Connecting the Dots: Understanding the Flow of Research Knowledge within a Research Brokering Network

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Abstract: Networks are frequently cited as an important knowledge mobilization strategy; however, there is little empirical research that considers how they connect research and practice. Taking a social network perspective, I explore how central office personnel find, understand and share research knowledge within a research brokering network. This mixed methods case study focused on the first two cohorts of school district Mental Health Leaders participating Ontario's Child and Youth Mental Health program (N=37). Data were collected and analyzed in two phases: 1) the administration of a social network survey to all participants (response rate = 97%), and 2) follow-up interviews with key informants identified by the social network analysis (*N*=11). The findings indicate that this is a sparse network and the pattern of incoming ties tends to focus on a subset of individuals. When the identified key players (who are sometimes but not always program staff) are removed, network activity is cut by more than half; the removal of the remaining program staff members renders the network virtually non-existent. Research knowledge typically flowed in a single direction as there were few reciprocal ties within the network. Interview data

yielded some important insights indicating that participants perceived formal CYMH events as their main access points to research knowledge and that Mental Health Leaders who were identified as prominent sources of research knowledge had pre-existing relationships with CYMH program staff.
Keywords: educational policy; research use; knowledge mobilization; social networks; mixed methods research

Conectando los puntos: entendiendo el flujo de conocimiento de la investigación dentro de una red de intermediación de investigación
Resumen: Las redes se citan con frecuencia como una importante estrategia de movilización de los conocimientos; sin embargo, hay poca investigación empírica que considere cómo se conectan la investigación y la práctica. Tomando una perspectiva de redes sociales, exploro cómo el personal de una oficina central encuentra, entiende y comparte los conocimientos de investigación dentro de una red de intermediación de investigación. Este caso de estudio de métodos mixtos se centró en las dos primeras cohortes de Líderes (N = 37 participantes) del distrito escolar de salud mental del programa de Jóvenes y Niños Salud Mental de Ontario (CYMH sigla en inglés). Los datos fueron recogidos y analizados en dos fases: 1) la administración de una encuesta de red social a todos los participantes (tasa de respuesta = 97%), y 2) entrevistas de seguimiento con informantes clave identificados por el análisis de redes sociales (*N* = 11). Los resultados indican que se trata de una red dispersa y el patrón de los vínculos entrantes tiende a centrarse en un subconjunto de los individuos. Cuando los actores clave identificados (que son a veces, pero no siempre personal del programa) se retiran, la actividad de red se corta por más de la mitad; la remoción de los miembros del personal del programa restantes hace que la red prácticamente inexistente. El conocimiento de la investigación normalmente fluye en una sola dirección, ya que había pocos lazos recíprocos dentro de la red. Los datos de las entrevistas dieron algunas ideas importantes que indican que los participantes perciben eventos formales de CYMH como sus principales puntos de acceso al conocimiento de la investigación y que los líderes de salud mental que fueron identificados como fuentes importantes de conocimiento sobre la investigación tenían relaciones preexistentes con el personal del programa CYMH.
Palabras clave: política educativa; uso de la investigación; movilización de conocimientos; redes sociales; investigación de métodos mixto

Ligando os pontos: compreendendo o fluxo de conhecimentos de investigação no âmbito de uma rede de intermediação da pesquisa
Resumo: As redes são frequentemente citadas como uma importante estratégia para mobilizar conhecimento; no entanto, há pouca pesquisa empírica que considere como a pesquisa e a prática estão conectadas. Numa perspectiva de rede social, explorei a forma como o pessoal do escritório central, localiza, compreende e compartilha conhecimentos de investigação no âmbito de uma rede de intermediação de pesquisa. Este estudo de caso de métodos mistos focou nas duas primeiras coortes de Líderes (n = 37 participantes) do programa de saúde mental e da Juventude do distrito Saúde Mental Ontario (CYMH sigla em inglês). Os dados foram coletados e analisados em duas etapas: 1) com uma pesquisa de rede social para todos os participantes (taxa de resposta = 97%), e 2) entrevistas de acompanhamento com informantes-chave identificadas pela análise de redes sociais (*N* = 11). Os resultados indicam que é uma rede frouxa e o padrão de ligações recebidas tendem a se concentrar em um subconjunto de indivíduos. Quando os atores-chave identificadas (que são, por vezes, mas nem sempre, pessoal do programa) são removidos, a atividade de rede é reduzida em mais de metade; remoção de funcionários restantes da rede torna o programa praticamente inexistente. Conhecimento de pesquisa normalmente flui em uma direção, com poucas ligações

recíprocas dentro da rede. Os dados das entrevistas dão algumas idéias importantes que indicam que os participantes recebem eventos formais da CYMH como seus principais pontos de acesso ao conhecimento da pesquisa e que os líderes em saúde mental que foram identificados como importantes fontes de conhecimento sobre a pesquisa tinham relações pre-existentes com pessoas do programa CYMH.
Palavras-chave: política educacional; usar da investigação; mobilização do conhecimento; redes sociais; métodos mistos de pesquisa

Introduction[1]

Ideas about what and whose knowledge informs decision-making in education is not a new topic (see Cousins & Leithwood, 1993; Huberman, 1994, 2002; Louis, 1994, 1998). However, the rhetoric of 'evidence-based decision-making' and 'evidence-based practice' is a growing (and loud) voice in educational administration and has brought the relationship between educational research and practice back into the fore. In Canada, the main federal social science research funding agency called the Social Sciences and Humanities Research Council (SSHRC) refers to the work of connecting research and practice as 'knowledge mobilization' (Social Sciences and Humanities Research Council, n.d.). The purpose of this article is to report on findings from an empirical study on a research brokering network that works to build capacity for evidence-informed school mental health policy and practice in Ontario. The study was guided by the following research question: In what ways do the patterns of interaction with the Child and Youth Mental Health (CYMH) initiative mediate knowledge mobilization activities in support of developing evidence-based school mental health policy in Ontario school districts? As such, this study is significant in that it responds to three important developments in education: 1) growing interest in the use of evidence in policy and practice; 2) increasing recognition of the importance of social networks in research and evidence use, and 3) recent acknowledgment that student mental health is a significant issue that is often inadequately addressed in Canadian schools.

This article is organized into four sections. The first section briefly reviews some of the literature on the role of knowledge brokers in connecting research and practice, suggesting the new concept of a research brokering network. From there, I outline how social network theory and methods are an innovative approach in education research and champion its use in investigating research brokering networks in an attempt to understand how the activity within them mobilize research knowledge. In the second section, after a brief description of the CYMH research brokering network, which sets the context for this work, I describe the methods used in this study. The third section of the paper reports the findings, highlighting that the patterns of informal interaction within CYMH are not entirely congruent with the program's formal theory of action. This leads to a discussion in the final section of the paper about how the formally organized CYMH events and program materials provide much of the access to research knowledge, and about how, in instances where research knowledge is informally mobilized within the network, the dominant sources of research knowledge are not always formal program staff. Suggestions for future research are included. The paper closes by recognizing this study's limitations and reviews its contribution to the literature on knowledge brokering.

The Role of Knowledge Brokers in Connecting Research and Practice

As the context of research mediation continues to be recognized by many scholars as an important, yet understudied, dimension of KMb (Cooper, 2013, 2014; Nutley, Walter & Davies, 2007), the role of knowledge brokers is also becoming increasingly recognized as an important element of knowledge mobilization (Meyer, 2010; Ward, House & Hamer, 2009). Part of the challenge of studying intermediaries is that they have not been clearly defined (Cooper, 2014) as there are many different types of organizations (and individuals) who are engaged in intermediary work. This lack of understanding has led some scholars to call for greater attention to defining and describing the nature of the individuals and organizations that explicitly focus on building connections between research and practice (e.g., Nutley et al., 2007; Sin, 2008).

Definitions and proposed models of knowledge mobilization demonstrate that KMb is a non-linear, iterative process (Canadian Institutes of Health Research, n.d.; Cooper, 2014; Ward, Smith, House & Hamer, 2012). There are a number of terms and descriptions used to capture the work of knowledge brokers (see Cooper, 2013, for a review across sectors), and the roles knowledge brokers play in the KMb process vary depending on the context within which they are working (Meyer, 2010). Nonetheless, there is common ground on the general role of knowledge brokers in bridging the research and practice gap in view of the present literature. According to Ward et al. (2009), knowledge brokers' work generally includes finding and disseminating relevant research to potential users (which often includes translating the research knowledge into usable forms); facilitating linkage and exchange activities (e.g., discussions) that connect research users and relevant experts; and developing the capacity of the people involved in knowledge brokering activities to be able to carry out the work independently as time moves forward. In a recent Canadian study in education (see Cooper, 2014), emphasis was placed on the functions that knowledge brokers perform, highlighting the purposive actions of knowledge brokers in facilitating research use. These functions include: *linkage and partnerships* – facilitating connections among diverse stakeholders and supporting collaboration; *awareness* – increasing awareness of empirical evidence on a topic; *accessibility* – increasing accessibility to research by tailoring products to particular audiences; *engagement* – increasing engagement with research content through making it appeal to more of our senses; *capacity building* – facilitating professional learning and skill development around KMb; *implementation support* – consulting to provide assistance to implement KMb initiatives; *organizational development* – assisting to build strategic KMb plans and processes or evaluating existing programs and practices; and, *policy influence* – using research to galvanize policy priorities or change (Cooper, 2014).

The work of knowledge brokers is inherently relational. The patterns of interaction among and between knowledge brokers and the people and organizations which they are assisting are the foundation of knowledge mobilization work, and of research mediation in particular. Discussions of KMb often include networks as they are often cited as an important KMb strategy (Cooper & Levin, 2010; Nutley et al., 2007). However, to its detriment, much of the previous work in KMb discusses networks without the requisite methods to explore them empirically to uncover what is actually happening within them. The term 'network' is often used at a superficial level in many cases, typically used to simply delineate the members within a particular group without paying attention to how the relational linkages within that group facilitate organizational activities, and in particular, knowledge mobilization. As such, I introduce the concept of a *research brokering network* (RBN) as a next step in understanding how knowledge brokering as a deliberate act bridges the gap between research and practice.

Connecting the Dots: Understanding the Flow of Research Knowledge within a Research Brokering Network

My conception of a knowledge broker is not unlike that of others (e.g., Cooper, 2014; Meyer, 2010; Ward et al., 2009) in that brokers fill the intermediary space between research and practice, and that knowledge brokering is multi-dimensional, fulfilling a variety of functions depending on the context of the work. In pursuing the idea of a research brokering network, however, I am shifting the focus from the qualities and characteristics of the people and organizations that broker research knowledge (although they, too, are an important piece of the puzzle) to the actions that connect network members to one another and to relevant bodies of empirical knowledge that facilitate KMb work. A research brokering network acts as a promoter and facilitator of knowledge mobilization among a collective group of individuals or organizations who are brought together through a common interest on a similar topic or area of interest guided by a specific mandate of connecting research, policy, and practice. For instance, the CYMH program represents a research brokering network because it brings together a diverse group of mental health practitioners (i.e., clinical psychologists and social workers) and education professionals (i.e., school district administrators) for the dedicated purpose of connecting school districts with relevant research knowledge in addition to building its' capacity for using it in their development and implementation of school mental health policy.

The challenge of studying knowledge brokering through a network lens is that conventional social science research methods do not lend themselves well to highlighting the relational linkages that comprise the network. A true understanding of a network does not emerge until we focus on the relationships that connect the members within it; it is the patterns of interaction within a network that brings it to life, not just the collection of actors within it. As such, a more innovative approach to understanding how research brokering networks function is required. Social network analysis augments a researcher's toolbox by providing a diverse array of concepts and tools that allow researchers to probe more deeply into the work of networks, particularly when used in both quantitative and qualitative ways. In the following section, I consider how a social network perspective has been used in understanding research and evidence use in education to date.

Taking a Social Network Perspective to Understanding Research Use

Indeed, there has been a growing interest over the last decade among education scholars about the applicability of social network theory and methods to their research agendas. Social network analysis has been applied in studies of teacher professional development (Penuel, Sun, Frank & Gallagher, 2012; Sun, Penuel, Frank, Youngs & Gallagher, 2013); diffusion (Frank, Zhao & Borman, 2004; Penuel, Frank, Sun, Kim & Singleton, 2013; Sun, Frank, Penuel & Kim, 2013); innovative climates in schools (Moolenaar, Sleegers & Daly, 2011); leadership (Daly & Finnigan, 2010, 2012; Spillane, Hunt & Healey, 2009; Spillane & Kim, 2012; Spillane, Kim & Frank, 2012); policy implementation (Coburn, Mata & Choi, 2013; Coburn & Russell, 2008; Coburn, Russell, Kaufman & Stein, 2012;); school and student performance (Leana & Pil, 2006; Pil & Leana, 2009); and teacher collaboration (Moolenaar, 2012; Moolenaar, Sleegers & Daly, 2012). Yet, despite the increased interest in using social network analysis in education research, there are only a couple of studies that examine practitioner use of evidence (including, but not limited to research knowledge) through a social network lens.

Coburn (2010) and Daly and Finnigan (see Daly, Finnigan, Moolenaar & Che, 2014; Finnigan, Daly & Che, 2013) have conducted studies that highlight the ways in which social network perspectives are beginning to inform thinking about the use of research and other forms of evidence in school district decision-making processes. Coburn's study used social network data to trace the source of research knowledge, demonstrating how it can be used to illustrate the importance of external partners in the acquisition and use of research knowledge in a partnership context between

a school district and an intermediary organization. Daly and Finnigan's work offered more nuanced insights into how one network concept, centrality, helped explain the diffusion and use of research evidence within and between low-performing schools and the central office within one mid-sized urban district. Both of these studies signal the relevance and timeliness of social network analysis in understanding district and school leaders' use of research-based knowledge in complex educational systems. Using these studies that relate specifically to understanding networks as a mechanism to connect research and practice, as well as the broader literature that uses social network theory and methods as examples to draw upon, I turned to social network theory to inform the theoretical framework in this study. In the following section I review the foundational social network concepts that informed this study, which takes a social network approach to understanding KMb processes.

Using Social Network Theory and Analysis to Investigate Knowledge Brokering

It is important to understand what a social network is in terms of social network theory and analysis. A social network is a set of *actors* that are connected to one another through their social *ties*. Actors can be individual (e.g., students, teachers, administrators) or collective (e.g., schools, school districts, programs), each of which is characterized by a defined set of attributes. *Ties* are the relationships that connect actors to on another within the network (e.g., friendship, similarities, and interactions). The underlying premise of social network theory is that an actor's position within a social network has consequences for intended outcomes; some actors benefit more greatly from a flow of resources than others because of their position within network (Borgatti & Ofem, 2010).

Cohesion is a theoretical concept that speaks to the degree of connectedness among members of a network. It is a widely used concept, which asserts that resources flow easily through network structures that are unlikely to become greatly disrupted should any of the members leave the network (Kadushin, 2012; Moody & White, 2003; Prell, 2012). Prell (2012) describes cohesion as "the extent to which a network 'stays together' versus the extent to which a network breaks apart" (p. 166). There are several measures that take into account all of the ties within a network which can be used to determine its level of cohesion. For example, *density* (*D*) describes the level of activity within a network and is considered to be an indicator of network cohesion (Borgatti, Everett & Johnson, 2013; Scott, 2000; Wasserman & Faust, 1994). Theoretically, dense social networks (i.e., networks with high numbers of ties) facilitate easier and more direct resource flow, and are thereby considered to be more cohesive than less connected networks (Kadushin, 2012; Reagans & McEvily, 2003).

However, only considering the quantity of ties within a network does not take into account the degree to which these relations are spread across all members within it. The density of a network could be quite high, but a disproportionate number of ties could be connected to one member or a particular group of members. *Centralization* (*CD*) is a network measure that reveals the extent to which the activity within a network focuses on a subset of individuals. The ways in which resources are distributed through ties within a network are affected by centralized structures given that a disproportionate amount of power and/or influence being attributed to some people over others (Carolan, 2014). High levels of centralization are indicative of networks with lower levels of cohesion because the removal of the central figures would reduce the amount of activity within the network. In highly centralized networks, "the power of individual actors varies rather substantially, and overall, positional advantages within the network are rather unequally distributed in this network" (Hanneman & Riddle, 2005, Ch. 10). Hence, there is an inverse relationship between cohesion and centralization. Furthermore, the presence of a highly centralized network implies the existence of a hierarchical structure where some members are more 'popular' than others. Social

network measures that consider ties at the individual actor level (known as the egocentric level) will help identify who are the most prominent people within this research brokering network.

Similar to centralization (a whole network level measure), centrality (an egocentric level measure) emphasizes actors who are at the center of activity within a network. By identifying who the central actors are and understanding what network conditions contribute to their centrality, we are better able to understand what is happening within the network (Prell, 2012). Central actors occupy positions of advantage within a network as a result of their patterns of activity (Borgatti et al., 2013; Freeman, 1979; Wasserman & Faust, 1994). However, it should not be assumed that the most central figures in the network are always those actors with the greatest number of ties. Borgatti et al. (2013) point out, centrality "is not one thing, but rather a family of concepts" (p. 164) that helps researchers to understand how an actor contributes to network structure. In this article, I focus on *degree centrality*, which is the simplest and one of the most frequently used centrality measures (Carolan, 2014; Prell, 2012).

Degree centrality measures levels of activity or involvement by calculating the number of ties that each actor has in a network. As Borgatti et al. (2013) describe, "If we assume that things — such as information and infections — flow through ties, then degree centrality can be seen as an index of exposure in the network" (p. 166). In this way, individuals with higher degree centrality are seen to have more opportunity or access to resources, thereby occupying positions of advantage; they may also have greater control over resources within the network (Scott, 2000; Wasserman & Faust, 1994). Degree centrality can be refined into *outdegree* (who is sending the tie), a measure of the expansiveness of an actor's network, and *indegree* (who is receiving the tie), a measure of popularity and prestige (Prell, 2012). Take the example where two colleagues, Sam and Ted are in contact about research. Sam emails Ted to ask if he could send him a research report. Sam contacting Ted represents outdegree, and Ted being contacted by Sam represents the indegree. Within the KMb context, degree centrality measures contribute to deepening our understanding of who is most often seeking out research knowledge (outdegree) and who most often provides it (indegree). Doing so permits us to identify who is important in the network (Prell, 2012), or rather, those individuals with the most access to and/or most control over resources within a network (Wasserman & Faust, 1994). Using a combination of network concepts (i.e., cohesion and prominence) and measures (i.e., density, centralization, and degree centrality), we are better able to understand the patterns of interaction within networks and the ways in which they facilitate (or constrain) KMb work.

Context: The Child and Youth Mental Health Initiative[2]

The Child and Youth Mental Health initiative is a program created in response to the Ontario Ministry of Education's involvement in a province-wide initiative that aims to improve awareness of and access to resources supporting the mental health and well-being of all its citizens (see Government of Ontario, 2011). The intent of the initiative is to provide support to publicly funded school districts as they develop and implement research-informed school district mental health strategies by focusing on three key areas: 1) developing organizational conditions and leadership for effective school mental health; 2) capacity-building for education professionals; and, 3) implementation support for school mental health promotion and prevention programming. To carry out this work, the program provides a suite of evidence-based resources, tools, and implementation supports that are developed in consultation with their partner organizations and other experts in related fields in Canada and the United States. The director of the program described the project as an "implementation intermediary [whose] goal is...bridging [the] knowledge

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[2] A pseudonym.

and doing gap and to do that in very systematic ways" (personal communication, January 3, 2014). The initiative connected school districts with program coaches who mentored and provided support to each district's Mental Health Leader (MHL) who was responsible for developing and implementing an evidence-based and research-informed school district mental health strategy.

The formal structure of this program was such that the project director served as the liaison between this program and the multiple Ministry representatives who are involved in the broader provincial commitment to mental health issues. In addition to her work with at the government level, the director coordinated and worked with the program coaches (who represented a mix of child psychologists, social workers, and former school district superintendents) to develop and deliver modular professional development programming to build the capacity of school districts to develop evidence-based district mental health strategies. These research-informed modules were shared with the MHLs at their regularly scheduled CYMH meetings that took place about five to six times per academic year. Coaches maintained contact with their assigned school districts and MHLs throughout the year, providing individualized assistance and mentoring as required to support the MHLs in developing their mental health strategies. Figure 1 presents CYMH's formal organizational structure. In an effort to protect the anonymity of the program director, she and all other coaches are collectively referred to as 'program staff' in further discussion of this research brokering network.
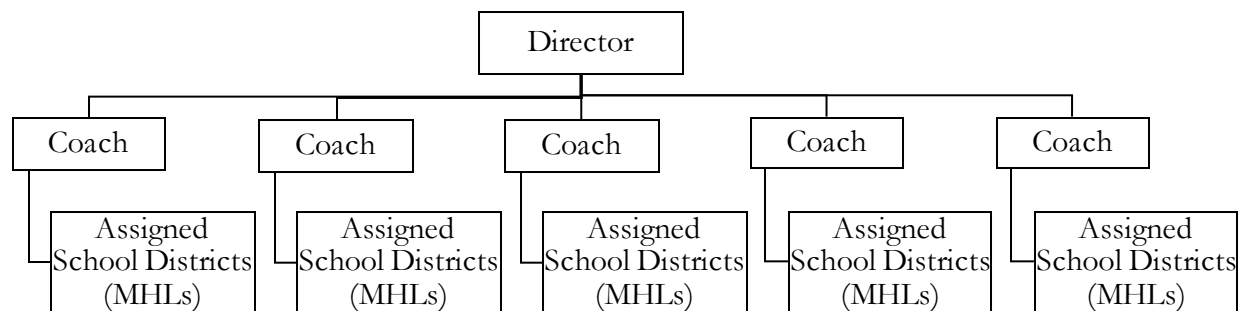
Figure 1. Organizational structure of the Child and Youth Mental Health initiative.

Methods

The data informing this paper were part of a larger exploratory case study (Yin, 2014) that focused on the ways in which informal patterns of interaction among CYMH participants (meaning those interactions that occurred outside of formally organized, whole group professional development meetings) mediated knowledge mobilization activities within the program. It followed an explanatory, sequential mixed methods design (Creswell & Plano Clark, 2011): survey data and analysis were conducted in phase one, followed by second phase interviews and analysis intended to deepen understandings of the structural network analysis findings. This article focuses predominantly on phase one findings, although insights from phase 2 data are briefly included as they relate to the informal exchange of research knowledge (a detailed account of the interview findings is available in Rodway, 2015). In this section, I present details on the participants of the study, as well as the methods and measures used to collect and analyze the survey data.

Connecting the Dots: Understanding the Flow of Research Knowledge within a Research Brokering Network

Participants

This study sampled program coaches ($n=5$) and Mental Health Leaders ($N=31$; Cohort 1: $n=15$; Cohort 2: $n=16$) from the first two cohorts of the program in addition to the program director. Thus, 37 individuals were invited to complete the phase one survey. The survey response rate was 97% ($N = 36/37$); one coach did not respond. Respondents provided details on their number of years of work experience in the field of child and youth mental health in exclusively education-based settings (e.g., school districts) as well as within the broader field outside of the education system. Overall, MHLs had an average of 12.4 years ($SD = 8.3$) experience working in education settings, ranging from 0.4 to 25 years. Coaches had nearly twice as much experience in education settings with an average of 21.4 years ($SD = 12.4$), ranging from 10 to 35 years. MHLs had more work experience in the field of child and youth mental health overall, averaging 20.8 years ($SD = 7.8$), ranging from 7 to 40 years. Program staff also had slightly more experience within the broader field with an average of 25 years work experience ($SD = 11.8$), ranging from 7 to 36 years. Table 1 presents basic demographic data for these participants (i.e., sex, highest degree obtained).

Table 1
Participants' Demographic Data

| | Mental Health Leads ($N = 31$) | | | | Coaches ($N = 5$) | |
| | Cohort 1 ($n = 15$) | | Cohort 2 ($n = 16$) | | | |
Variable	Count	(%)	Count	(%)	Count	(%)
Sex						
Male	2	(13)	0	(0)	2	(6)
Female	13	(87)	16	(100)	3	(8)
Degree						
Bachelor	2	(13)	1	(6)	1	(3)
Master	9	(60)	11	(69)	1	(3)
Doctorate	4	(27)	4	(25)	3	(8)

Note. Percentages may not equal 100 due to rounding.

Phase two interview participants ($N=11$) included the four participating CYMH coaches, the program director, and six Mental Health Leaders who were selected based on the degree centrality findings from phase one. I invited eight MHLs to participate, two for each of the following groups: 1) the most active seekers of research knowledge (high outdegree); 2) the least active seekers of research (low outdegree); 3) the most frequent providers of research (high indegree); and, 4) the least frequent providers of research (low indegree). I was successful in recruiting participants for each group except for individuals who rarely sought out research knowledge (low outdegree).

Data collection

Data was collected in two phases through a survey (phase one) and interviews with selected participants (phase two) as detailed below.

Survey. The phase one survey contained eight network questions that focused on five different relationships among CYMH colleagues (detailed in Rodway, 2015); questions were modeled on those questions that have been previously validated and used in other social network studies (i.e., Cross & Parker, 2004; Daly & Finnigan, 2010). Participants were asked to identify from whom they sought out information related to their policy development work and to also identify the type of information they received. Figure 2 presents the specific information network question from

which these findings were generated. The research knowledge network findings are the focus of this paper. Network questions can be labor intensive (Carolan 2014; Prell, 2012) and because in the original survey question they were asked to identify the type of information individuals acquired through their interactions with colleagues, respondents were not asked about how frequently they interacted around research knowledge. The survey was piloted with eight individuals with experience in policy and practice, and it was revised based on pilot feedback prior to administration.

From whom have you <u>RECEIVED INFORMATION</u> that has informed the development of your board's mental health strategy?

    a) <u>TYPE OF INFORMATION</u>: For each person that you identify as a source of information, please check off the type(s) of information that you have received from this individual, referring to the following definitions:

> **RESEARCH** = findings from published empirical studies on a particular issue
> **DATA** = administrative records such as testing data, non-academic student data
> **OTHER** = refers to any other type of information that you received that was helpful to your work.

Colleague's Name	Type of Information		
Director's name	Research O	Data O	Other O
Each coach's name (1/line)	Research O	Data O	Other O
Each MHL's name (1/line)	Research O	Data O	Other O

Figure 2. Information Network Survey Question

       The survey was administered online and respondents were prompted to consider their relationships with each of the program staff and their Cohorts 1 and 2 colleagues who were identified on a 'master list' (Carolan, 2014), an approach referred to as the roster method of data collection (Scott, 2000; Wasserman & Faust, 1994). Respondents checked the box for each type of information that they received from the named colleague; if they did not receive information from a particular person, they simply left that row blank. This method minimizes the burden on respondents to remember all of the possible people who could be identified (Carolan, 2014; Lima, 2010). Consequently, measurement error is reduced as there is a decreased likelihood of respondents forgetting to include individuals in their responses (Carolan, 2014). Due to the ethical concerns that surround the collection of network data (e.g., the use of names and identification of interpersonal relationships among colleagues), respondents were informed prior to completing the survey that all names would be converted to numerical codes for use throughout data analysis and in subsequent publications of the findings to preserve participants' anonymity (Prell, 2012).

       Interviews. During phase two of the study, data was collected through semi-structured interviews that ranged from 30-75 minutes in length; in general, participants were interviewed only once either in person or over the telephone. Three different interview protocols were used, one each for coaches, Mental Health Leaders, and the program director. The interview questions were

informed by other qualitative studies investigating research use (e.g., Finnigan et al., 2013), but they did not replicate any existing interview protocol. All interviews were recorded and transcribed verbatim for use in data analysis. The program director was interviewed twice: a preliminary interview was conducted to discuss the history and organization of CYMH, and a second interview was carried out using the coaches' protocol given that she also acted as a coach for a school district in the early years of the initiative.

Data Analysis

Because the data were collected in two distinct phases, with phase two participants being selected based on phase one findings, the analyses of these data were also carried out in two phases as described below.

Survey. Given that social network analysis allows for analysis at multiple levels (Kadushin, 2012; Scott, 2000; Wasserman & Faust, 1994), network data were analyzed at both the whole network and ego network levels using UCINet version 6 (Borgatti, Everett & Freeman, 2002). Network-level measures provide an understanding of how tightly connected individuals are to each other (density), and to what degree activity within the network tends to center on a central group of members (centralization). Together, these measures can be interpreted as measures of network cohesion, providing a sense of the robustness of the research knowledge network (Prell, 2012).

At the ego network level, outdegree and indegree centrality were calculated for each network member. Tie frequency distributions were examined to determine the most prominent individuals in terms of research seeking (outdegree) and provision (indegree) behaviour. A core-periphery (C-P) analysis was conducted to identify which individuals were the most active and made up the core of the network. I used NetDraw (Borgatti, 2002) to create two maps for the research network: one map that illustrates research seeking behavior and another the highlights the sources of research knowledge. Table 2 provides further explanations of each of these network measures, including the mathematical formulas used in their calculation. Descriptive statistics (mean, median, standard deviation, and range) were then generated for both outdegree and indegree centrality scores, disaggregating the data by cohort and role (cohort 1, cohort 2, and program coaches) to examine patterns of interaction for each participant group represented within the network. These data facilitated further investigations of mean differences in degree centrality scores by group, which were carried out using independent samples t-tests in SPSS (IBM, 2013).

Interviews. The complete transcripts were summarized into summary tables that contained passages that pertained to the research questions guiding this study. Participants were provided with a copy of the summary tables for review (member-checking) prior to the start of data analysis. There were no requests for substantial changes to the summary tables. The constant comparative method (CCM) of qualitative data analysis was applied to analyse the summary tables. I followed Boeije's (2002) step-by-step approach to developing the CCM procedure, resulting in comparisons made at three levels: 1) within a single interview of an identified group (e.g., program staff, high outdegree MHLs); 2) between interviews within the same group; and, 3) between interviews from different groups. Because of the exploratory nature of this study, the constant comparative method is the most appropriate for the inductive analysis of this qualitative data.

Table 2
Explanation of Network Measures

Measure	Definition	Explanation	Formula
Density	The number of ties (relationships between pairs) in the network reported as a fraction of the total number of possible ties.	A density score of 1.0 means that all of the possible ties within a network are present; everyone has identified a connection to everyone else in the network. This measure will inform us about the degree to which members in this network are connected to each other. To maximize KMb activity, a high density score would be desirable.	___
Centralization	A structural measure that reflects the degree with which a network's relations are focused on one or a small set of actors.	When results indicate a high degree of centralization in a complete network, it means that one person or a small group of individuals maintain most of the relationships within the network. The consequence in terms of knowledge mobilization practices could be that a disproportionate amount of influence is attributed to a small group of people (or to one individual). More nuanced centrality measures (closeness and betweenness centrality) will provide more insight into the consequences for KMb; these measures will be explained in the next section.	___
Degree Centrality (including indegree and outdegree)	The number of ties to and from ego. Indegree is the number of ties received and outdegree is the number of ties sent. Can be adapted and applied to complete network-level data analysis.	This is the most common centrality measure and is related to network size. It calculates the number who reported having a tie with the ego (indegree centrality) and the people with whom the ego reported having ties (outdegree centrality). Broadly defined, centrality measures capture the degree of prominence an ego has within the network; it "captures the extent to which a focal actor occupies an important position of prestige and visibility" (Carolan, p. 155).	___

Note. Explanations are informed by Carolan (2014) and the definitions are reproduced from the book's chapter resources retrieved from: http://www.sagepub.com/carolan/study/materials/KeyTerms.pdf .

Findings

## Cohesion and the CYMH Research Brokering Network

Overall, the network-level measures of cohesion suggest that the informal research knowledge network is not robust. It is quite sparsely populated with only 127 out of a possible total of 1 332 ties present – a network density of 9.5% ($D = .095$). This means that for every possible ten ties that could exist within this network, only one does. Given that this is the first time network data has been collected for CYMH, there is nothing to which to compare this finding. Furthermore, there is generally a lack of baseline data around evidence use in general (Cooper, 2014), especially in relation to social networks and KMb. Thus, it cannot be stated whether this is a high or low level of informal interaction given the absence of comparison data; however, the low density score does indicate that there is an infrequent exchange of research among CYMH colleagues outside of their formally organized activities. The low level of activity within this network is consistent of the findings in Daly and Finnigan's study of research evidence use (see Daly et al., 2014; Finnigan et al., 2013) where low levels of activity were also found, although it is important to keep in mind that direct comparisons between these networks cannot be made because of differences in their size, composition, and context.

Because I was able to determine the direction of a tie (i.e., who sent a tie and who received it), I investigated the degree to which the patterns of research seeking (outdegree) and research provision (indegree) behavior focused on a particular subset of individuals through the application of a centralization measure. The outdegree research network's low outdegree centralization score of 13% suggests that the research seeking activity within this network is generally spread across all of its members. Thus, the pattern of research seeking ties is generally spread across the program's membership regardless of role (program staff or MHL). However, the indegree research network's centralization score of 44% indicates that there is a subset a people within the network who are more often the sources of research knowledge than others. Recall that there is a negative relationship between centralization and network cohesion; thus, providing further evidence that the research network is not robust given that the removal of these key individuals would result in the demise of the network (Prell, 2012).

This level of indegree centralization prompted a core-periphery analysis (C-P) in order to identify who were the more central figures in this network. This analysis indicated that there were 16 individuals at the core of the research network (five program staff, eight Cohort 1 MHLs and three Cohort 2 MHLs) and that the majority of activity within the network occurs among these core members. Core-periphery structures have possible implications for information networks such as a research brokering network. On the one hand, given their roots in centralization, strong core-periphery models suggest that a subgroup of individuals may wield more power and control over the information that is being shared within the network. On the other hand, strong C-P models facilitate more efficient transfer of information from the core to the peripheral members, as information is likely to flow faster from the most active people in the network (the core) to those whose low levels of activity situate them on the periphery of the network (Daly & Finnigan, 2010). With the understanding that there is a low level of activity that is centralized in terms of who are the sources of research knowledge in this network, it is appropriate to look more closely at what is happening in this network at the individual level using degree centrality measures.

Patterns of Research Seeking Behavior

Network maps, also known as sociograms, provide insight into what is happening in the network prior to considering the more complex social network measures by simply illustrating the patterns of interaction among network members. Figure 3 illustrates the patterns of research seeking behavior based on outdegree centrality findings, which identify the levels of research seeking activity within the group. The size of each node corresponds with the corresponding individual's level of activity within this network; the larger the node, the more active that person is in seeking out information within that network.
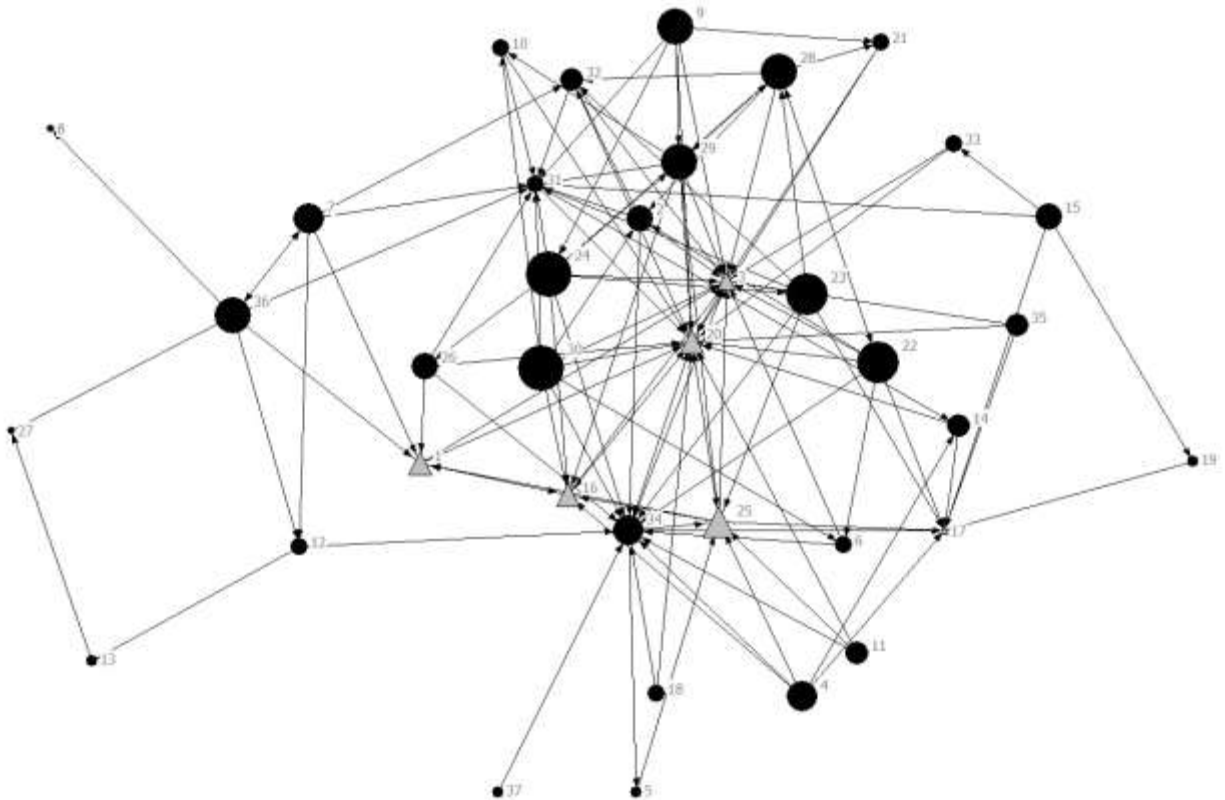
Figure 3. Research seeking behavior (outdegree) within Project CYMH. Black circles are Mental Health Leaders and grey triangles are program staff members.

This sociogram suggests that all MHLs are active in terms of exchanging research knowledge given that there are no isolates (i.e., people who are not connected to any others). It is important to note that this means that everyone in this network is either asking for or providing research-based information to their colleagues — not everyone is seeking out research information. The direction of the arrows in the image show the direction of the relation. Thus, it is evident that actors #8 and #27 (on the far left side of the sociogram) have been asked by their colleague (#36) for research knowledge (an indegree relationship), but there are no arrows from these two individuals indicating that they have asked any of their colleagues for research knowledge (an outdegree relationship), which tells us that they have an outdegree centrality score of 0. Hence, everyone is involved in the network, but not everyone is informally seeking out research knowledge.

Among both cohorts of MHLs, there are a few individuals who appear to be more active than others. The maximum (raw) degree centrality score is 36 (N (N-1)); if an individual asked each person in the network for research knowledge, that person's outdegree centrality score would be 36.

Cohort 1 MHLs have an average outdegree score of 10.4 (SD=7.06), and Cohort 2 MHLs have an average score of 9.6 (SD=6.08). Although there is a slightly wider variation in Cohort 1 outdegree scores, the patterns of interaction among both groups is quite similar; there is no significant difference in research seeking behavior between the two cohorts (t(27.7) = .346, p > .05). Program staff also seek out research evidence from their colleagues, but to a slightly lesser degree with an average outdegree score of 8.9 and much less variation (SD=3.04). Again, the mean difference between program staff and MHLs was not significant (t(11.2) = .59, p > .05). What we see in terms of who is informally seeking out research knowledge is that people possess about nine or ten outdegree ties on average, and that these ties are distributed across the network without any one group (i.e., program staff, Cohort 1 and Cohort 2 MHLs) being significantly more active than another.

Sources of Research Knowledge within CYMH

A very clear pattern is evident within the research network sociogram (see Figure 4): two Mental Health Leads (circles #31 and #34) and two program staff members (yellow triangles #3 and #20) are very clearly the dominant sources of research evidence within this network. The remaining four program staff are also sought out for research knowledge, but to a much lesser degree than the larger nodes in the centre of the graph.
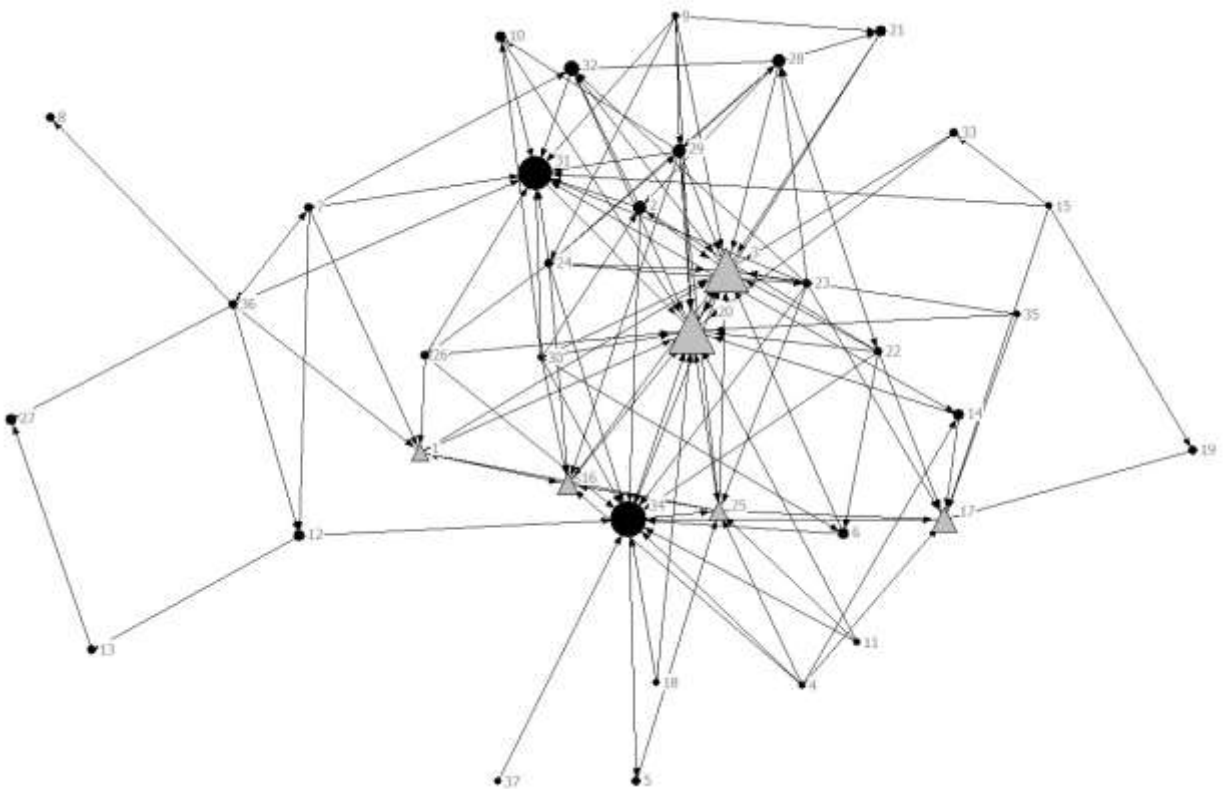

Figure 4. Sources of research knowledge (indegree) within CYMH. Circles are Cohort 1 MHLs; squares are Cohort 2 MHLs; triangles are program staff members.

On average, the mean indegree centrality score for program staff (M=30.56, SD=19.15) is more than three times higher than the scores for Cohort 1 MHLs (M=8.72, SD=11.96) and about ten times higher than Cohort 2 MHLs (M=2.78, SD=3.2) signaling that, overall, program staff are
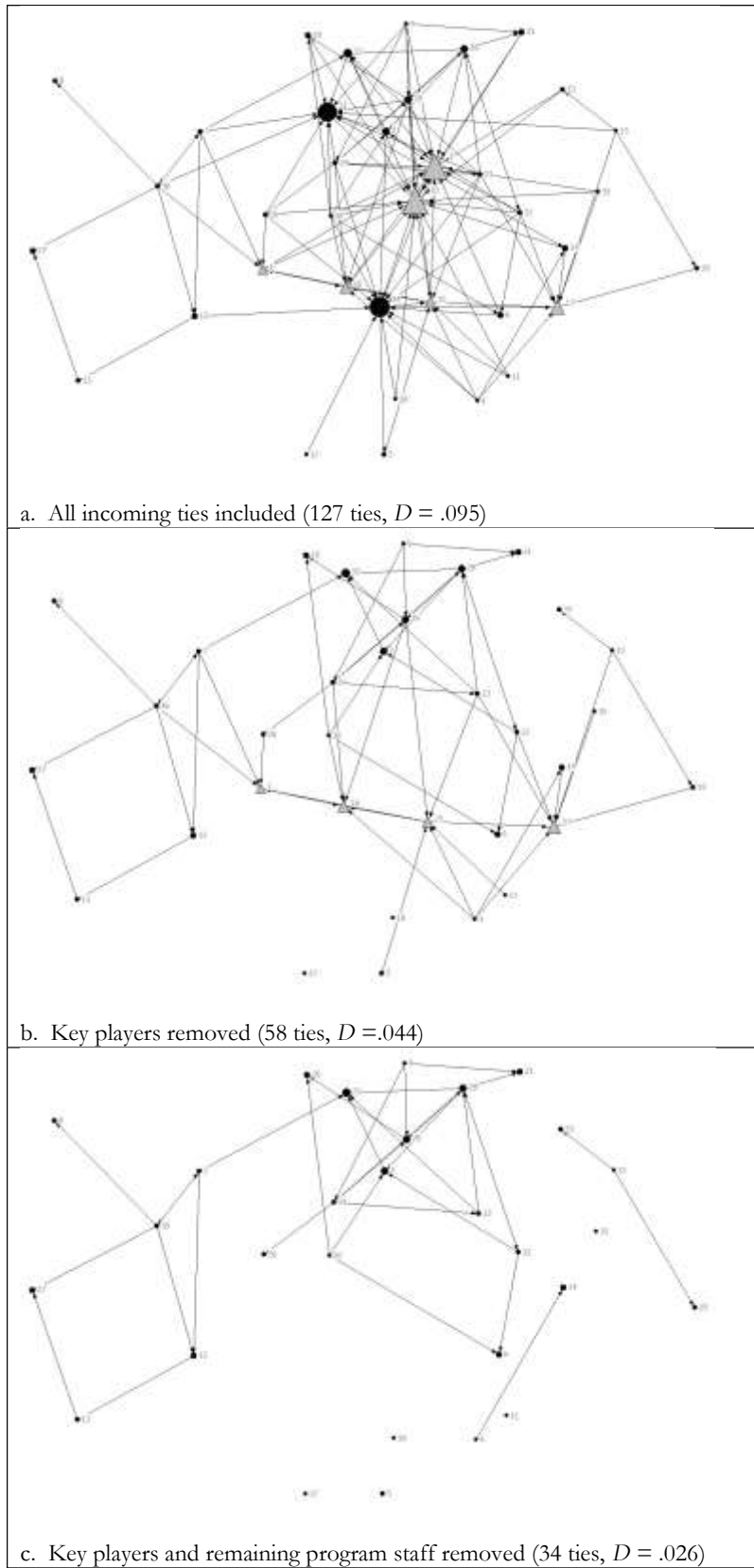
most often the sources of research evidence in general. Indeed, program staff have significantly more incoming research-based ties than MHLs ($t(4.3) = 2.86$, p < .05). Although, CYMH members typically turn to Cohort 1 MHLs more often than their Cohort 2 colleagues in search of research-based knowledge (when MHLs are sought out); the mean difference between cohorts was not significant ($t(15.9) = 1.86$, p > .05).

Recall from the core-periphery analysis that there is a subset of individuals who are more active than others within this network, among the network's core members there are four individuals whose indegree centrality scores are greater than one standard deviation above the mean. These people are the two MHLs (#31 and #34) and two program staff (#3 and #20) highlighted in the network sociogram at the beginning of this section. These people are 'key players' whose removal could result in greatly reduced activity in the network (Borgatti, 2003). Figure 5 illustrates what happens when the four key players and the remaining program staff (who were part of the network's core) are removed from the network. There is a greater than 50% reduction of network activity when the key players are removed as the number of ties falls from 127 to 58 ties ($D = .044$). Furthermore, when the remaining program staff (yellow triangles) are removed from the network, the level of activity drops to a mere 34 ties ($D = .026$), demonstrating that among themselves, MHLs are not often exchanging research-based knowledge with each other. Hence, there is typically a one-way flow of research knowledge in this network, most often from the CYMH program staff to the MHLs, although two MHLs also stand out as dominant sources of research knowledge.

Interview data revealed that the two MHLs identified as key sources of research knowledge have very close ties with CYMH's formal leadership. One MHL referred to herself as belonging to "Cohort 0" during her interview referring to her previous work with a program staff member in a school district that had an established culture of evidence-based decision-making. She also explained that she thought she was often sought out for information because this school district was often used an exemplar for what works and potential challenges that may occur during discussions at formal CYMH meetings. The other prominent MHL, who also worked in a school district with a strong culture of evidence use, held prior professional relationships with program staff members as well, even serving as a program staff member for a short period of time. In these ways, these two Mental Health Leaders differ substantially from their school district peers as they were tightly coupled to the formal program structure to the extent that one of these individuals has played a role in the formal leadership of the program.

In summary, CYMH members are not frequently mobilizing research knowledge outside of formally organized events as evidenced by the sparse number of network ties. In cases where research knowledge is mobilized, it tends to be a one-way relationship, with research knowledge most often flowing from a program staff member to a MHL colleague. That said, two MHLs with strong prior professional connections to the program leadership are also frequently sought out by their colleagues. In general, the network activity focuses primarily on a subset of sixteen individuals (which includes all program staff) demonstrating that some MHLs are more active in the informal network than others. Although there is some informal research exchange activity, these data suggest that the CYMH research brokering network is fragile given that activity diminishes greatly with the removal of the program staff and key players.

a. All incoming ties included (127 ties, D = .095)

b. Key players removed (58 ties, D =.044)

c. Key players and remaining program staff removed (34 ties, D = .026)

Figure 5. Patterns of interaction within the research evidence network once the 'key players' (#3, 20, 31, and 34) and program staff are removed.

Discussion

By taking a social network perspective to investigate the Child and Youth Mental Health network, I have been able to illuminate the informal patterns of interaction among the members in ways that richly describe and deepen our understanding of how this research brokering network is connecting research and practice. By mapping out the network's activity, we have learned that CYMH members were not very active in terms of exchanging research knowledge outside of the program's formal events (e.g., professional development days, webinars). Although every member of the group participates in the informal research network in some way (either seeking out or providing research knowledge), the low network density suggests that people are very rarely interacting with each other in terms of research knowledge exchange once they have returned to their daily work in the home school districts. Finding low levels of informal interaction among members of a network is not an uncommon finding in education studies that have taken a social network approach. Similar results were found in one of the only social network studies on research evidence use in education (see Finnigan et al., 2013; Finnigan, Daly, Jordan, Moolenaar & Che, 2014). There were a lack of ties within this school district-level network that was charged with mobilizing research evidence. There was also a high level of variance between the activity levels of school district superintendents who were formally charged with circulating school data and supporting school administrators with its use — results similar to in this work where some CYMH program staff were more active than others. However, CYMH differs from this other network study of evidence use in that the theory of action for the program includes formally organized events where making connections between research and practice is an explicit objective.

One of the CYMH initiative's primary goals is to build capacity for school district leaders to be able to use different forms of evidence, including research knowledge, in developing and implementing school mental health policy. By definition, this is one of the roles of knowledge brokers (see Cooper, 2014; Meyer, 2010; Ward et al., 2012). The low levels of informal activity within the CYMH research network could be explained by the fact that the program focused its attention on brokering research through various products (e.g., workshop modules, protocols, policy implementation tools) and events (e.g., professional development days, webinars) where research knowledge has been distilled and re-formulated for more practical use in school districts. Such activities are known to be effective KMb strategies (Cooper & Levin, 2010; Nutley et al., 2007; Ward et al., 2012) and contribute to participants' perceptions that the CYMH program is not only focused on assisting school districts in being evidence-based and research-informed, but it is also rooted in research itself. The importance of face-to-face interaction cannot be undervalued and is perhaps key to understanding why the informal research network is so sparse at this particular point in the evolution of this program.

Recall from figure 1 that the formal organization of the CYMH initiative is such that the program director serves as the overall coordinator for the program and the liaison between the program membership and the provincial Ministry of education. The coaches work with the director to design programming that responds to the needs of the school district MHLs, who in turn receive individual guidance and support from their assigned coach and MHL colleagues. This is the formal design of the CYMH initiative. However, in terms of the informal KMb work of the program, these findings demonstrate that the informal patterns of interaction among program staff and MHLs are not consistent with the formal organizational structure. Were the program's formal structure and the informal network structure aligned, we would expect to see a network map where the program director was situated in the middle with the five coaches branching off like spokes on a wheel, with each coach being surrounded by MHLs representing the coaches' assigned school districts.

However, this is not the case. What we do see in the network maps is that, to varying degrees, MHLs and program staff are reaching out to each other across formal roles, and that although all program staff are indeed being asked about research, there are four dominant sources of research within this group: two MHLs and two program staff members. What these data don't tell us is why this is the case.

Although there is very little research that considers the KMb processes from a social network perspective and none that considers the role of knowledge brokers in education explicitly, there is some discussion about why people tend to seek out certain people within their networks over others in the broader social network literature. Perceived expertise is an important factor when trying to understand why some individuals are more central in a network (Borgatti & Cross, 2003; Coburn & Russell, 2008). I hypothesize that interdisciplinary knowledge may help to explain some individuals were sought out more than others. The dominant sources of research knowledge in this study were experienced clinicians in the sub-specialized field of school mental health; they had spent much of their careers practicing in school district settings. These individuals not only could speak to clinical issues relating to child and youth mental health, but could also speak to educational administration issues such as dealing with superintendents and navigating school district offices as a particular type of institutional setting. This could explain why those program staff members who were coming from more of a mental health or educational administration perspective only were less often sought out within this research brokering network. Furthermore, this would suggest that interdisciplinary knowledge as it relates to the particular context in which the brokering activity is taking place may be an important consideration in future research on the role and effectiveness of knowledge brokers in mobilizing research knowledge.

Although not elaborated upon in this paper, MHLs routinely referred to the CYMH initiative as a key source (if not *the source*) of research knowledge as it related to their work of developing evidence-based school mental health strategies (see Rodway, 2015 for a complete description of qualitative findings). Thus, the modest level of informal research network activity may be explained by the fact that the majority of KMb work is being carried out through CYMH's formal programming. As stated earlier, explicit products and events connecting research and practice are recognized in the literature as important KMb strategies (Cooper & Levin, 2010). Future research should incorporate data collection from these sources as well and not strictly focus on informal patterns of activity as was the case in this study. Again, the broader social network literature in education alludes to the fact that dedicated, face-to-face time for collective sensemaking and problem-solving are important facilitators of effective professional learning (see Coburn & Russell, 2008; Penuel, Riel, Krause & Frank, 2009). Although not often framed in this way, the core of a knowledge broker's work is professional learning: by facilitating connections to relevant bodies of research knowledge and ensuring that the capacities needed to incorporate research knowledge into practice, the knowledge broker is contributing to both the professional learning of individuals and to the organizational learning of institutions. Combining future brokering studies with these theoretical perspectives in future empirical work would be beneficial.

Conclusion

Connecting research and practice, otherwise known as knowledge mobilization, is very quickly becoming a priority for research institutions and policymakers around the globe (Cooper, Levin & Campbell, 2009). Our understanding of the importance of knowledge brokers in facilitating this process increases as the knowledge mobilization literature continues to expand (Cooper, 2013, 2014; Meyer, 2010; Ward et al., 2009). Building and maintaining networks has been noted frequently

as a KMb strategy (Cooper & Levin, 2010; Nutley et al., 2007); however, what this process entails or what a network looks like remains an underdeveloped concept within this body of work. This study contributes to the KMb literature, and to the work on knowledge brokers in particular, by using social network theory and analysis to understand how the patterns of interaction within a particular initiative (i.e., a research brokering network) facilitated connections between research and practice. Although limited by its small sample size and single point in time data, this study provides important insights into the ways in which the formal and informal aspects of networks mediate knowledge mobilization activity. The importance of relationships in facilitating KMb work is not a new insight. However, investigating and understanding how research brokering networks function from a social network perspective is a new and innovative approach that should be seriously considered by scholars as the field moves forward.

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