Knitting Theory in STEM Performance Stories: Experiences in Developing a Performance Framework

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Abstract: *Gender equality has made its way to the forefront of discussions across various sectors in the Canadian context. Yet the intentional inclusion of gender and other intersectional identity dimensions is just beginning to permeate the realities of performance measurement and evaluation practitioners, particularly those using program theory. There is a vast body of knowledge regarding the measurement of women's empowerment, gradually declining availability of resources targeting the inclusion of gender in theory, and even less guidance on integrating gender in theory in the context of gendered programming. Similarly, coordinated efforts from multiple sectors have resulted in an abundance of theory regarding girls and women's representation, recruitment, retention, and promotion within STEM (Science, Technology, Engineering, and Math) but less guidance on the measurement and evaluation in these areas. This article shares recent efforts to bridge the divide using theory knitting to develop a performance measurement framework addressing the decreasing representation of girls and women across the STEM "leaky pipeline" using the COM-B theory of change model.*

Keywords: *engineering, gender, gender equality, integrating gender in theory, knitting, science, STEM*

Résumé : *La question du genre est dorénavant un sujet central dans plusieurs secteurs au Canada. Pourtant, la considération intentionnelle du genre ainsi que d'autres*

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dimensions intersectionnelles de l'identité n'est qu'à ses début chez les praticiens de l'évaluation pour ce qui concerne la mesure de la performance , particulière-ment chez les adeptes de l'évaluation théorique des interventions (theory-based). Il existe un vaste corpus de connaissances au sujet de la mesure de l'émancipation des femmes. Il y a moins de ressources pour l'inclusion du genre dans les théories d'intervention, et encore moins d'information sur l'intégration du genre dans les théories dans le contexte de la planification visant à tenir compte de la dimension du genre. De même, les efforts coordonnés de divers secteurs ont mené à une abondance de théories liées à la représentation, au recrutement, à la rétention et à la promo-tion des filles et des femmes au sein des STIM (sciences, technologies, ingénierie et mathématiques), mais il y a peu de données sur la mesure et l'évaluation dans ces domaines. Le présent article décrit les efforts récents entrepris pour pallier cette lacune en combinant des théories pour développer un cadre de mesure de la perfor-mance prenant en compte la représentation décroissante des filles et des femmes dû au phénomène de « tuyau percé » (leaky pipeline) en STIM en utilisant le modèle de théorie du changement COM-B.

Mots clés : *ingénierie, genre, égalité homme-femme, intégration du genre dans une théorie, combinaison, science, STIM*

CONTEXT AND PROGRAM BACKGROUND

Since the election and assumption of power of the Canadian Liberal Party's leader Justin Trudeau in 2015, gender equality has been reimagined as a federal govern-ment policy priority in a significant way. This extends across all federal government sectors and applies to all organizations and their expenditures. It is reflected in dis-cussions emphasizing foundational concepts related to gender, diversity, and inclu-sion at both the policy and program levels. Furthermore, gender equality and one of its measurement mechanisms, gender-based analysis, have been mandatorily embedded in the policy cycle in innovative ways that include federal government budgets), Treasury Board Submissions, and Memoranda to Cabinet (TBS, 2016, 2017). In addition, federal government efforts are underway to legislate gender-based analysis in the near future (SWC, personal communication, 2018)), which means that these once-foreign concepts will become part of an institutionalized performance dialogue for federal government programs, those in receipt of their funding, and those involved in measuring and reporting on performance.

It is with UNESCO's words of advice—"the way in which data related to STEM are currently predominantly collected renders women and their concerns, needs, and responsibilities relatively invisible" (UNESCO, n.d.)—that this effort begins. Without specifically articulating and making women and girls visible in performance products, performance practitioners can be guilty of being gender-blind in their inattention to gender issues, specifically those related to program theory, and the gendered nature of accompanying assumptions (Hivos, 2014). By not attending to these aspects affecting performance, the disregard serves to perpetuate experienced individual and systemic barriers; the Government of

Canada has committed to addressing these barriers with its renewed commitment to gender equality and gender-based analysis *plus* (GBA+) through its lead department on gender equality, Status of Women Canada (SWC). For the first time since the government's first evaluation policy circular in 1977, gender equality has been specifically articulated as federal government priority within the results domain (Whynot, 2015). While slower to follow, this is starting to be reflected in associated performance guidance documents in the federal government, including the *Interim Guidance on the Policy on Results* (TBS, 2017). As a funding organization, the Natural Sciences and Engineering Council of Canada (NSERC) deserves recognition for its early leadership on gendered reporting; in 2010 it undertook its first study regarding *Women in Science and Engineering*. Additionally, that contributed to the implementation of the multi-year Gender Equity Action Plan in 2016 (NSERC, 2016), and the tabling of its Equity, Diversity and Inclusion Framework in 2017. Cumulatively, these organizational commitments provide a strong basis for making women and girls in STEM visible.

The NSERC Chairs for Women in Science and Engineering (CWSE) Program is one of these initiatives. The CWSE Program was launched in 1989 with one position in engineering, and later expanded to five Chairs, to include both science and engineering and with the recognition that the scope of the challenge was too significant for one individual to address alone. Individual Chairs from the Atlantic, Quebec, Ontario, Prairies, and British Columbia/Yukon regions have been delivering unique regional programs targeting various aspects of what has historically been referred to as the "leaky pipeline" of girls and women in STEM. The original thinking behind the CWSE Program's creation was to address the underrepresentation of women and to provide successful, accomplished, and recognized mentors (NSERC, personal communication, 2017). This thinking progressed to include addressing barriers encountered by women in STEM. As a critical dimension in this endeavour, it is necessary to make the distinction between gender equity and gender equality. Simply put, gender *equality* in STEM means equal representation, whereas gender *equity* recognizes that women, men, and gender-diverse individuals have different needs that require different intervention supports. The CWSE Program's goal is to "increase the participation of women in science and engineering, and to provide role models for women active in, and considering, careers in these fields"(CWSE, 2012). Program objectives emphasize (1) the development, implementation, and communication of strategies to raise the level of participation of women in science and engineering as students and professionals in the field, (2) the provision of female role models who are accomplished, successful, and recognized researchers in science and engineering, and (3) the development and implementation of a communication and networking strategy to ensure regional and national impact on opportunities for women in science and engineering (NSERC, 2017). Chair activities are balanced amongst science promotion, research into factors and institutional mechanisms that influence the participation rates of women in science and engineering, public advocacy, role-modelling, and more. The balance is highly dependent upon the

research interests of the individual Chairs, the regional/national contextual factors, and the needs within their regional academic institutions.

LINKING THEORIES OF AND ABOUT THE ROLE OF WOMEN IN SCIENCE AND ENGINEERING PERFORMANCE STORIES

This effort begins by engaging with the various theories surrounding the roles of women in and for science as a precursor to the development of a program theory that will comprise the backbone of a performance measurement framework. Conceptually, the "leaky pipeline" notion can be traced back to the 1970s U.S. education sector, in which STEM fields were envisioned to contribute to both development and workforce diversity (Brown, Brown, Reardon, & Merrill, 2011). Concerns arose when it appeared that an insufficient number of individuals would be available to fulfill future STEM jobs, careers, economic, and educational competitiveness projections, as women's presence decreased as career stages advanced. This concern was not isolated to the United States, and Canada found itself sharing these same apprehensions that continue to the present day (Carey, 2014; CCA, 2012, 2014, 2015; Krug, 2012; Mishagina, 2012; PEA, 2012; Plesca & Summerfield, 2014).

Early related research found evidence of both vertical and horizontal segregation experienced by women in STEM education and careers (see, e.g., Schiebinger, 1999). The solution regarding girls' and women's underrepresentation and retention in STEM fields is not a simple one. Nobel Peace Prize winner Carol Greider summarizes: "[o]nce women have entered STEM, at every subsequent stage of their career, they run a gauntlet of subtle practical, psychological, and social holes in the way of their promotions, appointments to boards, and other indicators of seniority. While slapping patches on the pipe may help stop some of the leaks, and help women get ahead, it is often a simplistic fix because the root of the problem isn't just practical" (Future Tense, 2014). A review of the literature found that girls and women in STEM study and careers have been significantly researched both in Canada and internationally. Broadly, the research includes the identification of context regarding how girls and women are situated in these areas of study/work (Barbercheck, 2001; Blickenstaff, 2005; Harding, 1991; Hill, 2010; Huhman, 2012; Keller, 1985; NSERC, 2010; Polacheck,1979); structural, social, and economic barriers encountered in these environments (Bebbington, 2002; Chang, 2014; Lane, Goh, & Driver-Linn, 2012; OECD, 2015; Polacheck, 1987; Settles, 2014; Settles, Cortina, Buchanan, & Miner, 2013; Storrie, 2012); and potential policy and strategies supporting solutions (Battison, 2015; Dasgupta & Stout, 2014; Müller, Castano, González, & Palmén, 2011; Simard & Gammal, 2012). Each of these areas could independently create years of reading. Crasnow, Wylie, Bauchspies, and Potter (2016) summarize that "the presence of women in the sciences, feminist critiques and feminist theories have contributed to changes in modern science as well as the studies of science." Cumulatively, this research points out that the analogy of a linear leaky pipeline is not perfect and recognizes

that a more systems-focused, non-linear approach incorporating the inclusion of dynamic social norms and values as key facets of change, and its measurement, are necessary. Cumulatively, the research identifies and situates these efforts across various settings, such as various orders of education, life in the academy, and other workplace settings. These explorations serve to highlight the potential role of theory at both the micro- and meso-levels, which are important given the non-linearity of girls' and women's occupation of various spaces, at various junctures, across the leaky pipeline. While relevant to STEM, this may also be important to other areas in which gender equity struggles have been experienced. The intent of this article is to build on these contributions, made by diverse theorists to bridge feminist, science, and evaluation contributions.

Given the increasing worldwide emphasis on gender equality and girls' and women's participation in STEM, it is surprising how little related performance measurement and evaluation information is available globally to support the evaluation of strategies and actions used to address the leaky pipeline. Synthesis efforts directed at examining the impacts of regional and national award schemes in North America and Europe were undertaken by GENDER-NET (2015). This policy-focused effort funded by the European Commission under the Science in Society initiative found that only two of the eight regional and national awards schemes had completed robust evaluations. These two programs were Athena SWAN and Project JUNO. Recent theory-based evaluation efforts of Athena SWAN echoed these sentiments, noting that "empirical research on this process, and its impact is rare" (Ovseiko, Chapple, Edmunds, & Ziebland, 2017). Measurement and reporting progress has been hampered by inconsistent measurement indicators across jurisdiction and stakeholders; UNESCO (n.d.) has identified that "[a]s a consequence, the lack of data and indicators, as well as of the availability of analytical studies, can obstruct the design, monitoring, and evaluation of policies aimed at successfully tackling gender inequality in STEM." Their STEM and Gender Advancement (SAGA) initiative is intended to address these shortcomings in standardizing measurement dimensions; however, final study results are not anticipated until after the publication date of this article. The first working paper issued as part of this initiative proposes policy-level, standardized, predominantly quantitative indicators for use at various stages of the leaky pipeline. Echoing this demand for performance-measurement and evaluation information capturing both individual and structural changes, the National Science Foundation's (NSF) ADVANCE program included a longitudinal evaluation stream in its recent call for funding. No applications were received in response, however, nor does ADVANCE have an evaluation strategy in place at the program level (J. Dearo, personal communication, 2018), although it is on the agenda for future discussion.

While the issues regarding the measurement of empowerment of girls and women in STEM are presented briefly here, in this article we take one step backward to reflect on the integration of elements of gender, and on what gender entails as a social construct in program theory. Program theory is not a clear-cut issue (Leeuw & Donaldson, 2015; Astbury & Leeuw, 2010), although efforts promoting

its use in the context of complexity have gained traction in the last decade, something that certainly applies in gender equality discussions as well. Despite cautionary advice on theory knitting by Leeuw and Donaldson that "largely normative evaluation theories with explanatory theories may be difficult or impossible" (p. 474), efforts related to this initiative addressing women's empowerment of women in and of science and evaluation are well aligned. This is partly attributable to similarities in orientation, which are described in further detail below. Women's empowerment theories of change materialized from the development context, in large part attributable to evolving efforts of feminist theorists including Boserup (1970), Moser (1989), and Overholt, Anderson, Cloud, and Austin (1984). It is here that measurement and reporting dimensions stemming from these various models began to emerge (Podems, 2010), with the appearance of gender roles and relationships (including power and influence) as key analytical variables. As these theories have matured and related understandings of key dimensions become more sophisticated, so too have measurement and reporting had to evolve to keep pace. Despite these advancements, measuring women's empowerment in the development context has been recently described as "measuring the immeasurable" (Kloosterman, Benning, & Fyles, 2012), "a distorted metric" (Anderson & Langford, 2012), and the "art of the impossible" (Langford, 2012).

The argument could be made, however, that program theory as conceptualized in the context of this special issue remains a relatively unexplored domain. Only recently have program theory related policy briefs and guidance materials emphasizing the inclusion of gender as a unique concept begun to emerge (CCAFS, 2015; Hivos, 2014) to address measurement shortcomings. These materials identify that numerous reasons are driving the integration between gender and program theory, beginning with an increasing reliance on theories of change to guide monitoring, evaluation, and learning efforts; a need for gender transformative results to address power imbalances; and, perhaps most significantly, because theories of change have the potential ability to circumvent some of the challenges presented by traditional gender mainstreaming approaches. Similar applications of theory knitting may be beneficial to other initiatives grappling with experienced inequalities.

THE NEED FOR A PERFORMANCE MEASUREMENT STRATEGY

In September 2006, the five regional CWSE Chairs were formally linked through the creation of a National Network Grant (NSERC, 2017) which facilitates interaction among the five Chairs in order to (a) increase the effectiveness of the five regional programs through shared information and resources; (b) enhance communication among the regional Chairs through regular face-to-face meetings; (c) increase the visibility and impact of activities at a national level; and (d) undertake research activities that support the common objectives of the CWSE Program.

Towards these goals, the National Network undertakes a range of collaborative research, communication, and networking activities. Since 2011, the regional

Chairs have annually reported to funders on twelve indicators (predominantly focusing on activities, outputs, and reach. What differentiates each of the regional Chairs' programs, in addition to individual research and expertise, are the students, the industry, partner, and program beneficiary stakeholders, the jurisdiction (including rural/urban differences), the target audiences, the budgets, and the delivery mechanisms that are specific to what juncture of the leaky STEM pipeline the Chairs target. Program-recipient direct-delivery mechanisms include camps, information/sensitization and capacity-building training sessions and workshops, mentoring activities, panels/talks, and academic publications. Figure 1 graphically depicts the geographic dispersion of activities, including direct interventions, catalysts, and representations undertaken by the five Chairs. However, regional Chairs are also involved in a wider, but no less time-consuming array of indirect delivery mechanisms, including behind-the-scenes influencing activities that extend from institutional hiring and diversity committees, industry- and sector-specific gender-equality initiatives, professional association initiatives, and the array of initiatives that these stakeholders promote. Additionally, regional
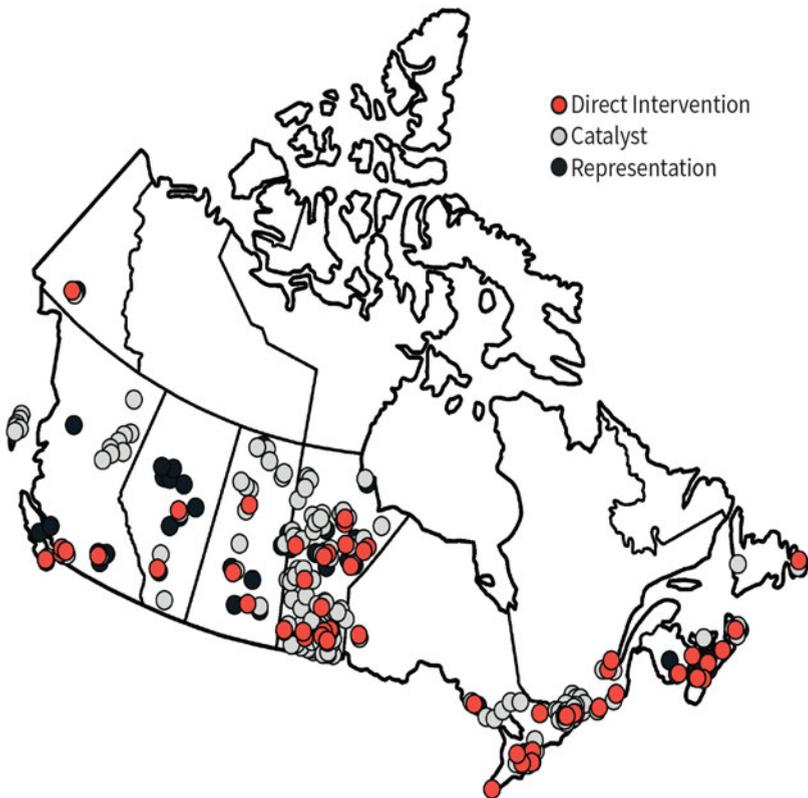

Figure 1: The CWSE program Chair activities

Chairs individually submit progress reports every 24 months based on elements highlighted in their individual action plans; these include activity reporting and monitoring mechanisms, as well as assessments of the impact and effectiveness of regional activities. To synthesize, cumulatively and collectively, the diverse and varied chair activities address various, and sometimes simultaneous, components of the leaky pipeline.

Specific goals related to the development of a program performance measurement strategy included analyzing common goals and elements of individual Chair programs to assist in reporting on the impact and effectiveness of each Chair in a coordinated manner (CWSE, 2017). Prior to the implementation of the *Policy on Results* (TBS, 2016), guidance materials for federal government programs on the development of performance measurement strategies were tabled identifying that strategy components should include a program profile, a logic model, a performance measurement strategy, and an evaluation strategy (TBS, 2010). The CWSE Program itself has never been formally evaluated as part of its parent organization's portfolio, as it was seen as a lower-risk initiative with a low material risk. Despite the organization implementing an expansion of the CWSE Program in its 2016–17 tabling of its *Report on Plans and Priorities* (NSERC, 2016), an evaluation plan was subsequently not included in the performance measurement strategy components, as this is generally undertaken by federal departments with input from the program. In this article, we highlight the development of one dimension of the performance measurement framework, the theory of change, which has been substituted for the logic model. Accepted definitions of a logic model identify "the depiction of the causal or logical relationships between activities, inputs, outputs, and the outcomes of a given policy, program or initiative" (TBS, 2015). Logic models and theories of change are interrelated, where the latter is expected to unpack how and why an intervention is expected to achieve the anticipated result, rather than solely providing a simplistic description (TBS, 2012). The complexity of addressing the entire leaky STEM pipeline by the various regional Chair programs requires performance tools beyond a logic model's simplistic description of anticipated results, which led to the adoption of a theory of change approach to frame current and future performance discussions.

APPROACH AND THEORETICAL FRAMEWORK SELECTION

Measuring changes in social norms and dynamics has long captured the attention of those involved in women's empowerment. Related methodological advancements accompanying the measurement of women's empowerment, however, have not yet translated into the development of program theory. One of the key dimensions of program theories is their situation in, and identification of, a specific context. When this is done for girls and women of STEM, not only is the visibility enhanced but the social norms and dynamics that may impede gender equality (CCAFS, 2015) are also identified. Evolving understandings of gender imply related understandings of structural and relational factors (Hankivsky et al., 2014),

which are the touchstones of the current federal government's approach to gender equality and the application of its GBA+ tool. Few federal government organizations have established related competencies; others are initiating plans for the growth and development of this competency. Program-specific explorations into these structural and relational factors include social-identity threats in professional naturalistic environments outside academia (Hall, Schmader, & Croft, 2015); the benefits of organizational and workforce diversity (Croft & Pelletier, 2012); hiring practices and career progression, including tenure and promotion (Smit Quosai, Davidson, Ghazzali, Moloney, & Vassileva, 2009), graduate study and career commitment (Darisi, Davidson, Korabik, & Desmarais, 2010); career choices and influences (WISEAtlantic Group, 2014); representation in STEM study fields (Perreault, Franz-Odendaal, Langelier, Farenhorst, Mavriplis, & Shannon, 2018), and multiple infographic/facts sheets on related topics such as unconscious bias, mentoring, stereotype threats, microaggressions, gendered communications, and supporting diversity in the workplace (Parker, Pelletier, & Croft, 2015). Needless to say, consideration of the various social norms and dynamics adds another layer of complexity in the design of a program theory and related performance measurement strategy. This holds true especially given that different socials norms and dynamics are in play for each of the regional Chair programs.

Embedding the knowledge, experience, and expertise of girls and women in STEM was a key facet of program theory construction, hence the significant investment in the literature review. Bringing theories from women in, and of science together with evaluation resulted in theory knitting, in which integrative strengths were emphasized. In theory knitting, "the best aspects of a set of given theories with one's own ideas regarding the domain under investigation" are employed (Kalmar & Sternberg, 2008). Doing this effectively removed the debate regarding which epistemological orientation would take precedence between positivists and constructivist epistemologies. Additionally, a theoretical framework would be required that was flexible enough to respond to both positions. Program theory has been recognized for its ability to do this and it additionally addresses both the individual and systemic shifts required to enact behavioural change for the empowerment of girls and women in STEM. Options considered included the Bennett Hierarchy, based on knowledge, aspirations, skills, and attitudes (KASA) (Mayne, 2015); Sen's (2004) and Nussbaum's (2011) Capability Approach (CA), with strong ties to policy and structural changes; and Michie, van Stralen, and West's (2011) COM-B approach, elaborated by Mayne (2017), which identifies that behavioural (B) change occurs only when the three dimensions of capacity—comprised of Capabilities (C), Opportunities (O), and Motivations (M)—are present. Consistent across these models is the introduction of the opportunity dimension as an integral component of results achievement. The CA was ultimately not selected for two reasons, including its normative orientation— "it is not a theory that will *explain* poverty, inequality, or well-being, but rather a theory that helps us to conceptualize these notions" (Robeyns, 2016; emphasis in original)—and despite its use in studies comparing economic impacts in STEM

areas (Battison, 2015), economic impact was not flagged as a longer-term outcome in early discussions regarding the performance measurement strategy with CWSE program stakeholders.

BALANCING THEORETICAL FRAMEWORK SELECTION AND PRACTICAL APPLICATION

Any theoretical framework serving as the foundation for program theory requires both the ability and sufficient flexibility to coalesce multiple theories to ensure that the experiences and expertise of girls and women are centrally located in performance discussions. Early discussions with CWSE program stakeholders, including the regional Chairs and the funding organization, were initiated to gather various perspectives for consideration in the development of a performance measurement strategy including program theory. These discussions generally echoed what was found in the related literature discussed above. It was noted that the return on the investment in the Chairs program was perceived to be significant, given the level of resourcing previously mentioned in relation to the activities undertaken. It was acknowledged that the limited number of Chair positions, and the subsequent breadth of their activities across Canada, would not likely be sufficient to enact sustainable, structural change. This supports conclusions drawn by the GENDER-NET study, which stated that "impact has been demonstrated within schemes that are adequately resourced, and so consideration must be given to how a transnational gender equality award scheme is resourced to be sustainable" (2015, p. 96). The complex nature of addressing multiple barriers to girls' and women's representation, recruitment, retention, and promotion in STEM takes time to address; it was important for the theory to reflect the anticipated entire change process, rather than just what occurred during the occupation of individual positions. This is also consistent with findings from the literature on integration of gender in theories of change to address structural and relational barriers to support increased representation of women at higher levels, where power and influence are accumulated. It was noted that a measure of the Chair's influence would be helpful to incorporate in subsequent performance frameworks, and that while the CWSE National Network was particularly strong in its quantitative reporting, it would also be helpful to build on existing qualitative reporting dimensions in any future efforts. Recent briefings on integrating gender in program theory have identified that the impact of requiring qualitative data has yet to be demonstrated (GENDER-NET, 2015, p. 101); however, anecdotal lessons learned suggest that social-learning processes have been the most effective in developing gender capacities in partners (CCAFS, 2015, p. 4).

The selection of the COM-B framework and discussions with the funding organization provided a point of departure to begin sketching the various components of the theory of change. The COM-B program theory model includes the following dimensions: outputs/activities; stakeholder reach and reaction; capacity change, composed of motivation, capability, and opportunity; and behavioural

change. Each of these phases in the causal-impact pathway is accompanied by related assumptions (Michie et al., 2011; Mayne, 2017). Discussions surrounding the development of the causal-impact pathway involved highlighting possible indicators for inclusion in the performance measurement framework. Indicators tabled for discussion included gender, both explicitly articulated and implicitly. It should be noted that while "reach" is an important early phase in the causal-impact pathway, to flag only gender at this juncture can contribute to gender-blindness, which is discussed in further detail below.

To support the development of a skeleton causal-impact pathway, each of the regional Chairs' websites was reviewed, and direct outreach to Chairs was undertaken by way of requesting related program documentation. These re-sources were then used to draft a CWSE COM-B program theory causal-impact pathway to serve as the foundation for the future performance measurement strategy. This process was facilitated by the regional Chairs' prior development of individual performance strategies to fulfil their jurisdictional action plans and related reporting efforts, as well as National Network updates undertaken at regu-lar intervals. Beyond the components previously identified in the COM-B model, the first iteration of the causal-impact pathway had additionally contained related conceptual areas (such as awareness, access, participation, etc.) aligned to affect pathway dimensions. Additionally, the causal-impact pathway highlighted what was under the control or influence of the CWSE Program. This was to facilitate understanding among Chairs who have limited experience with performance measurement and evaluation. It was found that the early stages of the causal-impact pathway (activities/outputs/reach and reaction) of the COM-B model were easily addressed, but latter stages required articulating various criteria to assist in facilitating a common understanding. For example, communication-related metrics regarding online social media presence were included at the activity phase, but discussion was required to define and differentiate between informa-tion or awareness-raising sessions and capacity-building activities. To support differentiating between the two, the level of program effort required was used as a defining criterion.

The first round of input from stakeholders was garnered through site visits to each of the jurisdictions accommodating the regional Chairs. The purpose of the site visits was two-fold: observation of or participation in program-sponsored interventions; and an opportunity to discuss, with the regional Chairs and their program staff, the overall state of performance measurement in their jurisdic-tions, the vision for a National Network performance measurement strategy, and any feedback that they may have had on the draft version of the National CWSE Network COM-B program theory. These site visits ranged in duration from one to two days and involved discussions with various program stakeholders in attend-ance at events, ranging from individuals in industry, representatives of academic institutions, program beneficiaries and their parents, as well as all of the Chairs and their program personnel. These site visits were not considered to be repre-sentative of Chair programs but rather provided a snapshot into their activities.

Continual updating of the draft occurred throughout the site visits based on information obtained. It is important to note that in the development of outcome statements associated with specific causal-impact pathway stages, girls and women were specifically articulated at every stage to avoid gender-blindness. This ensured that girls and women were not omitted from the performance discussions at any stage of the causal-impact pathway. While this appears to be a rather practical, common-sense approach, it is critical for several reasons. These reasons were referenced by keynote speakers Maria Klawe at the fall 2017 President's Dream Colloquium held at Simon Fraser University, and by Yves Desjardins-Siciliano at the 2017 Gender Summit 11, both of whom summarized that making these things explicit in performance stories ensures not only visibility but also a *continued* visibility. If gender and diversity are not specifically articulated, then attention can be diverted due to emerging and/or competing priorities, and what achievements have been made may not be sustainable.

PROCESS FINDINGS ON KNITTING THEORY IN STEM: LESSONS LEARNED

Several key process-oriented findings emerged that have both practical and more conceptual performance-measurement and evaluation implications for the integration of gender and theory for the CWSE Program. These findings may also have implications for others who are considering integrating gender in their respective theories of change.

At the indicator level

At the indicator level, the knitting of various program theories was very apparent, incorporating both quantitative and qualitative information for both individual and structural environments based on various aspects regarding the representation, recruitment, retention, and advancement of women and girls in STEM. Examples of these structural indicators include the total number of policy changes within Chairs' academic institutions (influenced by Chairs), as well as the total number of policy changes outside the Chairs' academic institutions that support girls' and women's representation, recruitment, retention, and advancement in STEM. As part of the development of the causal-impact pathway-development process, identifying assumptions for each of the stages was also a critical discussion point.

Regarding the identification of assumptions

Integrating gender considerations in assumptions requires making explicit what has remained hidden in the past, allows for discussion focusing on learning, and allows for the creation of evidence as part of a "collective construction" (Hivos, 2014, p. 8). It was interesting to note that gendered assumptions did not begin to explicitly emerge until the capacity-change stage of the causal-impact pathway, which is the juncture at which the Chairs' control is relinquished and influence

begins. The inclusion of specific gendered assumptions at this stage of the causal-impact pathway reflects the need for supportive environments, as well as changing social norms and values to support girls' and women's representation, recruitment, retention, and advancement in STEM. The articulation of making explicit the assumptions also necessarily involved the identification and assumptions related to the roles and responsibilities of stakeholders involved in the various aspects of the STEM leaky-pipeline continuum.

Reporting at regional Chair levels

As previously discussed, regional Chairs contribute to multiple-level reporting efforts. Reporting at the regional Chair level is mandated at 24-month intervals. These regional reports are predicated on action plans comprising individual Chair funding agreements. These agreements are valid for an initial five-year period and are renewable for an additional two- to five-year period afterward. After several years, and after the implementation of effective individual reporting strategies, the development of a program theory and accompanying performance measurement strategy has forecast impending reporting changes. It is anticipated that the indicators having been identified as critical for sharing the National Network performance story will serve as both additional and complementary to individual Chair reports. The addition of these new indicators adds a qualitative element that was previously less explicit, and it also holds space for reporting across the entire leaky pipeline to address changes beyond the tenure of individual Chairs. This is important, as the regional focus may also shift when new Chairs are introduced in a jurisdiction. The inclusion of these new indicators has associated methodological implications for tool development, data collection, and subsequent analysis, which will have to be balanced with existing resources in order to be successfully implemented.

Creating common understandings

To gather feedback on the draft COM-B program theory and elements of the performance- measurement strategy, teleconferences were held and an electronic survey were undertaken to garner input from the regional Chairs on the various aspects of the outcome statements and associated indicators at each results stage of the COM-B model. As part of the electronic survey, Chairs were asked, for each of the suggested indicators, whether they currently reported on it, whether it was viewed as important to the National Network, whether it was viewed as important to their region, the frequency of reporting, whether their region's performance story could be told without it, whether a tool had been developed to support reporting, and whether the indicator was reflective of the outcome to address the plausibility and coherence factors. All of the regional Chairs, or their personnel, responded to the survey, and their responses provided useful information. It was also critical to note that key questions were raised regarding the language used in the outcome, indicator, and assumptions components of the causal-impact pathway. This flagged a need for greater specificity for many

of the terms used and for how they would be reported on in the future. It was noted that differing interpretations of terminology existed among each of the regional Chairs. Ultimately, the questions posed contributed to the development of much more specific indicators associated with the various outcome stages in the COM-B framework for inclusion as the basis for the performance measurement strategy. Previously mentioned policy briefs and guidance on integrating gender and theory (CCAFS, 2015; Hivos, 2014) specifically reference program theory as a mechanism for facilitating understanding and creating opportunities to facilitate understanding from various situated knowledges, which was what occurred in this instance.

CONCLUSIONS AND NEXT STEPS

The academic literature can be broadly grouped into specific areas that include the representation, recruitment, retention, and promotion of girls and women in STEM; explorations of the environmental factors, including challenges and enablers affecting progression in these areas; and research synthesizing this information to guide future policy directions. The vast array of literature alludes to, and confirms, the complexity of the leaky-pipeline STEM continuum. This same literature also serves to highlight the deficit of resources on integrating gender in performance discussions, particularly when using program theory. Sector-specific areas have also emphasized this emerging area, one that will undoubtedly continue to flourish given the emphasis on gender equality, both within Canada and internationally, for STEM.

Theory can assist in highlighting and explaining perverse effects, such as those recently reported by Stoet and Geary (2018, p. 590), who noted that "countries with lower levels of gender equality had relatively more women among STEM graduates than did more gender-equal countries"(p. 590). This is an opportunity to draw on theories of change from multiple sources. Scientists, performance practitioners, and feminists can bridge intersections across these disciplines to contribute to the conversation regarding integrating gender in program theory for girls and women in STEM. Dedicated segments from these populations all have long-standing traditions representing the interests of those individuals who continue to be underrepresented in various aspects of the leaky pipeline. In part, this is attributable to a lack of access to and participation in opportunities that others have had as a result of structural impediments that impede accumulations of power and influence. It is these structural impediments that have garnered the attention of authorities internationally to coalesce efforts to standardize performance measurement and evaluation efforts related to girls' and women's representation, recruitment, retention, and promotion in STEM. These efforts have situated gender as a key analytical variable in performance discussions, and specific efforts related to performance measurement and evaluation have begun exploring integrating gender in program theory to reflect the more sophisticated metrics and understandings required.

A significant opportunity exists in the future for performance practitioners, as well as for the CWSE Program, given the dynamic landscape of standardizing gender-equality measurements in STEM. This rings particularly true, given the federal government's emphasis on the gender results framework informing budget discussions and the roles made visible for girls and women in STEM. Not only are girls and women specifically articulated in STEM, but future directions emphasizing new data-collection methods in this area have also been flagged by the federal government. Longitudinal data collection at the individual level throughout the entire STEM continuum is beyond the current ability of the Chairs due to limited financial resources and capacities and their existing responsibilities, but there exists a window in which this opportunity could be explored to spread longitudinal data-collection burdens across multiple stakeholders, including government and academia.

These initiating efforts to develop a performance measurement strategy that embeds across the outcomes, indicators, and assumptions dimensions of gender in program theory is a novel undertaking. Guidance materials (CCAFS, 2015; Hivos, 2014; TBS, 2017) reflecting on either gender equality or the related gender-based analysis outline a direct requirement to consider the needs of diverse program beneficiaries in the context of performance discussions. The experience offers, and validates in some instances, early insights offered on the process of integrating gender in program theory resulting from applied experiences. This has important implications for performance practitioners both conceptually and practically, which can guide future related actions for this sector, but more importantly across other sectors as they begin to think about the various complexities associated with gender equality and ensuring its representation in performance stories.

One of the key dimensions that remains yet unaddressed, but is alluded to by Podems (2010), is in being specific about language, particularly in distinguishing between gendered and feminist approaches. Canada's current government has self-declared as "feminist" with gender equality and gender-based analysis being entrenched across the policy cycle in novel ways. This, however, may not be the case for future political leadership. The repercussions of feminist declarations have been well noted worldwide (Chant & Sweetman, 2012; Podems, 2014), and practising feminist approaches without labelling it as such has been advised in order to contribute to sustainable practice. This has been reiterated in more recent studies of the federal government's Gender Focal Points, in which possible discursive strategies identified delinking gender and feminism (Paterson & Scala, 2016) and instead refocusing on evidence-based decision making.

At a practical level, the draft CWSE COM-B performance measurement strategy is moving toward finalization. Next steps include coordinating with the National Network to review the next iteration of the performance measurement strategy matrix and supporting regional Chairs in the process of aligning current individual reporting frameworks with the National Network model to ensure that consistency is maintained and that efficiencies are maximized where possible.

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