationship between the nerd-genius stereotype and women's STEM identity and motivation. This may be because the stereotype is incongruous with what women "should" be. This means that in addition to explicit gender stereotypes, stereotypes about people in STEM being nerdy geniuses may work to dissuade women from pursuing STEM careers. (Starr, 2018)
G. Ego identity could be an important component of Black women engineers' science identity formation. Ego identity is defined as the extensive accomplishments individuals must develop in childhood to best prepare for responsibilities most associated with adulthood. Early exposure to STEM, interest in and commitment to engineering, and parental support are also highlighted as important characteristics. (Richardson et al., 2019)
H. Results indicate that having a high scientific identity and reporting fewer instances of discrimination increased the likelihood of remaining in a STEM undergraduate program. The findings about the centrality of race are supported by other work that highlights the value of "creating environments that STEM and psychosocial identities compatibility, by showing that students with varying levels of race identity are willing to stay in a support program that values their particular contribution to the field." (Osueguera et al., 2019)

Promising Practice 1 - Community Spaces

A. First Generation Native Hawaiian college students in STEM report the value of finding community with other NH students, as well as from mentors and advisors as being essential to their success. (Allaire, 2019)
B. The development of feelings of belonging can significantly help or harm the development of science identity (Cheryan et al. 2015)
C. Women and URMs may benefit from participation in learning communities. Women participating in one such program had higher grades, and completed more credits of coursework than their peers. (Russell, 2017)

D. Demographic isolation is associated with lower levels of belonging in STEM, meaning, and Women of colour report belonging less than other demographic groups. The presence of personal relationships with faculty, and other students is a key factor is persistence in STEM fields. (Rainey et al. 2018)
E. Counterspaces are spaces at the margins for groups outside of mainstream STEM education. Within this review, the term community spaces is used instead for clear communication. Counterspaces function as a haven for women in colour in STEM from microaggressions and isolation. They also contain important heterogeneity, including women from multiple ethnic groups for example. Counterspaces operate in peer to peer relationships, mentoring relationships, National STEM diversity conferences, STEM and non-STEM campus student groups, and STEM departments. Within this review, the term community spaces is used instead for clear communication. The closer these spaces are to STEM's center (departments) the more they can address bias and exclusion. (Ong et al., 2018)
F. Counterspaces are defined as spaces that "serve as sites where deficit notions of people of color can be challenged and where a positive collegiate racial climate can be established and maintained." Within this review, the term community spaces is used instead for clear communication. These spaces are created within and without academic environments giving students space to foster their own learning and "to nurture a supportive environment wherein their experiences are validated and viewed as important knowledge." (Solorzano et al., 2000)
G. Undergraduate research can potentially represent a counter space that helps students develop a sense of science identity. This in contrast to classroom environments, in which students experience microaggressions. (Lane, 2016)
H. Counterspaces challenge deficit-oriented societal narratives concerning marginalized individuals' identities, and enhance well-being. Challenging can occur through three processes: (1) narrative identity work, (2) acts of resistance, and (3) direct relational transactions. Within this review, the term community spaces is used instead for clear communication. (Case & Hunter, 2012)
I. Black female engineering students emphasized the need for counterspaces to cope with their difficult experiences, build solidarity, and overcome barriers. Within this review, the term community spaces is used instead for clear communication. (Blosser, 2019)
J. Online spaces are one way for female STEM practitioners to find crucial mentorship, information, and community from same-gender academics. This mentorship and community has been shown elsewhere to inform rates of persistence of women within STEM academic programs. (Murthy et al., 2013)

Promising Practice 2 - Undergraduate Research Opportunities

A. Research-based courses in Marine Biology can help students to develop their own science identity by providing them with opportunities to develop competence, enhance their performance, and create greater self-recognition. (Anthony et. al 2017)
B. Undergraduate research, conducted by black students within the first or second year of their program, helped to develop feelings of confidence, belonging, self efficacy, and science identity.

These experiences were in direct contrast to classrooms, in which students experienced alienation and microaggressions. (Lane, 2016)

C. A Community Mentoring model helps to improve outcomes of Undergraduate Research Experience programs, particularly for URM STEM students. (Kobulnicky & Dale, 2016)

D. Undergraduate research experiences, supported by mentorship, can change the perspective URM students about what science field work and research are, and increase their sense of science identity. (Marrero et al., 2017)

E. While URM student interest in STEM careers can decrease over time during undergraduate study, undergraduate research experiences help to maintain interest in science for URM students who already have an interest in pursuing a science career. (Schultz et al., 2011)

F. Undergraduate research was positively correlated with a willingness to pursue careers in computer science, and graduate school, for black STEM majors. (Jackson et al., 2013; Borum & Walker, 2012)

G. Self-efficacy (the internal belief that an individual has the ability to pursue a goal or complete a task) is a strong predictor of STEM undergraduate's declaration of a STEM major. (Heilbronner, 2011)

H. In a study of a URM-focused conference focusing on undergraduate research, URM Undergraduate STEM students experienced increased self-efficacy, sense of belonging within Science, and intention to pursue a graduate research degree from just attending. URM Students, and URM women students in particular, experienced greater increases than non-URM students. The benefits were above and beyond the benefits of engaging in undergraduate research. Increased attendance at conferences was also positively linked to increases in these areas. In addition, presenting at or being awarded at the conference further increased greater reported self-efficacy, sense of belonging within Science, and intention to pursue a graduate research degree. (Casad et al., 2016)

I. Within a focused program to recruit URM students into STEM at a small university in the USA, an academic a student-led learning community, mentored undergraduate research, and cocurricular student engagement lead to program participants outperforming matched control peers on overall GPA, average number of credits per semester, graduation in 4 years, and placements in graduate schools. (Goonewardene et al., 2016)

J. Lab settings represent a microculture where URM students learn about science norms and values that can influence motivation. In a study of student's prosocial affordance beliefs within students working in a faculty-led lab, it was shown that the more that an URM student's lab mates believed that science has prosocial value, the more that URM student was interested in that lab's research and in a science career. This finding shows that lab peer's opinions influence URM students' motivation. (Thoman et al., 2017)

Promising Practice 3 - Mentorship

A. Student participation in Earth and Ocean sciences programs mirrors other STEM fields. Mentoring is a positive practice that can help address the diversity gap in Oceanic Sciences. Mentorship programs should take factors such as cultural competency and relevancy into account when they are being designed. Ideally a structured approach should be taken. (Johnson et al. 2016)

B. Undergraduate research experiences, supported by mentorship, can change the perspective URM students about what science field work and research are, and increase their sense of science identity. (Marrero et al., 2017)
C. The engagement of undergraduate students as mentors within programs for highschool STEM clubs has been shown to increase the science identity of undergraduate students, as well as their metacognition, and self efficacy. (Ferrara et al., 2018)
D. Black Women are more likely to take advantage of mentorship programs than men (Osueguera et al., 2019)
E. Blacks Women Mathematics PHD recipients cite Mentorship as a key factor in their persistence and retention within the field. (Borum & Walker, 2012)
F. Mentoring is a key factor in ensuring more URM students enter teaching streams in STEM. (Morton et al., 2020)
G. A Community Mentoring model helps to improve outcomes of Undergraduate Research Experience programs, particularly for URM STEM students. (Kobulnicky & Dale, 2016)
H. Not all mentorship experiences are equal when it comes to URM interests in science, and the quality and kind of relationship may be important factors. Just having a mentorship experience is not sufficient to increase interest in a science career for URM students. (Schultz et al., 2011)
I. Sponsorship, rather than mentorship, may be a promising avenue for the creation of opportunities of URMs in STEM. (Huston et al., 2019)

Promising Practice 4 - Interventions

A. Social Entrepreneurship intensive for URM students in STEM, based in Social Cognitive Career Therapy, and Critical Consciousness improved retention and outcomes for URM students. (Cadenas et al., 2020)
B. Example of the KL2 Program from the NIH, which has high retention and success rates for URM faculty. They deliver training programs for recipients in traditional grant and scientific writing; “contemporary offerings of team science”, entrepreneurship, leadership, community engagement, and health disparities research; evidence-based research mentor and mentee training. This is for URM scholars in the biomedical field, including scholars participating in clinical, basic, and population research. This benefit extends beyond program recipients, who take the learnings and training back to their home faculties and share them with other early career scholars. (Sorkness et. al., 2020)
C. Within the Ecology and Evolutionary Biology field, field courses are associated with higher self-efficacy gains, higher college graduation rates, higher EEB major retention, and higher GPAs at graduation in URM students. (Beltran et al., 2020)
D. Grant-writing boot camps designed to increase relatedness, autonomy, and competence of women in STEM increase the number of grants submitted, number of proposals led as a PI and amount of external funding dollars awarded to women in STEM. (Smith et al., 2017)

E. One time presentations don't significantly affect the likelihood of black students wanting to pursue a career in computer science, though it significantly increased their interest in graduate school and decreased negative views of computer scientists. High faculty contact and participation was a motivating factor for pursuing grad school and computer science careers. (Jackson et al., 2013)
F. Growth Mindset interventions in Computer Science can be shown to improve interest in subject material. (Burnette et al., 2020)
G. The engagement of undergraduate students as mentors within programs for highschool STEM clubs has been shown to increase the science identity of undergraduate students, as well as their metacognition, and self efficacy. (Ferrara et al., 2018)
H. In a gender-based intervention in STEM departments at the University of Wisconsin-Madison, the intervention increased the self-efficacy of faculty to engage in gender equity promoting behaviors. Where more than 25% of a department's faculty attended the workshop, faculty reported a significant increase in self-reported action to promote gender equity at 3 months. Faculty who took part in the gender bias habit reducing intervention, which gave participants strategies to practice personal awareness, reported higher levels of requisites of behavioral change: internal motivation, perception of benefits, and self-efficacy to engage in gender equity-promoting behaviors. Post-intervention, faculty in experimental departments reported changes in faculty culture, including greater perceptions of fit, valuing their research and comfort in raising personal and professional conflicts. (Carnes et al., 2015)
I. Instructors from the Life Sciences participating in a gender-based workshop intervention expressed less gender bias, and more willingness to engage in actions to reduce gender bias two weeks after participating in the intervention compared with two weeks before the intervention. The workshop was associated with increased awareness of diversity issues, reduced gender bias, and, importantly, a heightened propensity to take action to address diversity challenges. (Moss-Racusin et al., 2016)

Appendix 2 - Literature Review Protocol

Research Question

What is the state of discussions about EDI issues and practices within STEM Disciplines?

Inclusion criteria

Date	2010- 2020
Study Populations	Students at the undergraduate and graduate level, Professors in STEM-related faculties.
Language	English
Gender of Research Participants	Underrepresented/traditionally marginalized groups including but not limited to women, Indigenous peoples, persons with disabilities, racialized/visible minorities, and queer and trans folks (2SLGBTQQIA+)
Exposure of Interest	Having experienced STEM education as a student, having been the focus of EDI policies, having directly experienced equity focused education initiatives
Geographic Region	Institutions located within Canada and the USA
Peer Review	Peer reviewed publications, as well as grey literature
Setting	Universities
Type of study	Focused on classroom content, classroom environment, or the effects of EDI issues on outcomes for URM students.

Proposed Search Strategies

The following strategies attempt to address both the subject (equity of women and indigenous persons within the Faculty of Science) and the contributions to this topic of the relevant disciplines within the Faculty of Science at UBC (Botany, Chemistry, Computer Science, Earth, Ocean, and Atmospheric

Sciences, Mathematics, Microbiology & Immunology, Physics & Astronomy, Statistics and Zoology). This strategy will likely be subject to refinement.

Strategy #1
(EDI OR “equity” OR “diversity” OR inclusion OR JEDI (justice, equity, diversity, inclusion) OR IDEA (inclusion, diversity, equity and access) OR representation) AND *education* AND (STEM OR Science OR *physics OR math* OR *biology OR Computer Science OR Zoology OR Astronomy OR “Life Sciences” OR *chemistry OR *botany OR *science*) AND (women OR female OR *gender*)

Strategy #2
(EDI OR “equity” OR “diversity” OR inclusion OR JEDI OR IDEA OR representation) AND
education AND (STEM OR Science OR *physics OR math* OR *biology OR “Computer Science” OR Zoology OR Astronomy OR “Life Sciences” OR *chemistry OR *botany) * AND (indigenous OR aboriginal OR Native OR Metis OR Inuit OR “First Nations”)

Strategy #3
(EDI OR “equity” OR “diversity” OR inclusion OR JEDI OR IDEA OR IDE OR representation) *education* AND (STEM OR Science OR *physics OR math* OR *biology OR Computer Science OR Zoology OR Astronomy OR “Life Sciences” OR *chemistry OR *botany) AND (underrepresented OR marginalized OR excluded)

Relevant databases

Recent Literature reviews from the Skylight office on EDI issues were reviewed for the most common Catalogues to search for relevant work.

Catalogue	**Sample of Relevant Journals**
SAGE Journals	Perspectives on Psychological Science Personality and Social Psychology Bulletin American Behavioral Science Sociology of Education
Science Direct	Economics of Education Review Journal of Research in Personality Journal of Experimental Social Psychology
JSTOR	Journal for Research in Mathematics Education American Journal of Physics Proceedings of the National Academy of Sciences International Journal of Science Education

Catalogue	**Sample of Relevant Journals**
PubMed	Journal of Applied Psychology Journal of Personality and Social Psychology
Wiley Online Library	New Directions for Higher Education British Journal of Educational Technology Journal of Educational Psychology Journal of Engineering Education

Appendix 3 - Search Strategy

Database	**Search**	**Results**	**Review process**
JSTOR	(Diversity OR Equity OR Inclusion OR Representation) AND ("STEM" OR "science" OR *physics OR math* OR *biology OR zoology OR astronomy OR *chemistry OR *botany OR *science*) AND (Women OR Female OR *gender* OR *LGBT*) English language; 2010 – 2020; Journal articles only	90	Reviewed all results
	((ab:(Women OR Female OR gender OR LGBT) AND ab:("STEM" OR "science" OR physics OR math OR biology OR astronomy)) AND ab:(Diversity OR Equity OR Inclusion OR Representation)) AND la:(eng OR en) English language; 2010 – 2020; Journal articles only	205	Reviewed all results
	((((Women OR Female OR Minority OR "URM") AND ("STEM" OR "science")) AND ("Higher education" OR "Post-Secondary" OR university OR College)) AND (Diversity OR Equity OR Inclusion OR Representation)) English language; 2010 – 2020; Journal articles only	35,090	Filtering results by subject area, then reviewing the first 100 results

Database	Search	Results	Review process
PubMed	(Diversity OR Equity OR Inclusion OR Representation) AND ("STEM" OR "science" OR *physics OR math* OR *biology OR zoology OR astronomy OR *chemistry OR *botany OR *science*") AND (women OR female OR *gender*) English language; 2010 – 2020; Journal articles only	51,132	Reviewed the first 100 results
	(Diversity OR Equity OR Inclusion OR Representation) AND ("STEM" OR "science" OR *physics OR math* OR *biology OR zoology OR astronomy OR *chemistry OR *botany OR *science*) AND ("Native American" OR "American Indian" OR Aboriginal OR Metis OR Inuit OR "First Nation") With filters for English Language	7	Reviewed all results
	(Diversity[Title/Abstract] OR Equity[Title/Abstract] OR Inclusion[Title/Abstract] OR Representation)[Title/Abstract] AND ("STEM"[Title/Abstract] OR "science"[Title/Abstract] OR *physics[Title/Abstract] OR math*[Title/Abstract] OR *biology[Title/Abstract] OR zoology[Title/Abstract] OR astronomy[Title/Abstract] OR *chemistry[Title/Abstract] OR *botany[Title/Abstract] OR *science*")[Title/Abstract] AND (women[Title/Abstract] OR female[Title/Abstract] OR *gender*)[Title/Abstract]	5601	Reviewed the first 300 results
Wiley Online Library	"Diversity+OR+Equity+OR+Inclusion+OR+Representation" anywhere and ""STEM" OR "science" OR *physics OR math* OR *biology OR "computer science" OR zoology OR astronomy OR *chemistry OR *botany OR *science*" in Keywords and "women OR female OR *gender*" in Keywords	15	Reviewed all results
	"Diversity+OR+Equity+OR+Inclusion+OR+Representation" anywhere and ""STEM" OR "science" OR *physics OR math* OR *biology OR "computer science" OR zoology OR astronomy OR *chemistry OR *botany OR *science*" anywhere and "women OR female OR *gender*" in Keywords	193	Review first four pages, then filtered by relevant subject area
	"Diversity+OR+Equity+OR+Inclusion+OR+Representation" anywhere and ""STEM" OR "science" OR *physics OR math* OR *biology OR "computer science" OR zoology OR astronomy OR	63	Reviewed all results

Database	**Search**	**Results**	**Review process**
	*chemistry OR *botany OR *science*" in Keywords and "*LGBT* OR Queer OR sexual minority OR gay" anywhere		
	"Diversity+OR+Equity+OR+Inclusion+OR+Representation" anywhere and ""STEM" OR "science" OR *physics OR math* OR *biology OR "computer science" OR zoology OR astronomy OR *chemistry OR *botany OR *science*" in Keywords and ""Native American" OR Indigenous OR Aboriginal OR "American Indian" OR "First nation" OR Inuit OR Metis" anywhere	80	Reviewed all results
	"Diversity+OR+Equity+OR+Inclusion+OR+Representation" anywhere and ""STEM" OR "science" OR *physics OR math* OR *biology OR "computer science" OR zoology OR astronomy OR *chemistry OR *botany OR *science*" in Keywords and "Minorities OR Underrepresented OR Excluded"	265	Reviewed first three pages, then filtered by subject area
	"Diversity+OR+Equity+OR+Inclusion+OR+Representation" anywhere and ""STEM" OR "science" OR *physics OR math* OR *biology OR "computer science" OR zoology OR astronomy OR *chemistry OR *botany OR *science*" in Keywords and "Minorities OR Underrepresented OR Excluded" anywhere and "*education* OR "higher education" OR "post-secondary"" anywhere	119	Reviewed first three pages, then filtered by subject area
	"Diversity+OR+Equity+OR+Inclusion+OR+Representation" anywhere and ""STEM" OR "science" OR *physics OR math* OR *biology OR "computer science" OR zoology OR astronomy OR *chemistry OR *botany OR *science*" in Keywords and "Minorities OR Underrepresented OR Excluded OR Minority OR Racialized" anywhere and "University OR "higher education" OR "post-secondary"" anywhere	251	Reviewed first three pages, then filtered by subject area
ScienceDirect	Title/abstract/keywords: women OR female OR gender Anywhere: (equity OR diversity OR representation) AND (STEM OR Science OR physics OR math OR biology OR Computer Science)	23,725	Reviewed first 300 results, then filtered by publication, year, and relevance

Database	Search	Results	Review process
	Articles with these terms Anywhere: (STEM OR Science OR physics OR math OR biology OR "Computer Science") AND "post-secondary Years 2010-2020 Review Articles, Research articles, conference abstracts Title/abstract/author specified keywords: women OR female AND (equity OR inclusion OR diversity OR representation)	452	Reviewed first 300 results, then filtered by publication, year, and relevance
	Years 2010-2020 Review Articles, Research articles, conference abstracts Articles with these terms Anywhere: (STEM OR Science OR physics OR math OR biology OR "Computer Science") AND "post-secondary" Title/abstract/author specified keywords: (women OR female OR gender) AND (equity OR inclusion OR diversity OR representation)	49	Reviewed all results
	Articles with these terms anywhere: (STEM OR Science) AND (university OR "post-secondary" OR "higher education") Title/Abstract/Author specified keywords(women OR female OR gender) AND (equity OR inclusion OR diversity OR representation) 2010-2020: Review Articles, Research articles, Conference abstracts, data articles, abstracts, Examinations, Practice Guidelines, replication studies.	4305	Reviewed first 300 results, then filtered by publication, year, and relevance.
	Articles with these terms Anywhere: (STEM OR Science) AND (university OR "post-secondary" OR "higher education") Title/Abstract/Author specified keywords (indigenous OR "Native American" OR "First Nation" OR "American Indian" OR Aboriginal) AND (equity OR inclusion OR diversity OR representation) 2010-2020: Review Articles, Research articles, Conference abstracts, data articles, abstracts, Examinations, Practice Guidelines, replication studies.	798	Reviewed first 300 results, then filtered by publication, year, and relevance.

Database	**Search**	**Results**	**Review process**
	Articles with these terms Anywhere: (STEM OR Science) AND (university OR "post-secondary" OR "higher education") Title/Abstract/Author specified keywords ("Native American" OR “First Nation” OR "American Indian" OR Aboriginal) AND (equity OR inclusion OR diversity OR representation) 2010-2020: Review Articles, Research articles, Conference abstracts, data articles, abstracts, Examinations, Practice Guidelines, replication studies.	131	Reviewed all results.
	Articles with these terms anywhere: (STEM OR Science) AND (university OR “post-secondary” OR “higher education”) Title/Abstract/Author specified keywords (LGBT OR Queer OR Gay OR Bisexual OR Transgender) AND (equity OR inclusion OR diversity OR representation) 2010-2020: Review Articles, Research articles, Conference abstracts, data articles, abstracts, Examinations, Practice Guidelines, replication studies.	102	Reviewed first 300 results, then filtered by publication, year, and relevance.
Sage Journals	for [[All edi] OR [All "equity"] OR [All "diversity"] OR [All inclusion] OR [All jedi] OR [All idea] OR [All representation]] AND [[Keywords stem] OR [Keywords science] OR [Keywords *physics] OR [Keywords math*] OR [Keywords *biology] OR [Keywords computer]] AND [[Keywords science] OR [Keywords zoology] OR [Keywords astronomy] OR [Keywords *chemistry] OR [Keywords *botany] OR [Keywords *science*]] AND [[All women] OR [All female] OR [All *gender*]] AND [Keywords *education*]	1933	Reviewed first 300 results for relevance then filtered by subject.
	for [[All edi] OR [All "equity"] OR [All "diversity"] OR [All inclusion] OR [All jedi] OR [All idea] OR [All representation]] AND [[Keywords stem] OR [Keywords science] OR [Keywords *physics] OR [Keywords math*] OR [Keywords *biology] OR [Keywords computer]] AND [[Keywords science] OR [Keywords zoology] OR [Keywords astronomy] OR [Keywords *chemistry] OR [Keywords *botany] OR [Keywords *science*]] AND [[All women] OR [All female] OR [All *gender*]] AND [Keywords *education*] within	38	Reviewed all results.

Database	Search	Results	Review process
	for [[Keywords edi] OR [Keywords "equity"] OR [Keywords "diversity"] OR [Keywords inclusion] OR [Keywords jedi] OR [Keywords idea] OR [Keywords representation]] AND [[All stem] OR [All science] OR [All *physics] OR [All math*] OR [All *biology] OR [All computer]] AND [[All science] OR [All zoology] OR [All astronomy] OR [All *chemistry] OR [All *botany] OR [All *science*]] AND [[Keywords women] OR [Keywords female] OR [Keywords *gender*]] AND [Keywords *education*] within Within: research article, 2018 - 2019	1367	Reviewed first 300 results for relevance then filtered by subject.
	for [[All edi] OR [All "equity"] OR [All "diversity"] OR [All inclusion] OR [All jedi] OR [All representation]] AND [[Keywords stem] OR [Keywords science] OR [Keywords *physics] OR [Keywords math*] OR [Keywords *biology] OR [Keywords computer]] AND [[Keywords science] OR [Keywords zoology] OR [Keywords astronomy] OR [Keywords *chemistry] OR [Keywords *botany] OR [Keywords *science*]] AND [[Keywords indigenous] OR [Keywords aboriginal] OR [Keywords native] OR [Keywords metis] OR [Keywords inuit] OR [Keywords "first nations"]] AND [Keywords *education*] within Within: research article, since 2010	205	Reviewed all results.
	for [[All edi] OR [All "equity"] OR [All "diversity"] OR [All inclusion] OR [All jedi] OR [All representation]] AND [[Keywords stem] OR [Keywords science] OR [Keywords *physics] OR [Keywords math*] OR [Keywords *biology] OR [Keywords computer]] AND [[Keywords science] OR [Keywords zoology] OR [Keywords astronomy] OR [Keywords *chemistry] OR [Keywords *botany] OR [Keywords *science*]] AND [[Abstract indigenous] OR [Abstract aboriginal] OR [Abstract native] OR [Abstract metis] OR [Abstract inuit] OR [Abstract "first nations"] OR [Abstract decolonization]] AND [Keywords *education*] Within: research article, since 2010	187	Reviewed all results.

Database	Search	Results	Review process
	for [[All edi] OR [All "equity"] OR [All "diversity"] OR [All inclusion] OR [All jedi] OR [All representation]] AND [[Keywords stem] OR [Keywords science] OR [Keywords *physics] OR [Keywords math*] OR [Keywords *biology] OR [Keywords computer]] AND [[Keywords science] OR [Keywords zoology] OR [Keywords astronomy] OR [Keywords *chemistry] OR [Keywords *botany] OR [Keywords *science*]] AND [[Keywords underrepresented] OR [Keywords marginalized] OR [Keywords racialized] OR [Keywords *lgbt*] OR [Keywords queer] OR [Keywords trans*] OR [Keywords ethinic] OR [Keywords minority]] AND [Keywords *education*] Within: research article, since 2010	72	Reviewed all results.
	for [[All edi] OR [All "equity"] OR [All "diversity"] OR [All inclusion] OR [All jedi] OR [All representation]] AND [[Keywords stem] OR [Keywords science] OR [Keywords *physics] OR [Keywords math*] OR [Keywords *biology] OR [Keywords computer]] AND [[Keywords science] OR [Keywords zoology] OR [Keywords astronomy] OR [Keywords *chemistry] OR [Keywords *botany] OR [Keywords *science*]] AND [[All *lgbt*] OR [All queer]] AND [Keywords *education*] Within: research article, since 2010	364	Reviewed all results.