Learning in networks: 
A systematic review of public Administration research

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Abstract
Policy networks play a decisive role in solving complex public problems by fostering individual and collective learning processes. In networks, transfers of information and deliberation can facilitate individual acquisition of information and cognitive changes. In turn, individual learning can foster the development of collective understandings of public problems and solutions, as well as joint action. Surprisingly enough, however, public administration research lacks an overview of existing studies on the influence of networks on learning processes. Building on a review of 39 public administration studies collected and analyzed with the PRISMA method, the objective of this paper is to provide such an overview.

Our statistics demonstrate that a majority of the reviewed articles are conceptual and relates to the management of natural resources. Methodologically speaking, case studies and surveys are most common within the empirical works but social network analysis becomes popular. Our findings point to two main gaps in our understanding of the causal chain between networks and learning processes. On the one hand, existing studies demonstrate that learning is influenced by factors operating at different levels, within networks. However, few studies assess the relative importance of those factors at different levels at the same time. On the other hand, existing research remains limited on the processes through which individual learning becomes collective, which we relate to weaknesses in the conceptualization and measurement of learning. All in all, this review demonstrates that network characteristics have a key role in shaping learning processes. We conclude with an agenda for future studies in public administration research on learning within networks.

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Introduction

Public policy is the result of multiple interactions between public and private actors that together form networks. Since the emergence of the concept of governance in the 1990s, the impact of those networks on policy processes and outcomes have increasingly been studied. Networked policy making helps solve complex policy problems by bringing together different expertise, experience, interests, and values. It mitigates conflict between the interests at stake and support informed choice (Weible & Sabatier, 2009). One of the major reasons why collaborative type of governance has such positive effects on policy outcomes, governance scholars argue, relates to its capacity to support learning processes (Newig et al., 2010).

Learning is essential for policy processes as it is can determine policy outputs and collective action (Leach et al., 2014). At the same time, learning is a prerequisite of organizational success and public sector innovation (Argote, 2011; Gieske et al., 2016). At the most general level, learning is understood as an update of belief (Dunlop & Radaelli, 2013). There is also some agreement that learning is a social process that entails interactions (Freeman, 2006). Learning can be defined as a process that leads to cognitive or behavioral changes through the acquisition and the interpretation of new information by experience, intentional search or interaction with others (Heikkila & Gerlak, 2013). Learning is individual when the changes only affect a single agent, being a person or an organization. It starts to be collective when the changes take place amongst a group and lead to shared understanding or collective action.

The core of networks is the set of individuals linked by some kinds of relations (Knoke, 1994). Within public administration, a first strand of research focus on policy network and more recently governance networks (Rhodes, 2006; Torfing & Sørensen, 2014). Those studies look at the interactions between actors involved in the policy process. A second strand specifically looks at relations independently of the context, or social networks (Siciliano, 2017). The nature of the relations is manifold. Common membership of an organization, involvement within the same policy process, friendship, contacts or exchanges of resources are some of the links that can exist between actors. This has been operationalized by the social network analysis method as a set of nodes, representing the actors, and ties corresponding to their relations.

The importance of learning in networks emerges when we assume that learning is the product of social interactions (Lee & Van de Meene, 2012). Networks provide a space for such interactions, facilitating both the acquisition and the interpretation of information. Learning in networks is essential to tackle complex policy issues structured around conflicting demands, such as environmental problems (Newig et al., 2010; Gerlak et al., 2017). Networks make available the different knowledge needed to cope with public problems and promote their exchange by bridging the relevant stakeholders. Hence, networks can facilitate learning amongst policy actors. Learning, in turn, can support collective action (Heikkila & Gerlak, 2013).

The aim of this article is to review existing evidence about relations between networks and learning in public administration research. Many studies point to the importance of policy networks in individual and collective learning processes. At the same time, they point to important network characteristics that impede learning processes, such as the power held by certain participants, the nature of their relation, or the structure and rules of the network. However, a synthesis of this knowledge on the role of networks in learning processes related to public policies or public organizations does not exist yet.
Given the crucial role played by learning in various administrative and policy processes, we offer such a synthesis by looking at the network characteristics and processes influencing learning and the type of learning those characteristics foster or impede. To do so, we conducted a systematic review of the literature in public administration research. This article starts with a presentation the method and scope of our literature review. The second section offers an overview of the conceptualization and operationalization of networks and learning in the literature. The third section describes the relations between networks and learning at the individual, relational and network. We conclude with an agenda for future research on this topic.

1. Method and scope of the review

Our systematic literature review follows the “Preferred Reporting Items for Systematic Reviews and Meta-Analyses” or PRISMA statement (Moher et al., 2009). Developed in the health care science (Liberati et al., 2009), it has recently started to be used in public administration research (e.g., De Vries et al., 2015; Voorberg et al., 2015). The method offers a checklist of 27 items that should be applied in order to provide transparent and replicable review results. With PRISMA, review readers are given the indications they need to assess the quality of the review.

We collected studies indexed in two subject areas of Web of Science: public administration research and environmental studies. In public administration research, the literature on network-learning relations remains scarce. However, this literature strongly pointed to the evidence reported in environmental studies about this topic. While environmental sciences are mainly grounded in natural sciences, environmental studies adopt a multidisciplinary approach, especially in order to understand how humans interact with the environment and with each other to address environmental challenges. This gave rise to a wide range of studies on environmental policies and environmental governance dealing with network and learning that proved to be very useful to our review. This literature also includes Gerlak et al. (2017)’ review on learning in environmental policy, as well as Bodin & Crona (2009)’ review on the role of social networks in environmental governance, but no systematic literature review on network-learning relations in environmental studies or in public administration research.

Our review includes all post-1970 articles proposed by Web of Science in July 2017, 25th on the basis of the following query referring to title, abstract or keywords: “learning AND ((“social network*”) OR (governance network*))”. Simpler queries have been tested, such as “Learning AND Network*”: this led to 620 articles including a disproportionate number of items that, clearly, did not relate to the network-learning relations. Within networks, learning may be influenced by social relations as well as the institutional context in which they occur: while the literature on social networks focuses on the former, the literature on network governance (or governance networks) focuses on the latter (Torfing & Sørensen, 2014).

The search results contained 403 articles, mostly from environmental studies. Two authors independently excluded irrelevant articles on the basis of their abstract according to following eligibility criteria. First, the articles had to be published in English within a peer-reviewed journal. This led to the exclusion of 43 results. Second, the abstracts had to report research relating to public administration, public organizations, or public policy. Despite our specific search query, some articles related to irrelevant topics, such as computer networks, student learning, or industrial and innovation network: we excluded them. Third, the abstracts had to make clear that relations between networks
and learning would be investigated in the article. Note that learning does not necessarily have to be the only or the main concept addressed: it can be one dimension of a broader concept or one process amongst others. The comparison of the two lists resulted in a consensus about a sample of 39 articles. We analyzed those articles with a coding grid addressing our research question: what is the individual, relational and network-level variables fostering or impeding learning within networks? After a full reading of the articles, 5 were excluded because they were irrelevant, which lead to a final sample of 34 articles.

Focusing on English journal articles can potentially lead to review biases. There is a publication bias if there is an indication that books reveal findings that differ from findings published in journals. However, books are few in number compared to peer-reviewed articles. On 403 records in the original list, only four records were book chapters compared to 360 peer-reviewed articles. Moreover, one of out those four has been published in a journal. Because the number of books considering learning in networks is limited, excluding them from the review does not lead to publication bias. Focusing on English articles facilitates the replication of the review (Wilson et al., 2003). In Web of Science, the English query only leads to four articles in Spanish. Tests conducted with the same query in French and German lead to zero records. This suggests that our review is not biased.

Records identified through Web of Knowledge searching (n=403)

Records screened on journal, abstracts and title (n=360)

Records excluded (n=43)

Records selected on screening of journals, abstracts and title (n=39)

Contributions excluded after full reading (n=5)

Records included in the review (n=34)

81% of the reviewed articles have been published in journals of environmental science. Ecology & Society is the most represented journal with 25% of the articles. In Public Administration research, articles come from major journals such as the Journal of Public Administration Research and Theory and the Policy Studies journal. 75% of the articles have been written after 2010, which indicates a
growing interest in this topic. We observe a relative diversity in the geographical origin of the studies\(^1\) even if a majority 63\% of them comes from America or Europe. American cases mostly come from the United States. European cases are mostly concentrated in Western Europe countries such as Germany, the Netherlands and Sweden. Articles looking at data from two or more countries concern regional cooperation in South Asia (Pietri et al., 2015), international transmunicipal network (Lee & Van de Meene, 2012), or compare policymaking processes across continents (Montpetit, 2009; Never, 2002).

In terms of theoretical approaches, we find an equilibrium between the agency and the structural perspective. 28\% of our sample adopt an agency-based perspective and consider the individual free will as the main driver of learning. If this approach is actor-centered, it still recognizes that individual actions and opportunities are constrained but not determined by the institutional environment (Ben & Fürst, 2002; Fischer & Leifeld, 2015). Studies emphasize individual initiatives, motivation and willingness (Dedeuwaerdere et al., 2015; Lee & Van de Meene, 2012). A structural perspective considers that institutions, pattern of relationship or structure of cooperation are the main driver of learning, even if individuals may adopt strategic behavior to gain benefit from those structures (Bodin et al., 2006; Fischer et al., 2014; Hatmaker, 2015; Henry & Vollan, 2014).

In terms of empirical settings, most of the articles look at learning in social or governance networks related to environmental issues, even within public administration research (e.g., Gerlak & Heikkila, 2011; Resh et al., 2014). 47\% of the records related to environmental resource management. The main concern of half of them is water management, including fisheries and flood management (Pietri et al., 2015; Stöhr et al., 2014; Van Herk et al., 2015). Climate change policies are the second most studied topic with 18\% of the articles (Baird et al., 2014; Boyd & Osbahr, 2010; Lee & Van de Meene, 2012). Others studied sectors include conservation, biotechnology and agricultural policies. Only three articles do not situate themselves within a specific context.

As far as data collection and analysis are concerned, 59\% of the studies build upon their own data collection, while one article uses data collected in the case of another study. Within the articles drawing on empirical findings, 55\% use a single case study. 35\% compares 2 to 4 cases. The other 10\% of the sample is built on the analysis of more than 10 cases. 38\% are conceptual articles mainly based on literature review. The proportion of quantitative, qualitative and mixed method is similar. Action-research method or embedded research is used in four articles (Baird et al., 2014; Cundill, 2010; Stöhr et al., 2015; Wyborn; 2014). 35\% of the articles explicitly explain the method they used to test the causal link between learning and network variables. Mentioned quantitative method includes statistical regression (Temby et al, 2017; Crona & Parker, 2012), hierarchical linear modeling technique (Resh et al., 2014) or Exponential Random graph analysis (Lee & Van de Meene, 2012; Siciliano, 2017). Both Pietri et al. (2015) and Van Herk et al. (2015) triangulate data gathered through different methods while Never (2012) uses process-tracing.

2. Concepts & operationalization

In this section, we look at the conceptualization and operationalization of the concepts of ‘learning’ and ‘network’ in the reviewed articles.

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\(^1\) For the conceptual articles with no geographical ground, we relied on the institutional affiliation of the first author to identify the geographical origin.
2.1. Learning

A clear definition of learning may be identified in 85% articles of the sample. Consistent with Gerlak et al. (2017), four categories of definitions may be distinguished. A first set of articles (38% of the sample) look at ‘social learning’. Those definitions particularly emphasize the role of social interactions and consider that cognitive or behavioral changes such as changes in understandings or actions must have effects on larger communities (Ensor & Harvey, 2015; Henry & Vollan, 2014; Pahl-Wostl, 2007; Pietri et al., 2015; Reed et al., 2010; Yamaki, 2016). The second category of articles (16% of the sample) look at ‘policy learning’. This literature considers changes in policy beliefs and interests as the core of learning (Benz & Fürst, 2002; Howlett et al., 2017; Montpetit, 2009; Lee & Van de Meene, 2012). Articles dealing with ‘organizational learning’ form a third, smaller category of articles (6% of the sample). Those studies focus on knowledge exchange process within organizational settings (Fischer et al., 2014; Marsden et al., 2012; Siciliano, 2017). The last category (25% of the sample) relates learning to broader definitions (Gunderson, 2006; Henry, 2009; Newig et al., 2010), other concepts such as collective learning (Gerlak & Heikkila, 2011; Heikkila & Gerlak, 2013) and definitions based on learning types, such as Baird et al. (2014)’s distinction between cognitive, normative and relational learning. Across those categories, most of the authors consider learning as a process of information acquisition that lead to changes but only a few clearly develop an integrated framework linking process to outcomes (Heikkila & Gerlak, 2013; Lee & Van de Meene, 2012). Numerous authors recognize the driving role of social interactions in the learning process as it supports knowledge exchange (Heikkila & Gerlak, 2013; Henry & Vollan, 2014; Lee & Van de Meene, 2012; Reed et al., 2010; Siciliano, 2017; Yamaki, 2016).

The changes identified as learning or products of learning processes can be differentiated according to three dimensions: the level of change, addressing the question of who’s affected by the changes, the type of change, cognitive or behavioral, and the depth of changes. Learning mostly takes place at the individual or collective levels – a distinction which is made explicit in 79% of the articles. From an individual-level perspective, changes affect uniformly an agent, being an individual or an organization taken as a unit, i.e. cities (Lee & Van de Meene, 2012). A collective-level approach is adopted by 48% of the sample. Those articles are interested in changes occurring across actors, individuals or organization, somewhat transcending individual learning (Dedeurwaerdere et al., 2015; Ensor & Harvey, 2015; Heikkila & Gerlak, 2013; Pahl-Wostl, 2009). Those perspectives are not mutually exclusive as learning can occur at both individual and collective level, but studies tend to focus on one or another perspective (Benz & Fürst, 2002; Heikkila & Gerlak, 2013). Newig et al. (2010) are a noticeable counter-example in this respect.

Learning implies cognitive or behavioral changes. Those kinds of changes are developed in 78% of the sample. Cognitive changes refer to changes occurring within mental models such as the acquisition of knowledge (Resh et al., 2014), the alteration in belief (Montpetit 2009) or, at the collective level, to the emergence of shared ideas, values or understanding across the member of a group (Heikkila & Gerlak, 2013; Levesque et al., 2017; Pietri et al., 2015; Reed et al., 2010). Behavioral changes refer to alterations in individual practices, such as the adoption of an expected behavior, the use of knowledge in decision-making (Corna & Parker, 2012; Hatmaker, 2015, Temby et al., 2015), or to changes in collective actions, i.e. the revision or the creation of a new policy (Benz & Fürst, 2002; Heikkila & Gerlak,
Most of the articles consider cognitive changes as a prerequisite for behavioral change: changes in practices result from the acquisition of knowledge (Crona & Parker, 2012; Heikkila & Gerlak, 2013; Lee & Van de Meene, 2012; Pietri et al., 2015; Siciliano, 2017).

The type of changes can also be distinguished according to their depth. 11 articles (32%) develop double or triple loop models of learning. 9 of them specifically refer to Argyris & Schön (1978) or Argyris (1977, 1982) work. Single-loop learning refers to small changes that do not call into question underlying assumptions, i.e. learning new facts or changes operational rules while double-loop learning requires changes in the underlying assumptions, for instance changes in values and the adoption of new routines (Boyd & Osbhar, 2010; Reed et al, 2010). The third loop refers either to questioning of the values and norms underlying the assumption (Cundill, 2006; Never, 2002; Pahl-Wostl, 2009) or to changes in governance structure (Never, 2002).

Even if most researchers recognize that cognitive changes are central in learning, empirical studies tend to operationalize learning as a behavior (63%). This includes the adoption of new practices (Dedeurwaerdere et al., 2015), the use of knowledge (Crona & Parker, 2012; Pietri et al., 2015; Temby et al., 2017), the search for knowledge (Howlett et al., 2017; Lee & Van de Meene, 2012; Siciliano, 2017) or, more broadly, interactions (Fisher et al., 2015). Cognitive changes are operationalized as knowledge acquisition (Resh et al., 2014; Levesque et al., 2017) or change in policy opinion (Montpetit, 2009). Moreover, collective-level learning studies are limited. Exceptions are Gerlak & Heikkila (2011) study of an Everglade restoration program, as they look at policy changes and Never (2012) study of collective change in perception and strategies reformulation in climate change policy in South Africa and India. Most of the empirical work uses quantitative methods to measure of learning (58%). Surveys are the most used tool. This includes longitudinal survey (Baird et al., 2014; Montpetit, 2009) or social network survey (Howlett et al., 2017; Lee & Van de Meene, 2012, Siciliano, 2017). The last, based on graph theory, allows visualizing the networks as a set of nodes and their ties. Each node represents the actors while the ties correspond to their relations. Some studies use both quantitative and qualitative method and complete survey data with interviews (Never, 2012; Baird et al., 2014; Pietri et al., 2015).

### 2.2. Network

There are 66% of the studies in which a clear definition of the notion of ‘network’ can be identified. A relative majority of the articles (41%) use networks to describe a real phenomenon made of a set of actors and their relations (Bodin, 2006; Gunderson, 2006; Henry, 2009; Henry & Vollan, 2014). This category includes studies of social networks, defined as the set of ties established by an individual with other (Hatmaker, 2015; Yamaki, 2015). In a second set of articles (32%), networks are defined as a mode of governance based on the integration of various stakeholders into the policy process. Those definitions consider network as a way to coordinate relationship in order to solve complex problems. In this context, networks are defined as relatively stable patterns of coordination between interdependent actors involved in a public issue (Newig et al., 2010; Stöhr et al., 2014) or weakly institutionalized patterns of cooperation (Benz & Fürst, 2002). Dedeurwaerdere et al., (2015) further precise the notion and define collaborative networks, a mode of governance characterized by regulation by informal institutions, high participation and the use of interactions as a tool for problem solving. The third category (27%) of articles includes other definitions such as policy networks (Lee &
Van de Meene, 2012; Temby et al., 2017), learning networks (Pietri et al., 2015) or shadow networks (Boyd & Osbhar, 2010; Pahl-Wostl et al., 2007).

Network studies can be divided into two categories according to how they approach networks. A wide majority of the articles (77%) study multi-stakeholder process. Most of them look at specific institutional arrangement created for information exchange across diverse actors. Co-management initiatives is the main interest of 24% of the sample. In those processes, the stakeholders affected by the changing conditions of their environment participate in the management of natural resources and exchange knowledge in order to achieve resilience, or the capacity for the community and the environment to adapt to changes (Bodin et al., 2006; Cundill, 2010; Gunderson, 2006; Pahl-Wostl, 2007; Stöhr et al., 2014; Van Herk et al., 2015). Policy forums are studied in 33% of the articles. Defined by Fisher & Leifeld (2015) as stable and neutral arrangements that have clear organizational boundaries, represent many interests and are characterized by regular interaction, they include collaborative arrangements and bridging or boundary organizations. The first bring diverse actors around the table and facilitate the exchange of information in order to coordinate services delivery, solve shared problems or give advice (Gerlak & Heikkila, 2011; Resh et al., 2014; Temby et al., 2017). The second is defined as formal and neutral institutions composed of representatives of different social groups created to facilitate knowledge exchange and co-production, mediate between the different interest and values and resolve shared problems (Crona & Parker, 2012; Deurwaerdere et al., 2015). Other types of multi-stakeholder process includes policy subsystem (Howlett et al., 2017, Montpetit, 2009), polycentric arrangements (Wyborn, 2014) and communities of practice (Never, 2012). The second set of articles adopt a more narrow approach and study the structure of relationships as such. Henry & Vollan (2014) analyses the social network structure. Fisher et al. (2014) are interested in the structure of interaction and the communication pattern. It also includes studies on interpersonal advice seeking and knowledge-sharing relations (Siciliano, 2017) or socialization (Hatmaker, 2015). The two approaches of networks are not mutually exclusive, as studies of multistakeholder processes are often interested in the interaction pattern.

Network foster learning as they provide support to the acquisition and the transfer of information. Relations and more precisely interactions, which are at the core of networks, are a privileged channel through which information flows between actors. Interactions allow individuals to collect, interpret and therefore acquire knowledge at lower transaction costs (Heikkila & Gerlak 2013; Henry & Vollan, 2014; Newig et al., 2010; Siciliano, 2017). Moreover, network drive the formation of certain form of interaction, referred as social processes that can further foster learning. For Henry & Vollan (2014), a major process is social influence. In this case, cognitive and behavioral changes depend upon other’s thought and behaviors. Those so-called “peer effect” emerge because of psychological elements, i.e. conformity and social status or the exchange of information. However, for most of the article reviewed, deliberation is the main driver of learning (Dedeurwaerdere et al., 2015; Fisher & Leifeld, 2015). The exchange of argument and point of view is expected to foster individuals and collective production of creative ideas and solutions (Newig & al., 2010; Pietri et al., 2015; Reed, 2010). The argument is built on Habermas (1981) idea of “communicative action”. Through deliberative process, individuals build upon each other argument and find out alternative meaning or new approaches toward existing information (Heikkila & Gerlak, 2013). It is a way through which change in opinion can occur (Montpetit, 2009) and it facilitates the generation of shared understanding and collective action (Heikkila & Gerlak, 2013). If all networks are made of relations and therefore creates opportunities for information exchange, they do not per se positively affects learning. Indeed, network’s capacity to
foster learning depends on characteristics that can be founded at the individual, relational and whole network level.

3. Public administration research on learning in networks

This section offers an overview of the characteristics and processes fostering or impeding learning within networks, based on evidence existing in public administration research. We look at individual-level characteristics before turning to relational characteristics and network-level characteristics, including institutional settings of networks. This division is purely analytical as the effect of those characteristics on learning is mutually dependent.

3.1. Individual characteristics fostering or impeding learning in networks

Individuals are at the core of learning as they are the agents that ultimately collect, interpret and diffuse the information. 69% of the articles look at individual characteristics that influence learning. To simplify the analysis, we differentiate between structural position, individual behavior and intrinsic attributes.

The structural position or the individual’s localization within a network is central for learning. In a networked context, holding a central position gives the power of control over the flow of information. Not only this can determine learning opportunities of the actor in such position, by improving its access to information, but it can influence learning across the network as central actors may foster information transmission (Henry & Vollan, 2014; Pietri et al., 2015). 45% of our sample looks at the influence of such central positions on learning. Two conceptualizations of the actor’s centrality emerge from our review that differs according to whom an actor shares relationships. The most intuitive conceptualization of centrality is based on the actor’s level of activity within the network: are central actors who have the highest number of relationships, holding therefore a power of direct influence (Resh et al., 2014). The second way to look at centrality is by considering central actors as brokers that connect actors otherwise disconnected (Bodin et al., 2006; Pietri et al., 2015). A broker can be a boundary spanner if his relations cross boundaries such as organizations, hierarchies or jurisdiction (Resh et al., 2014) or a policy broker if he mediates between diverse advocacy coalitions (Howlett et al., 2017). Five types of policy brokers can be distinguished from each other according to the groups he connects: the liaison, the mediator, the consultant, the representative and the coordinator (Howlett et al., 2017; Pietri et al., 2015). In this position, power derives from the actor capacity to control information transmission across groups, as he plays the intermediary between two actors (Resh et al., 2014). As the broker has access to various types of information, he can gain new knowledge and creates new understanding. In other words, the broker would learn more than other network members (Bodin et al, 2006). At the collective level, the broker can promote shared understanding and collective action in a fragmented context by bridging actors across groups, facilitating interaction, information dissemination (Fisher & Leifeld, 2015; Heikkila & Gerlak, 2013; Henry & Vollan, 2014; Newig et al., 2010).

The influence of centrality on learning varies according to those conceptualizations and their operationalization, which results in contrasting empirical results. The impact of centrality grasped as the number of relationships at the individual level is mixed. Resh et al. (2014) in their study on
government centrality in US aquaculture partnership did not find a relation between either a high number of relations or the fact of being the intermediary between a high number of actors, measured as a betweenness degree, and the acquisition of a better understanding of aquaculture topic. Central actors, being a broker or not, acquire less knowledge than the other members of the network. The result is, however, not surprising as educated people are most likely to be central. Crona & Parker (2012) study of a research unit bringing policy makers and scientist together to advance knowledge on water governance offers similar result regarding the broker as they do not find a relationship between knowledge utilization, a behavioral measure of learning, and the individual broker position. However, they found that policy makers with the highest number of contacts with academics and other policy makers are more likely to use the knowledge they gathered within the network to inform their own work. In other words, central individuals are found to learn more than their counterparts. Regarding the impact of central actors on others’ opinion change or acquisition of knowledge, results depend on the author’s conceptualization. Pietri et al. (2015) in their study of the Coral Triangle Initiative, a topical regional exchange on marine resources management, found that broker served as coordinator that could promote reflection and opinion changes by connecting individuals with different knowledge and views. On the contrary, Resh & al. (2014) do not find a relation between the presence of a broker and a general increase understanding of aquaculture topics across the collaborative partnership. However, when centrality is conceptualized by the number of relationships, the presence of a central actor is positively related to the acquisition of a better understanding of the other members. In other words, actors who are actively involved in the collaboration seem to promote learning across the participants.

Whether it is the number of relationships or a brokerage position that influence the most learning remains an unsolved question. However, studies agree on the fact that central actor, broker or not, play a major role on information transmission and promote all types of learning across the network.

Structural position is not the only one individual dimension grasped in the literature. A set of behaviors, i.e. the tasks an individual performs, shall be adopted in order to support information exchange and the transmission of information across the network. Those behaviors are analyzed in 63% of the articles and are mainly related to the leadership style. As Pietri & al (2015) find out, without a leading person or organization responsible for network activities participants won’t engage. The leader shall bring people together and act as a facilitator, supporting the exchange of resources, communication and risk-taking actions of network participants (Fisher & Leifeld, 2015; Lee & Van de Meene, 2012). The leader shall maintain trust, give a vision and initiate the information-seeking process. He shall manage and synthesize the knowledge exchanged, work on the integration of understandings and finally support the collective findings (Boyd & Osbahr, 2010; Gunderson, 2006; Pahl-Wostl et al., 2007). The leader shall be a trusted person that does not follow its own interest and mediate conflicts (Cundill, 2010). He shall be engaged in boundary-spanning activities, creating links between actors and organizations and coordinate the actions (Gunderson, 2006; Pietri et al., 2015; Resh et al., 2014). As Stöhr & al. (2014) observe in their analysis and evaluation of two participatory fisheries management cases, the presence of a facilitator that brings together the view of the participants is needed to achieve actions. Gerlak & Heikkila (2011) in their study of the program Acceler8, created to foster the restoration of the Everglade, found that leaders, by engaging the right participants and easing concerns, supported the dissemination of information across the network and in the creation of trust needed to adopt Acceler8 program. Shared understanding and collective action is therefore dependent upon the presence of a committed leader that facilitates the emergence of new ideas (Heikkila & Gerlak, 2013). The distinction with structural position relies on the fact that here, it is certain behavior
that leads to learning, not a certain position. Someone may act as a facilitator without being in a central position. However, both often come together as acquiring a central position pass through the adoption of certain behaviors, which is why leaders hold often central position (Pietri et al., 2015, Resh et al., 2014). As Fischer & Leifeld (2015) note, leadership depends on different resources such as individual skills, formal authority or relational assets.

A final more heterogenous set of traits or intrinsic attributes influencing network learning has also been investigated by existing studies. Actors shall be willing to listen to alternative viewpoints, take part in the exchange of information process and therefore learn (Cundill, 2010; Heikkila & Gerlak, 2013). They need a minimum set of skills (Ensor & Harvey, 2015) and shall actively seek out information. According Hatmaker (2015)’s theoretical framework over socialization process within public administration, individual pro-activity depends upon the social cost related to admitting a lack of knowledge. He also suggests that in this context, individual motivated by public service values are more inclined to acquire new information and therefore learn the skills, values and expected behavior needed to become an organizational member. Lee & Van De Meene (2012), in their study of a transmunicipal learning network on climate change, found out that the likelihood of a member to seek out information from another member depend upon its awareness of the other knowledge. Benz & Fürst (2002), in their study of favorable conditions for policy learning within a region, hypothesis that actors should share both a competitive and cooperative orientation to promote change in participants’ action and collective action within a region. Because it’s an important resource in political game, competition stimulates the information searching process. However, in could be detrimental for the acquisition of knowledge, as competitive actors tend to keep the information for themselves. Those authors also suggest that individual perception of the situation and of the feasible solutions influences the readiness to accept new ideas. A last studied characteristic is the actor perception of the process. Resh & al. (2014) find that a positive perception of the fairness of the process is positively related to a general increase in the understanding amongst participants of aquaculture policy and related topics. Montpetit (2009), in its comparative study of learning propensity between actors involved in the bio-industry policy in the European Union and in America, find that the perception of a legitimacy deficit in the institution foster individual changes in opinion regarding bio-industry because it encourages policy actors to search for inspiration in foreign experience.

Individual characteristics, being structural position, behavior or intrinsic attributes, appear to be crucial for learning processes and mutually reinforcing each other. The positive influence of a central actor on other’s learning depends on it adopted behavior and the intrinsic attributes of others’ member of the network. For instance, an actor in a brokerage position may positively influence learning only if he adopts certain behavior, i.e. take the initiative or act as a facilitator and if others are willing to learn or perceive the process as fair. The presence of all those individual’s characteristics is needed for a network to promote learning.

3.2. Relational characteristics fostering or impeding learning in networks

As mentioned above, network impact on learning is related to the structure of social interaction, which in essence implies relationship. Looking at relations means being interested in the characteristics that support the exchange of information between two individuals. 88% of the reviewed articles deal with this topic. The questions addressed are with whom do people interact and share information with,
what kind of relation support interaction and how strong relations and interactions should be to promote the exchange of information.

According to the human communication theory of Rogers (1995), individuals are most likely to interact and with people looking alike (Henry & Vollan, 2014; Newig et al., 2010; Pietri et al. 2015). Therefore, the exchange of information depends on the extent to which two network participants share similar attributes, defined as homophily or bonding ties (Newig et al., 2010; Fischer et al., 2014). Interaction with similar people takes less effort. It facilitates communication and knowledge exchange as information are quicker and foster the creation of common norms, the development of trust and mutual understanding (Fisher et al., 2014; Newig et al., 2010; Siciliano, 2017). On the contrary, actors that are too different from each other, i.e. cultural difference or difference in the framing of an issue can create miscommunication and conflict (Crona & Parker, 2012; Pahl-Wostl et al., 2007).

61% of the articles looking at relational variables identify common characteristics that should drive the information exchange process, from group membership to shared policy beliefs or values. For Heikkila & Gerlak (2013), actors with less differentiation in roles and positions may share a common way of knowing, translating the ideas in the same way and therefore fostering the dissemination of information within the network. They also identified in their study of the Florida Everglades restoration program, a network managing and restoring the Everglades that divergent political position and conflicting agenda as an obstacle to exchange of information (Gerlak & Heikkila, 2011). In their study of a transmunicipal learning network on climate change, Lee & Van de Meene (2012) conceptualize homophily as geographical proximity and language. Only language appears to positively affect learning, as cities sharing a language are more likely to learn best practice from each other. Some authors look at peer relations. For Hatmaker (2015), they could contribute to the acquisition of knowledge as peer share a similar experience. Crona & Parker (2012), in their study on a bridging organization, validate the hypothesis as they observe that peer-to-peer interactions foster knowledge utilization. Siciliano (2017) found similar result in his study of the knowledge-sharing network of teachers from Midwestern public school: knowledge exchange is more likely to occur between individuals sharing a similar formal position within an organization. At the collective level, Montpetit (2009) finds that consensus occurs amongst participants that belong to the same actor category, being industry, government or advocacy. Homophily positive influence on learning is, however, not as straightforward. First, not all common attributes fosters the acquisition of knowledge. Following the Advocacy Coalition Framework theory, Resh et al. (2014) suggest that individuals with shared policy beliefs are more likely to interact and to acquire new knowledge from each other. However, they found no statistical relationship between belief homophily and the acquisition of a better understanding of aquaculture topics. Second, sharing similar attributes can be detrimental for the generation of new knowledge and the emergence of new ideas. Homophilious people tend to reject other perspective and to form close groups reluctant to outsider information (Henry, 2009; Newig et al., 2010). It is the existence of relationships between actors with different knowledge and world perception, also defined as heterophily or bridging ties that allows for the generation of knowledge build upon diverse perspective as they give access to external sources of information and knowledge (Henry & Vollan, 2014; Fisher & al., 2014; Gerlak & Heikkila, 2011; Pietri et al., 2015). Those divergent reflection and results do not suggest that homophily is a barrier to learning. It highlights the fact that certain similarities enhance information transmission and the acquisition of knowledge while others impede the generation of new knowledge and the emergence of news ideas. Individuals should therefore be similar up to a certain extent, in order to avoid group closure and the denial of external information.
As we argue earlier, relations and interactions play a major role in learning. It is through communication that individuals can access and share knowledge, increasing therefore their opportunities to acquire new information and to create common interpretation (Heikkila & Gerlak, 2013; Pietri & al., 2015). To support interactions and exchange of information, relations shall be characterized by trust (Henry & Vollan, 2014; Fisher et al., 2014; Stöhr et al., 2014). 61% of our sample highlight the importance of trust for interaction and exchange of information. Trust implies an agreement to be vulnerable to the actions of a trustee, assuming that the trustor will not behave at his expense (Resh et al., 2014). It reduces the cost related to collaboration (Temby et al., 2017; Wyborn, 2014), facilitates both information acquisition and dissemination and is therefore essential to develop shared idea and collective action (Gerlak & Heikkila, 2011; Heikkila & Gerlak, 2013). Trust is self-reinforcing as successful trust-based interaction support further interactions, enabling more learning opportunities (Henry & Vollan, 2014). Wyborn (2014) recognizes this as an element of the “virtuous cycle between communication, trust, commitment, understanding and outcomes”. Network characterized by trust are more efficient in achieving joint goal and in creating solutions to complex problems (Gunderson, 2006; Henry & Vollan, 2014). Some ambiguities remain regarding the link between trust and cognitive blocking toward new information, as trust may conduce to homophil in worldview. There is also no evidence that trust should be present at the beginning of the learning process or can be built over time (Ensor & Harvey, 2015; Pietri et al., 2015). However, the limited number of empirical findings tend to confirm the positive effect of trust. Resh et al. (2014) found that people trusting most of the participants in the network state higher learning outcomes in terms of better understanding. Marsden et al. (2012) results on policy transfer in the field of urban transport and planning across cities suggest that it is through trusted contact that cities search for relevant lessons. Temby et al. (2017) in their study of climate change governance in New York City found that fair play trust and more strongly relational comfort trust is an important predictor of the use of information in decision-making transmitted through informal communication channel. Relational comfort trust is understood as mutual understanding emerging from long-term working relationship while fair-play trust reflects relationship expectations i.e. fairness of the collaborators in dealing with the topic. Relational Comfort trust also predicts impact of formal channels on decision-making. If theoretically, the impact of trust is ambiguous, the few empirical works on trust suggests that trust has a positive impact on learning.

How strong relations and interactions should be to promote exchange of information is the last question addressed by the literature. The impact of the strength or intensity of the relations and interaction on learning is approached in 57% of our sample. Two articles explore relations strength as a whole. They differentiate between weak and strong ties according “the amount of time, the emotional intensity, the intimacy and the reciprocal services characterizing the tie” (Newig et al, 2010). Strength of tie effect on learning is quite similar than those arising from homophily. Strong ties, such as friendship, support deliberative processes and therefore enhance the creation of shared understanding and limit the level of conflict, as actors are more inclined to trust information coming from strong relationship (Benz & Fürst, 2002; Newig et al., 2010). However, strong ties may lead to groupthink, a closed common view of an issue and reticence to accept new information within a group which is detrimental for individuals’ changes in values or opinion (Newig et al., 2010). By contrast, weak ties are flexible, less redundant, provide access to more diverse information and support risky actions which drive collective changes (Benz & Fürst, 2002; Newig et al., 2010). Because homophily and strength of tie have similar effects, some authors associate strong ties with relation within a group
whose members are defined according to certain similar attributes, and weak ties to cross-boundary relations between members of different groups (Benz & Fürst, 2002; Gerlak & Heikkila, 2011). If relation strength influence on learning is somewhat mixed, results are clearer when looking more precisely at interaction intensity. A first set of articles considers that frequent and regular interaction foster opinion or behavioral changes. Hatmaker (2015) suggests that newcomers learn how to adapt to an organization through frequent interactions with experienced co-worker and manager, as it gives access to information and feedback on practices. In their study of a flood program in the Netherlands, Van Herk & al. (2015) found that the interactions within working groups lead to an increase in understanding of mutual interest and supported discussions on integrated solution. Crona & Parker (2012) reach a similar conclusion as the interest between the different participants in water management has converged thanks to regular interactions. At the behavioral level, Dedeurwaerdere et al. (2014) observe in their study the implementation of agri-environmental measures in the context of the EU common agricultural policy in the Walloon Region, Belgium, a significant correlation between farmer’s adoption of medium and deep agri-environmental measures and regular interactions with environmental network organizations. Similarly, Temby et al. (2017) found that the impact of information on decision-making depends on the frequency of both formal and informal communication. A second set highlight face-to-face interactions as the most efficient channel for information exchange. Gerlak & Heikkila (2011) found in their study of the Florida Everglades restoration program, a network managing and restoring the Everglades, that face-to-face communication is a key tool for information sharing and a key information source. Boyd & Osbahr (2010) find similar result in their research on learning mechanism within international development and aid organization in the United Kingdom: people prefer face-to-face interaction for exchanging information. If the influence of strength of tie is somewhat mixed, maybe because the concept is mixed with homophily, the frequency of interactions and the use of face-to-face communication seems major factors fostering exchange of information and cognitive and behavioral changes.

Relations and interactions are at the core of learning. Those should be characterized by a certain degree of homophily, trust and strength to ensure the acquisition of knowledge, its generation, shared understanding and collective action. For all those elements, the remaining ambiguities rely on the question of how similar individuals should be to foster learning.

### 3.3. Network characteristics fostering or impeding learning in networks

The set of relations that form the network is characterized by a structure with specific properties that affect knowledge exchange across the network and the emergence of individual and collective changes. Key elements are the institutional context or institutional characteristics, the composition of the network, which addresses the question of who and how many participants shall be involved in a network and the network structure understood as the pattern of relationship. Network level characteristics are the most studied in our review as 88% of the articles address at least one of those elements.

The institutional context surrounding networks is a key element for the success of the knowledge exchange and the emergence of changes. This element is developed in 61% of our sample. The main large-scale debate relates to a second debate present in the literature regarding the impact of formal and informal institutions on the knowledge exchange and the emergence of new ideas in a network.
Formal institutions are defined as codified rules while informality refers to socially shared rules, i.e. social norms (Pahl-Wostl, 2009). Informal institutions characterized by open membership, flexibility in role, negotiable rules and absence of formal control enhance individual access to new knowledge and interpretation as well as support the integration of new insight (Dedeurwaerdere et al., 2015; Gunderson, 2006; Pahl-Wostl et al., 2007; Pahl-Wostl, 2009). Gunderson (2006) observe in his study of three water-based ecological systems that informal and flexible institutions have a greater capacity to learn than formal arrangements because they support risky action and tolerate failure. Network that are not bounded by formal rules support creativity as individuals may be less attached to a specific position (Pahl-Wostl et al., 2007). However, network characterized by a lack of institutionalization are vulnerable to changes and can lead to a lack of accountability, arbitrariness, and tacit power relationships (Pahl-Wostl et al., 2007). Wyborn (2014), in her study of a conservation arrangement in Australia, found that the lack of formal links and coordination mechanism undermine the exchange of information process and the decision-making. A balance between formal and informal institutions has to be found.

A second more specific debate present in the literature concerns the decision-making rules and the potential advantage of consensus-based decision for learning. We address here consensus as a decision mode of decision and not as a form of learning. A consensus is a decision based on the interest of the whole, supported by every member of the network and is ideally adopted without majority vote rules. Following Montpetit (2009), consensus building depends on actors’ willingness to listen to others’ arguments and their openness to change of opinion. This decision-making system may create incentives to share information, promoting the acquisition of knowledge and changes in opinion (Montpetit, 2009; Resh et al., 2014). It can prevent the cooptation of the decision by powerful individuals (Fisher & Leifeld, 2015). The positive effect of consensus building is, however, not straightforward. When conflicts and extreme positions characterize a network, the search for consensus can hinder successful information exchange and decision-making (Fisher & Leifeld, 2015). For Ensor & Harvey (2015), consensus building can lead to a biased decision toward more powerful actor. Finally, in their empirical work, Resh et al. (2014) found that groups using formal vote procedures instead of consensus are more likely to report higher acquisition of knowledge but as they note, votes may occur only once an agreement is already informally reached. Positive effect of consensus seems to depend on other networks' characteristic such as conflict or power imbalance.

Finally, more precise element of institutional features are mentioned in the literature. Incentive and reward for members that collaborate and share knowledge may increase the level of interaction and therefore learning opportunities (Cundill, 2010; Hatmaker, 2015). In her monitoring of collaborative co-management process in South Africa, Cundill (2010) observes the negative effect of regular elections of network member and manager on learning interaction as a certain continuity in membership should be maintained to avoid the loss of knowledge. Fisher et al. (2015) reviewed a wide range of network characteristic that could affect collaboration and learning processes. Transparence ensure the quality of deliberation but may impede policy learning of politicians. Elector might penalize them if they change their view during the debate. Non-binding decision in a network may ensure large participation as actors face fewer risks if they do not support the final decision but it can lead to demotivation and disinvestment, which impede the knowledge exchange process. Finally, long-term processes develop relationship and trust while exclusivity regarding the problem at stake is a success factor of collaborative networks. The wide diversity of institutional elements studied and the
ambiguities concerning institutional formality and decision-making rules do not allow us to conclude on their general impact on learning.

The question of who shall be included in the network is of major importance in the literature as it determines the knowledge that will be available within the network, independently of the level of exchange. Influence of network composition on learning processes is discussed in 43% of our sample and include size and diversity. While size refers to the number of individuals involved in a network, diversity refers to how different they should be. Large networks give access to more knowledge (Newig et al., 2010). However, very large networks increase transaction costs of information sharing, limit face-to-face interaction, are less suited for deliberation and have difficulties to take position on a specific issue (Newig et al., 2010; Fisher & Leifeld, 2015). Never’s (2012) in her comparative study on the nature and scope in the domestic climate governance of India and South Africa observes that the limited number of actors involved in the South African climate governance seems to have conducted to the establishment of a community of practice and the production policy changes.

A diverse network, in turns, gives access to different knowledge and interest that can serve for the “right decision” or innovative solution (Ben & Fürst, 2002; Dedeurwaerdere et al., 2015; Fisher & Leifeld, 2015; Newig et al., 2010; Pahl-Wostl, 2009). Including all the relevant stakeholders, such as citizen organization can facilitate the exchange of information process and reduce conflict between different interests (Yamaki, 2016). For Cundill (2010), the fact that all the interests are present within a network is a criterion for the evaluation of social learning. Diversity determines the probability of homophilious ties. A diverse network limits network polarization into sub-groups of people with similar interest that may exacerbate conflict and inhibit knowledge exchange (Henry & Vollan, 2014). However, this can create miscommunication, conflict and therefore be detrimental to knowledge exchange and the achievement of consensus (Fisher & Leifeld, 2015; Henry & Vollan, 2014; Pahl-Wostl, 2009). The results of Wyborn (2014) in her study of a connectivity conservation initiative in Australia confirms this problem as she finds out that the diversity of participants and perspectives present in the network negatively impact coordination and therefore collective action.

It seems from those elements that a relatively small but diverse network is the most conductive environment for learning as diversity ensure knowledge availability while limited number of participant ease information sharing. However, other factors such as the goal of the network have to be taken into account to reach the ideal ratio between size and diversity (Fisher & Leifeld, 2015).

Network structure includes the way responsibilities and task are organized within a network and the overall pattern of relationship between the actors involved (Heikkila & Gerlak, 2013; Henry, 2009; Van Herk et al., 2015). The organization of tasks and relations, mainly grasped by the concept of centralization and density, are assumed to influence learning for 50% of our sample. Density relates to the number of relations existing in a network (Newig et al., 2010). Density facilitates access to information and supports deliberation, as participants tend to know better each other’s (Henry & Vollan, 2014; Newig et al., 2010). However, it has a negative impact on the quality of the information as they are easily distorted when transmitted by numerous individuals (Newig et al., 2010). Dense networks can lead to knowledge homogenization (Henry & Vollan, 2014; Newig et al., 2010) while low density allows new ideas to enter the network (Pietri et al., 2015). According to Henry & Vollan (2014), network density effects on learning adopt an inverted U shape: an increase in the density is positively related to learning until a certain point where it becomes detrimental.
Centralization is the extent to which a few individuals that hold the decision-making power or a central position within the network dominate the network. On the one hand, highly centralized networks have a positive effect on information sharing as they accelerate the diffusion process and the adoption of shared understanding of collective action (Bodin et al., 2006; Newig et al., 2010; Pietri et al., 2015). It supports consensus on goals and values (Newig et al., 2010). This may be due to lower cost of decision-making or because only a few individuals are necessary to spread information across the whole network (Heikkila & Gerlak, 2013). On the other hand, centralization can isolate network members from each other and reduce their opportunities to access to diverse sources of knowledge (Bodin et al., 2006; Heikkila & Gerlak, 2013). Characterized by imbalances of power, centralized structure is detrimental for deliberation, limiting the possibilities of debate and are less resilient to change (Newig et al., 2010; Pietri et al., 2015). For Gerlak & Heikkila (2011), a decentralized and open structure including some actors highly connected is the most appropriate network structure for learning. However, Resh et al. (2014)' results confirm the positive influence of network centralization as they found a positive relation with the acquisition of knowledge in their research on government centrality in aquaculture partnerships. What seems to lead to those confusing results is the use of diverse conceptualization of centralization. Moreover, as centralization depends on the presence of central individuals, effects of centralization cannot be clear without studying the behavior of those powerful actors.

Network level variables are the most studied in the literature. However, theoretical reflection and empirical results are not sufficient to assess their impact on learning. This may be due to the variety of variables studied, the often blurred conceptualization and the lack of empirical work looking specifically at those variables.

4. Conclusion and agenda for future research

Social and governance networks are recognized as a key driver of learning as they support knowledge exchange amongst individuals. Understanding learning in networks would provide useful insight on how to manage public administration and policy processes so as they facilitate learning, and, thereby, support public sector innovation and the creation of better policies (Sørensen & Torfing, 2016; Leach et al., 2014). However, existing studies do not provide a comprehensive overview of the conditions that should be met for a network to promote effective information exchange and the emergence of changes. There is a gap in our understanding of the conditions under which network foster learning. We have fulfilled this gap by looking at the individual, relational and network characteristics fostering or impeding learning within networks, on the basis of a systematic literature review of public administration research. Our review highlights the importance of social interactions for the acquisition of knowledge and its translation in new understanding and behavior at both the individual and the collective level. Our results suggest several avenues for future research about the role of social and governance networks in learning processes.

First, there is still a lack of consistency in the conceptualization and the operationalization of learning, which hinders the identification of the relevant variables and the causal relationships. If conceptually, learning do often refer to a process of information exchange that leads to changes, articles tend to operationalize one or another. The link between interactions and changes remain therefore misunderstood. The same observation apply for the link between cognitive changes and action. As
most of the articles operationalize learning as a behavior, we cannot affirm that cognitive changes are a prerequisite. Finally, the lack of empirical studies that assess both individual and collective level learning complicated our understanding on how collective level changes, such as shared understanding and collective action, arise from individual changes. Heikkila & Gerlak (2013) have already raised this concern but until now, no article fully explores the mechanisms through which individual learning gives rise to collective learning. Without a clear comprehensive operationalization of learning, the influence of networks will remain difficult to assess and our understanding limited.

Second, so as learning, some network variables remain vaguely conceptualized and operationalized, which further complicated the identification of clear causal relationship. This is particularly true with whole network characteristics. If they are the most cited in the literature, their impact on learning remain a mystery. This is partially due because of unclear operationalization, i.e. what are the formal or informal institutions and the variety of rules and norms that could affect exchange of information and the emergence of changes. One solution could be to operationalize institutional conditions as network management rules or metagovernance strategies (Klijn et al., 2010; Sørensen & Torfing, 2009). Fischer & Schläpfer (2017) in their study of metagovernance and policy forum output in Swiss environmental politics found interesting results about which combination of rule leads to the production of joint position paper. A similar approach could be used to study learning in networks. Homophily is another variable whose effect on learning widely depends on the attributes chosen to operationalize it. Empirical studies show that the effect of common language, similar formal position within an organization or common belief on learning is quite different (Lee & Van de Meene, 2012; Resh et al., 2014, Siciliano, 2017). To remove some ambiguities related to how homophily affects learning, future studies could assess the influence of different types of attributes on different dimension on learning, i.e. the acquisition of knowledge, change in opinion or the adoption of certain behavior. All in all, this will help to clarify causal relationships as variables effect rely heavily on the operationalization used.

Third, the mutual effect of network's variables on each other must be considered to fully grasp their impact on the exchange of information process and the emergence of changes. Considering each variable independently from each other both within and across the individual, relational and whole network level's categories is useful from an analytical perspective but cross-variable analysis could resolve some ambiguities as the variables often depend on each other. For instance, the effect of similar attributes on learning goes beyond the study of homophily as it also influences trust building, the strength of ties and other level variables such as density. Together with conceptual clarity, cross-variable analysis could help us to understand the impact of homophily on learning. Does it follow an inverted U shape, meaning that sharing similar attributes is beneficial for learning upon a certain point where an increase in similarity becomes detrimental, or does the presence of certain variables overcome the benefice of homophily, i.e. does trust helps to overcome misunderstandings problems between heterophilious individuals. The study of mutual effect would also be useful to grasp the effect of central individuals and centralization on learning. Central individuals are defined according the position they hold within a network. However, their positive influence on the exchange of information process and the emergence of changes probably also depends on the behavior they adopt, such as acting as a facilitator. Studies on network centralization would also gain looking at who are the central individuals and how they behave to understand how centralization influence the diffusion of information across the network. Moreover, it is only through cross-variables research that we could
gain insight on which are the necessary and sufficient conditions for learning to occur, if we assume such rules exist.

Fourth, there is a need for empirical articles that rely on strong methods for data collection and analysis. A first suggestion is to try using longitudinal data. Not only is one of the strongest methods to assess knowledge acquisition and opinion changes (Gerlak & Heikkila, 2014), but they can be useful to clarify some causal link. For instance, homophily can lead to the creation of strong ties, i.e. frequent, intimate and reciprocal relations. At the same time, strong ties support homophily as people frequently interacting with each other may develop a common worldview (Newig et al, 2010). Another question remain regarding trust. Does trust need to be present before the starting of network’s activities for interaction to occur or can trust be built in the course of time? If probably effects are mutually enforcing, i.e. homophily support frequent interaction that in turns further creates homophily, longitudinal data could provide useful insight on those processes. A second suggestion would be to specify the method used to analyze the data and to discover the causal relationship. Indeed, for the existence of a causal relationship and its direction to be proved, the analysis method, being qualitative or quantitative, shall at least be clearly stated.

In the current policy context where wicked problems become the norm and can only be solved through collective action, there is an increasing need for knowledge exchange and learning across individuals within public administration or policy processes. Networks support this process by facilitating information transmission and interpretation. Studying the characteristic that affects learning in networks could bring relevant insight on how to promote learning processes.

5. References


