K-12 STEM Outreach at Canadian Universities: A Typology of Organizational Features and Knowledge Mobilization Processes

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Abstract - Knowledge Mobilization (KMb) is the reciprocal and complementary flow and uptake of research knowledge between knowledge producers, knowledge intermediaries, and knowledge users. The purpose of this investigation is to explore the typology of Canadian university-based Science Technology Engineering and Mathematics outreach organizations and understand if/how they function as knowledge mobilization intermediaries. Three research questions guide this first study; 1) What are the organizational features of K-12 STEM outreach organizations; 2) To what extent do STEM outreach organizations interact with K-12 educators or administration and 3) What knowledge mobilizations processes do they currently use? The methodology used for data collection will be an online questionnaire consisting of qualitative based open-ended questions. The educational importance of this study aligns with the goals of KMb as it has relevance to both within academia and beyond. Within academia, the results will contribute towards the body of knowledge within K-12 STEM education. Beyond academia, this study has value in practice, as the results will engage STEM outreach organizations in conversation about KMb strategies.

Keywords: Knowledge Mobilization; Intermediary; K-12 STEM Education, Engineering

1. INTRODUCTION

The ideology of using evidence-based research to inform policy and practice has been a topic of importance across multiple public sectors within Canada in recent years. Evidence to support this comes from the federal granting agencies that promote and support research, which include the Canadian Institutes of Health Research (CIHR), the Natural Sciences and Engineering Research Council of Canada (NSERC), and the Social Sciences and Humanities Research Council of Canada (SSHRC). As publically funded organizations, all three have a fundamental interest in promoting research findings and strongly support the principle of knowledge sharing and mobilization as an essential objective of academia.

According to CIHR, knowledge translation (KT) is defined as ‘a dynamic and iterative process that includes synthesis, dissemination, exchange, and ethically-sound application of knowledge to improve the health care system. The KT process takes place within a complex system of interactions between researchers and knowledge users which may vary in intensity, complexity and level of engagement depending on the nature of the research, the findings, as well as the needs of the particular knowledge user’. Referring to a similar KT process, SSHRC define knowledge mobilization (KMb) as ‘the reciprocal and complementary flow and uptake of research knowledge between researchers, knowledge brokers/intermediaries, and knowledge users. KMb both within and beyond academia—in such a way that may benefit users and create positive impacts within Canada and/or internationally’. This definition of KMb also applies to NSERC and the field of engineering education.

One strategy for potentially strengthening KMb efforts between research and practice is focusing on the role of brokers/intermediaries. For this study, a KMb intermediary refers to third party organizations whose role is between research producers and users as a catalyst for KMb. They focus on targeted, systematic efforts to increase connections between research and practice in public services [1].

1.2 Literature review

Traditionally, linear models of KMb refer to a pure dissemination approach where researcher producers push their research onto practitioners to use, but they do not interact with each other. In such models, knowledge within the research is viewed as factual, unambiguous, discrete, and able to be straightforwardly applied to practice decisions [2]. This type of research use is called instrumental, and is the most widely held view of what it means to use evidence-based research to inform policy and/or practice. It refers to how a specific piece of research has a direct impact on decisions [3].
Another approach for KMb and research use is an interactive model, which suggests that research use is more of a dynamic and unpredictable process, rather than a single event [3]. The interactive model focuses on mutual exchanges between research producers and users, proposing a relationship between one another, and is a powerful framework for understanding how research is used today [4]. This model also incorporates ‘conceptual use’ of research that includes the complex and indirect ways in which research can have an impact on the knowledge, understandings and attitudes of practitioners.

In the context of education, conceptual use of research is more likely to be used for practitioners as a means of informing and potentially changing their perception, rather than directly influencing their practice [5]. According to the literature, educators use research to enhance their understanding of key issues, provide motivation, an insight towards innovative approaches to practice, and to challenge their current teaching methods [6] [7] [8]. However, one of the challenges that exists within KMb is the access to research pathway between research producers and users. It is rare that educators turn to the academic, peer-reviewed literature that most researchers look to publish within. Instead, some educators tend to read about research findings in professional journals, magazines, internet, conferences, professional develop workshops, and the media [9] [10] [6]. Many educators also mention that the sharing of research findings is through personal contacts, which in education, often means talking to their colleagues [11] [6]. This suggests that social learning through peers may be an important KMb process through which practitioner’s access and use research.

1.3 Conceptual framework

Knowledge mobilization activity within education has highlighted the increasing diversity of intermediary organizations such as charitable organization, research centers, government agencies, researchers, interest groups, media, and private companies [3] [12]. These intermediary organizations can take a variety of forms depending on their context, purpose, target audience, and where they fit within the education system. One of the challenges that exists within KMb is that many organizations identify as an intermediary, without clearly defining why and how [13]. The conceptual framework used to guide this paper originates from the work of Cooper [1], who draws upon previous KMb literature [12] [14] [13], and helps to clarify what it means to be an intermediary organization. The overarching framework suggests that there must be three essential elements for research use: research production, research use, and the connection between them through third party mediation [1]. On another layer deeper, the conceptual framework explores the components of third party mediation, while introducing the contextual elements of each KMb intermediary as shown in Figure 1.

The first component of this framework explores the types of organizations based on their location and role within the education system. To narrow the scope for this particular research study, a preliminary inclusion criterion will be implemented to include only the STEM outreach organizations that are based within one of Canada’s fifteen leading research-intensive publically funded universities. This group of fifteen universities share common interests to provincial and federal governments, concerning the research enterprise and programs supporting research. The justification for the inclusion criterion in this study is that this focus on research at the university systems level might imply that these universities have similar views towards research use and knowledge mobilization. With this inclusion criterion and since all fifteen STEM outreach organizations potentially share a similar structure within a university, the first component of the framework will provide specific insight on each organization such as their position within the education system and the types of funding that support the organization.

The second component of the conceptual framework investigates the organizational features. Some of the main barriers to knowledge use in the public sector are not at the individual level, but originate in the organizational culture [5]. Previous studies have drawn upon organization ecology literature to explore organizational variables and the impact they might have on KMb efforts [15] [13]. In addition to the organizational variables, the mission statement of an organization is also an important feature to capture as they are recognized as one of the cornerstones towards an organizations unique purpose and practice [16]. The second component of the conceptual framework in Figure 1 provides a synthesis of the organizational features based on literature [1] [15] [13] [16]. Therefore, all of the individual elements within this second component will be explored to help provide insight towards the structure of the STEM outreach organizations within this study. Table 1 provides a brief description of the six organizational variables that will guide this study.
The third component of the conceptual framework investigates the KMb processes that intermediaries might use and consists of three parts: strategies, functions, and dissemination mechanisms. A list of each part is illustrated in Table 2. This component will provide specific insight on who the outreach organizations are interacting with, how they are doing it, what they using, and why they have selected these methods.

### Table 1: Organizational features of organizations

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission</td>
<td>The purpose of an organization</td>
</tr>
<tr>
<td>Scope</td>
<td>The spread of intermediary’s work (school, one district, provincial)</td>
</tr>
<tr>
<td>Size</td>
<td>The number of full-time employees</td>
</tr>
<tr>
<td>Resources</td>
<td>Strengthening connections between research and practice. This can include staff roles, funds (operating expenses), or research capacity roles</td>
</tr>
<tr>
<td>Membership composition</td>
<td>The stakeholders of the organization (researchers, teachers, principals, parents, policymakers, the public)</td>
</tr>
<tr>
<td>Target audience</td>
<td>The groups that intermediaries interact with (researchers, teachers, principals, parents, policy makers, students, the public, or other intermediaries)</td>
</tr>
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</table>

The final component of the conceptual framework used to guide this study is the modification of the terms ‘research production’ and ‘research use’ as stated in the original framework [1], to ‘knowledge production’ and ‘knowledge use’. Modifying the framework to include the word ‘knowledge’ is an attempt to broaden the scope as it allows for the inclusion of tacit and experiential knowledge in addition to researched-based knowledge. As previously mentioned, research suggests that educators share research findings to inform their practice through social learning with peers [11] [6]. This study aims to determine if this peer group might include K-12 STEM outreach organizations. The proposed conceptual framework that will be used to guide this study is shown in Figure 2.

### Figure 2: Conceptual framework

1.3 Problem definition

For educators in particular, training and professional development activities as well as opportunities to network with their peers represents an important method for KMb and keeping up with educational research [6] [3]. When it comes to concepts and teaching strategies related to Science, Technology, Engineering, and Mathematics (STEM), many educators look for addition training or resources to supplement their practice. To help with this training, many STEM outreach organizations draw upon their subject (tacit) knowledge and education experience to provide support for educators. Therefore, the purpose of this field of research is to explore the typology of Canadian university-based STEM outreach organizations and understand if/how they function as knowledge mobilization intermediaries.

This paper presents the first of a multiple-paper manuscript format with the aim to explore the organizational features and KMb processes of university-based STEM outreach organizations as intermediaries. Three research questions guide this first component of the larger study:

### Table 2: Knowledge mobilization processes

<table>
<thead>
<tr>
<th>KMb Process</th>
<th>Component</th>
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| Strategies  | 1. Research products  
              2. Capacity building  
              3. Non-researched based  
              4. Events  
              5. Network  
              6. Media |
| Functions   | 1. Linkage & partnership  
              2. Awareness  
              3. Accessibility  
              4. Policy influence  
              5. Engagement  
              6. Organizational development  
              7. Implementation support  
              8. Capacity building |
| Dissemination Mechanisms | 1. Online strategies  
                            2. Media  
                            3. Face-to-face |
1) What are the organizational features of university-based K-12 STEM outreach organizations?

2) To what extent do STEM outreach organizations interact with K-12 educators or administration?

3) What knowledge mobilizations processes do they currently use?

1.4 Methodology

The initial inclusion criteria for this study is that the STEM outreach organizations must be based within a Faculty of Engineering, Faculty of Science, or Faculty of Education within one of Canada’s fifteen leading research-intensive publically funded Universities. Based on this criterion, the maximum number of Canadian K-12 STEM outreach organization that could be included in this study is fifteen. The methodology used for data collection will be an online questionnaire consisting of qualitative based open-ended questions and will be divided into two sections. The first part designed to provide insight towards the organizational features (RQ1), while the second will provide insight towards the processes they use towards KMb (RQ2). The open-ended responses from the questionnaire will be collected using Qualtrics and then content data analysis, including open coding, will be used to allow themes to emerge.

1.5 Motivation for this study

The motivation for this study is driven by the curiosity of the researcher who is currently employed as an engineering outreach lead within the Faculty of Engineering and Applied Science at Queen’s University. As the outreach lead, the research has experienced an increase in requests from local schools to help with building educator capacity around STEM related concepts. With these requests, the researcher is motivated to establish whether other outreach organizations are experiencing similar requests to become more involved in K-12 education as third party organizations, or knowledge intermediaries. Therefore, the specific motivation is to see if/how other STEM outreach organizations view themselves as knowledge mobilization intermediaries.

1.4 Significance of the results

According to the Social Sciences and Humanities Research Council (SSHRC), KMb initiatives are typically dependent on the research area, objectives, context, and target audience. Within academia, KMb must inform, advance, and/or improve the following: research agendas, theory, and/or methods. Beyond academia, KMb must inform, advance, and/or improve the following: public debate, policies, practice, enhance/improve services, and/or inform the decisions of people in business, government, media, practitioner communities, and society.

The potential significance of this study could be used to inform both within academia and beyond. Within academia, the results from this study may contribute theory towards the broader field of knowledge mobilization and STEM education. It will also contribute towards the body of literature surrounding K-12 engineering education.

Beyond academia, the results from this study may inform the practice of K-12 STEM outreach organizations towards building their capacity, which may also have an influence on K-12 teachers responsible for teaching STEM subjects. The results also have the potential to influence education practice, especially through an increased understanding of the role of the social learning that is happening through education and through outreach. This is significant, especially given the Ontario ministry’s increased focus on collaborative inquiry projects [17].

3. RESULTS AND DISCUSSION

The information presented in this paper is a current draft of the research plan. With the goals of KMb to connect knowledge producers and knowledge users, it is highly probable that this study will be modified after conversations with colleagues in academia, individuals within STEM outreach organizations, and practitioners. Currently, the next steps towards conducting this research is to finalize the research proposal, apply for ethical clearance, and start data collection. By presenting this preliminary proposal, the goal is to obtain suggestions and constructive feedback on the scope of the research, the specific research questions, the methodology, or the overall significance of the study.

4. CONCLUSION

The conclusions for this study are to be determined.

5. ACKNOWLEDGEMENTS

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6. REFERENCES


