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Too much of a good thing? A systematic review about the conditions of learning in governance networks

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Abstract

Learning is decisive for successful problem solving in governance networks: it is by acquiring, interpreting and diffusing information that public and private actors build joint action and innovative policy solutions. Yet, little is known about the conditions that lead to learning in such context. Following the PRISMA approach, we systematically reviewed 40 public administration studies that provide evidence about the individual, interpersonal and structural conditions of learning in governance networks. We find that learning is conditioned to a balanced configuration of these characteristics, where too much of a single condition may be harmful. Still, some mixes of conditions appear more effective than others, especially the joint presence of trust between and diversity of participants, a skillful leader centrally positioned, and an appropriate blend of formal and informal institutional rules. We conclude with several avenues for future research.

Keywords

Governance networks; Learning; Social networks; Trust; Leadership

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Too much of a good thing? A systematic review about the conditions of learning in governance networks

Introduction

Nowadays, the formulation of most policy solutions does not only require technical and legal skills of civil servants, but also expert knowledge from academic and corporate actors, as well as political will and citizen participation. Similarly, the implementation of many public services depends on interactions between public and private actors from multiple organizations (Osborne 2006). Solving complex public problems such as “wicked problems” requires governance networks which refer to a group of actors from multiple public and/or private organizations who interact within a relatively institutionalized context at the local, national or international level. Those networks allow the achievement of objectives that one individual or one organization could not achieve alone (Torfing and Sørensen 2014). In governance networks, actors share their expertise, interests, and values. In doing so, they develop a common understanding of problems and generate new knowledge that supports alternative policy choices and joint action (Emerson et al. 2012). In other words, the success of governance networks depends on individual and collective learning (Newig et al. 2010). Yet, evidence about the conditions that facilitate learning in governance networks remains scattered. Based on a systematic review of the literature about network-learning relations, this article synthesizes existing knowledge, provides insights on how to support learning in governance networks, and suggests several avenues for future research.

Consistent with mainstream research in policy science, learning may be defined as any individual or collective update of beliefs that can result in behavioral adaptations (Dunlop and Radaelli 2013; Heikkilä and Gerlak 2013 Moyson et al. 2017). Scientific concerns for the role of learning in addressing societal uncertainty and in developing governmental capacity date back to the

1960s and 1970s (e.g., Heclo 1974). In public policy research, three main sets of approaches to learning may be distinguished (Moyson and Scholten 2018). First, the “managerialist” approaches are based on the articulation between organizational sciences and political science to examine the development of the intelligence, sophistication, and effectiveness of the government. Second, the “diffusion and convergence” approaches look at the processes through which decisions made in some institutional settings result from decisions made in other settings. Learning is a key causal mechanism considered by managerialist studies as well as by convergence and diffusion studies to explain the development of governments as well as policy transfers. Third, the “social learning” approaches are concerned with the management of uncertainty and the puzzling of ideas by decision-makers, with a focus on “policy learning” by central decision-makers or a broader consideration for “social learning” in larger communities of public and private actors (Gerlak et al. 2017). All three sets of approaches share the idea that learning influences policy outputs and outcomes without, however, any normative assumption about such influence. Learning, on the one hand, is a mechanism of knowledge acquisition and belief change through which public managers and policy actors can sophisticate public policies addressing important needs and can adapt them to changing realities. Learning, on the other hand, can be “pathological” (Dunlop and Radaelli, 2018), for example when it leads to policy failure or facilitates the implementation of undesired policies.

Governance networks are defined by Klijn and Koppenjan (2016, 21) as more or less stable patterns of social relations between mutually dependent actors which cluster around a policy problem, a policy programme, and/or a set of resources. The concept encompasses any type of multi-stakeholder coordination or collaborative process that has emerged to address complex problems that could not have been solved by one organization alone (Bouckaert et al. 2010; O’Toole 1997; Torfing and Sørensen 2014), assuming that it is the pattern of relations that shape individual and collective perceptions and actions (Klijn and Koppenjan 2016; O’Toole 1997). In

this regard, various studies pinpoint the capacity of governance networks to promote learning (e.g., Agranoff 2006; Berry et al. 2004; Provan and Kenis 2008; Torfing 2016, 153-181). By bridging diverse actors together, governance networks provide a space for interaction and increase the availability and exchange of diverse types of information and opinions. In doing so, they foster the individual generation and acquisition of knowledge. In turn, they support the collective production and diffusion of creative ideas and solutions, the emergence of shared understandings, and collective action regarding complex problems (Heikkila and Gerlak 2013; Klijn and Koppenjan 2016). In other words, governance networks' capacity to influence policy outcomes relies on their ability to promote learning. Much like learning itself, such influence of governance networks on policies is not necessarily desirable. Through learning among actors in small groups, for example, these actors can be able impose their views to a larger part of the society.

Yet, while scholars recognize learning as an important function of governance networks, the evidence about network-learning relations, in the existing literature, is most often presented implicitly. As a result, our knowledge about the drivers of learning, in such networked context remains, to a large extent, very fragmented (O'Toole 2015). Existing reviews mostly address the conceptualization of learning rather than its factors (e.g., Gerlak et al. 2017; Rodela 2011), with the exception of Suškevičs et al. (2019) who look at the antecedents of a specific form of "action-oriented learning" in a specific context natural resources management. The review presented in this article brings together conceptual and empirical evidence in order to offer a comprehensive understanding of the conditions of learning in governance networks. Such an understanding is crucial when considering the influence of learning on collective action as well as on policy outputs and outcomes.

This article provides a synthesis of multiple findings about the characteristics of governance networks influencing individual and collective learning. To do so, our review addresses the

following questions: What types of governance network are investigated (issue, function)? How learning is conceptualized? Finally, what are the individual, interpersonal and structural conditions that foster or hinder individual and collective learning? How learning produces changes in networks falls out of the scope of this review. Likewise, this article focuses on conceptual and theoretical insights: methods – such as applications and implications of social network analyses of learning in networks – are not reviewed as such. This article starts with an overview of the scope and methods of the review, as well and a presentation of the reviewed studies. The following sections look at the conceptualization and conditions of learning in governance networks. The conclusion provides insights on how to promote learning in governance networks and suggests several avenues for future research.

Scope and methods of the review

This article presents the results of a systematic literature review. Such a method is particularly well-suited to organize the existing but implicit and scattered body of knowledge about the conditions of learning in governance networks. This systematic 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, it has recently started to be used in public administration research (e.g., De Vries et al. 2016; Moyson et al. 2018). The PRISMA statement offers a checklist of items that should be presented in order to be transparent in reviewing the literature. These items involve a presentation and discussion of the search, selection and eligibility criteria of the reviewed studies, a clear overview of the methods implemented to analyze them, as well as guidelines in order to present the results. This method combines high flexibility in the choices made for doing literature reviews with high requirements in reporting these choices in such a way that, ideally, the same choices applied by different researchers should lead to similar review results. In other words, the application of the PRISMA statement leads to

replicable review results. The results of the review presented in this article are detailed in the online Appendix.

Scope of the review

The authors collected studies indexed in two subject areas of Web of Science: public administration research and environmental studies. Public administration is the research area that encompasses policy studies. Yet, the literature exploring the link between governance networks and learning in this field is very scarce (see below). Most of this research has been conducted in empirical settings related to environmental policies (e.g., Gerlak and Heikkila 2011). In addition, it strongly points to evidence on network-learning relationships reported in environmental studies. As environmental studies provide significant and relevant evidence about learning in governance networks, they have been included in our review.

The review includes all studies indexed in Web of Science on January 1st, 2019, on the basis of the following query referring to title, abstract or keywords: “learning AND ((governance network*) OR (‘social network*’))”. The term “social network” has been included because research on governance networks relies upon social network analysis to describe and explain the outcomes of governance networks, including learning (Apostolopoulos and Liargovas 2018; Klijn and Koppenjan 2016). We acknowledge the bias that can result from our focus on the Web of Science. We also acknowledge that some studies rely on other concepts than “network” and “governance”, such as “collaborative partnerships”, in order to look at governance networks.

Eligibility criteria and selection of the studies

The initial search results contained 534 articles which were selected if they met all the following eligibility criteria. First, as far as the research field is concerned, they had to report results in

public administration or policy research. Second, as far as the topic is concerned, the abstracts had to make clear that the study would investigate the conditions of learning – even if learning is not the only and/or central subject of the article. Similarly, the abstract had to make clear that learning in the context of networked governance, policy processes or collective decision-making processes (e.g., collaboration) would be investigated in the article¹. Third, the studies had to be written in English. Fourth, they had to be published in a peer-reviewed journal. The risk of bias resulting from the non-inclusion of divergent findings that would be reported in non-English studies or in books seems limited given the low number of book chapters (4) and non-English records (11) resulting from our initial search on the Web of Science. The year of publication and the research design were not used as eligibility criteria.

Based on the eligibility criteria, forty studies were included in the analysis, according to the selection process summarized in Figure 1. First, all studies that were not published in peer-reviewed journals and not written in English were removed. Second, two authors independently screened all abstracts to exclude studies dealing with irrelevant fields (e.g., computer networks or student learning), but indexed in public administration or environmental research, as well as studies that do not address the conditions of learning in networked governance. The two authors reached a consensus on forty-eight studies. The analysis of full texts further revealed that eight selected studies were actually irrelevant: the two authors decided to exclude them too.

[Figure 1 about here]

¹ This eligibility criterium is relatively conservative: it involves that studies were selected only when their authors considered that they engaged with network-learning relations significantly enough to mention them in the abstract of their article; conversely, this criterium involves that studies providing evidence about network-learning relations without mention of this evidence in the abstract were not selected.

Analysis of the studies

The first author coded sentences of the selected studies in an excel dataframe. This frame summarises the author(s), the publication year, the title, the journal, the type of research (empirical or conceptual), the type of venues, the conceptualization of learning, as well as the conditions of learning. The conditions of learning were divided into three broad categories: the individual (micro), interpersonal (meso), and structural (macro) conditions which respectively refer to the attributes of individual network members, of their interpersonal relations and of the overall relational and institutional structure of the network. Furthermore, subcategories were identified within each category (e.g., homophily at the interpersonal level). The choice of categories – individual, interpersonal and structural – results from a choice made a priori to organize the information collected in the reviewed studies efficiently. The subcategories, in contrast, emerged inductively over the analysis, depending on the topics covered by the reviewed studies. For example, we did not necessarily expect “homophily” to be an interpersonal condition of learning addressed by the reviewed studies before analyzing them. Intermediate results were frequently discussed by the authors throughout the analysis. The overall process was carried on in a few weeks, which maximises the internal consistency of the results.

Overview of the reviewed studies

The forty articles appeared in twenty-four different journals. Twenty-nine articles (73%) are labelled as environmental studies. *Ecology & Society* is the most represented journal with ten records. Public Administration studies were published, among others, in the *Journal of Public Administration Research and Theory* (2) and in *Policy Sciences* (2). Twenty-three (58%) articles were written after 2014, which suggests a growing interest in this topic. Many studies were

conducted in the United States (12) and Western Europe (12)². There are twenty-eight (70%) empirical articles. Twenty-two (79%) of them explore learning in governance networks related to environmental issues, the most prevalent being water and fisheries (8) and climate change (6). This confirms the strong interest in environmental topics in learning and governance networks research. Fifteen (54%) empirical studies are based on quantitative data, nine (32%) studies are qualitative, and four (14%) studies use both quantitative and qualitative data. Social network analysis is used in eight studies (e.g., Hileman et al. 2018; Pietri et al. 2015).

Different functions of governance networks can be distinguished in the reviewed studies. Twenty-two (55%) articles describe networks aiming at the generation of new knowledge. Fifteen articles (38%) look at networks involved in the development of new regulation. Thirteen (32%) articles deal with coordination processes for the use and preservation of natural resources. Six (16%) articles consider governance network aiming at influencing policy processes (e.g., “advocacy coalitions”). Three (7%) studies identify other functions, such as rule enforcement. The sum of percentages is higher than 100% because many studies identify multiple functions. A comprehensive overview of the different forms of governance networks falls out of the scope of this review (but see, e.g., Lecy et al. 2014).

Conceptualization of learning in governance networks

Most of the reviewed articles (80%) provide a definition of learning (Table 1). Twenty-four (75%) of them explicitly consider learning as a relational process that leads to cognitive or behavioral changes by exposing individuals and groups to new knowledge, opinions, or social influence. Thirteen (40%) studies look at the dynamic of “social learning” in large communities of actors involved in a given policy process. The concept “policy learning” is used in six (19%)

² For the conceptual articles, we relied on the institutional affiliation of the first author.

studies. Three (10%) studies define “organizational learning” (Fischer et al. 2014; Marsden et al. 2012; Siciliano 2017). Ten (31%) articles do not specifically relate to one public administration approach and use generic definitions (e.g., Crona and Parker 2012) or define other types of learning, e.g., collective learning (Heikkila and Gerlak 2013).

[Table 1 about here]

Beyond definitions, the conceptualizations of learning differ, in the reviewed studies, according to the level of learning and the type of changes resulting from learning (Table 2). Individual-level learning or learning by a single actor is the concern of sixteen (40%) studies. Collective-level learning or learning by multiple actors is examined twenty-two (55%) studies. Two (5%) studies explicitly address both levels (Ensor and Harvey 2015; Newig et al. 2010). Seven (17%) studies explicitly consider individual-level learning as a prerequisite for collective-level learning (e.g., Siciliano 2017).

Thirty-four (85%) of the reviewed studies identify specific types of changes resulting from learning. Most (47%) of them conceptualize learning as a process resulting in cognitive changes, such as the acquisition of new knowledge (e.g., Resh et al. 2014) or belief updates (e.g., Papadopoulos 2018). Seven (21%) studies focus on behavioral changes resulting from learning, such as the use of information in decision-making process (Crona and Parker 2012) or changes in interpersonal relations (e.g., Siddiki et al. 2017), while eleven (32%) articles look at both types of changes.

[Table 2 about here]

Conditions of learning in governance networks

This section reviews the conditions of learning within governance networks. We start with the individual conditions before looking at the interpersonal conditions and structural conditions of

learning. Individual-level learning and collective-level learning are also differentiated when possible. The main findings of this review are summarized in Table 3.

[Table 3 about here]

The individual conditions of learning

The individual conditions of learning in governance networks are addressed in twenty-three (58%) studies. Fifteen (65%) of the studies looking at individual conditions of learning examine general characteristics or behaviors of network participants. Collective learning seems facilitated when network members actively search for information and are willing to listen to alternative viewpoints (Baird et al. 2014; Cundill 2010; Heikkila and Gerlak 2013). Benz and Fürst (2002) also suggest that collective learning is more likely when network members are competitive and cooperative at the same time: competition stimulates the search for information while cooperation facilitates mutual understanding. Hatmaker (2015) points to public-sector motivation as a driver of individual-level acquisition of knowledge. According to Pattison (2018), individual learning is also more likely when network members do not hold extreme beliefs.

More specifically, the reviewed literature points to the complex relations between network members' perceptions and individual learning. As far as perceptions of expertise are concerned, the likelihood of a member to seek information and learn depends upon his or her awareness that other participants hold such information (Lee and van de Meene 2012) or are experts whose knowledge domain is explicit or recognized (Papadopoulos 2018; Siciliano 2017). At the same time, individuals need to have sufficient expertise to learn (Papadopoulos 2018). Yet, expertise may also inhibit learning, as experienced actors can be reluctant to admit their lack of knowledge (Hatmaker 2015). Siciliano (2017) does not find evidence of learning by experienced actors. The

relations between perceptions of legitimacy or fairness and individual learning are complex too. For example, in collaborative partnerships, learning among network members is higher when they hold positive perceptions of collaboration fairness (Resh et al. 2014; Siddiki et al. 2017). At the same time, when perceptions of network legitimacy are low, actors can be more likely to learn from outside the network (e.g., from foreign experience: Montpetit 2009). In other words, positive *and* negative perceptions of the network can foster individual learning, but in different ways.

Learning also depends on the presence of a skilful leader, according to fifteen (65%) of the reviewed studies interested in the individual conditions of learning. In those studies, a leading person or an organization coordinating network activities is necessary to bring people together, to support information exchange across networks members, as well as to create a vision, which fosters individual learning (e.g., Fischer and Leifeld 2015; Lee and Van de Meene 2012) and collective learning (e.g., Boyd and Osbahr 2010; Gerlak and Heikkila 2011; Pietri et al. 2015). The reviewed studies also point to the key role of several leadership skills. For example, the presence of a respected mediator who effectively manages conflict positively influences individual learning in aquaculture partnerships (Siddiki et al. 2017). Collective learning is also facilitated by a strategic leader (Boyd and Osbahr 2010; Gerlak and Heikkila 2011; Gunderson et al. 2006) who manages cooperation and conflict (Pahl-Wostl et al. 2007, Stöhr et al. 2014), creates trust (Gerlak and Heikkila 2011; Gunderson et al. 2006), and disseminates information across subgroups in the network (Gerlak and Heikkila 2011; Pietri et al. 2015).

Overall, three main lessons may be drawn from the reviewed studies. First, a diversity of individual conditions influences individual and collective learning in networks. Second, the effects of these conditions are complex. In particular, perceptions of others' expertise can foster individual learning but the effect of self-expertise seems ambiguous. Positive perceptions of governance networks can foster within-network individual learning, but negative perceptions can

promote individual learning from external sources. Third, the presence of skilful leaders able to facilitate information exchange and to integrate different opinions seems crucial to promote both individual and collective learning in governance networks.

The interpersonal conditions of learning

In governance networks, learning is the product of social interactions. Thirty-four (85%) studies look at interpersonal conditions of learning. Ten (30%) of the reviewed studies looking at interpersonal conditions of learning focus on the effect of the structural position of actors within networks. The position of network members can be conceptualized in two ways. On the one hand, the degree of centrality of an actor measures the total number of his or her relationships with other actors (Resh et al. 2014). On the other hand, brokering is the extent to which an actor connects actors otherwise disconnected (Bodin et al. 2006; Pietri et al. 2015). A broker is, typically, a “boundary spanner” who connects different organizations, hierarchies and jurisdictions (Resh et al. 2014) or a “policy broker” who mediates between diverse advocacy coalitions (Howlett et al. 2017). Social network analysis also refers to “betweenness centrality” or “brokerage score”.

The strategic structural position of network members can facilitate or hinder individual and collective learning. Some of the reviewed studies suggest that network members who are central or hold a broker position access a wealth of information, which should increase the likelihood of individual learning (Bodin 2006; Henry and Vollan 2014). For instance, in the study of a research unit bringing policymakers and scientists together to advance knowledge on water governance, Crona and Parker (2012) find that policymakers use more evidence to make decisions when they are related to a higher number of scholars and other policymakers. However, in one article about US aquaculture partnerships, inversely, Resh et al. (2014) conclude that a strategic structural position, defined both in terms of the number of relationships and brokering, can also affect the

acquisition of a better understanding of aquaculture topics. Perhaps, they suggest, central actors learn less because their position arise from higher initial levels of knowledge. Actors in strategic structural positions can also foster collective learning, e.g., opinion convergence, given their ability to diffuse information (Heikkila and Gerlak 2013; Henry and Vollan 2014; Yamaki 2016). For instance, in a regional network of marine resource management, brokers facilitated opinion changes among network members holding different initial knowledge and views (Pietri et al. 2015). Yet, studies highlight that actors in a strategic structural position can also inhibit individual and collective learning, given their capacity to control the flow of information (Heikkila and Gerlak 2013; Henry and Vollan 2014; Howlett 2017).

The effect of the intensity of social relations among network members, which encompasses their depth and their frequency, is examined in seventeen (50%) of the studies looking at the interpersonal conditions of learning. Generally speaking, intense social relations seem favourable to individual learning. A study about a network of teachers from Midwest public schools suggests that both reciprocity and transitivity - two indicators of deep relations – positively influences individual information seeking and learning (Siciliano 2017). Similarly, a study about agri-environmental policy in Belgium reports a correlation between regular interactions with environmental organizations and policy adoption by the farmers (Dedeurwaerdere et al. 2015). In the same vein, the frequency of both formal and informal communication has fostered knowledge acquisition in the governance of climate change in New York (Temby et al. 2017). Intense social relations matter for collective learning too. Several studies notice that collective learning is fostered by frequent face-to-face interactions (Gerlak & Heikkila 2011; Pahl-Wostl 2009; Wyborn 2014). According to a study on a flood program in the Netherlands, intense social relations facilitate the convergence of interests and the emergence of integrated solutions (van Herk et al. 2015). Yet, two articles point out that intense relations can also lead to groupthink, closed views, and reticence to accept new information within a network

(Benz and Fürst 2002; Newig et al. 2010).

The effect of homophily, i.e., the tendency of a network member to interact with actors that share similar attributes, is examined by twenty-one (62%) of the reviewed studies about the interpersonal conditions of learning. Several studies suggest that homophily has a positive influence on individual learning. For instance, according to the study of European regulatory network, the perception of situational similarity drove individual learning (Papadopoulos 2018). Common language and geographical proximity were positively related to learning best practices in a transnational city network (Lee and Van de Meene 2012). Similarly, individual learning is easier through communication with peers (Hatmaker 2015; Siciliano 2017). Homophily also seems to facilitate collective learning, especially similar professions (Heikkila and Gerlak 2013), similar epistemological beliefs (Reed 2010), or common interests (Cundill 2010). Yet, some studies suggest that homophily impedes the diversity of ideas, which inhibits individual learning (Newig et al. 2010) as well as collective learning (Fischer and Jasny 2017; Hileman and Lubell 2018; Newig et al. 2010). In the same vein, collaboration with actors holding different rather than similar policy views about energy and climate change facilitated individual alterations of policy beliefs, within a dedicated policy subsystem in Colorado (Pattison 2018).

Eleven (30%) of the reviewed studies looking at the interpersonal conditions of learning point to the key role of trust. Conceptually speaking, several studies suggest that the role of trust is closely related to the effect of social relations and of homophily: frequent interactions would lead to trust which, in turn, would support further interactions and would increase the odds of learning new ideas and opinions (Henry and Vollan 2014). Wyborn refers to a “virtuous cycle between communication, trust, commitment, understanding and outcomes” (2015, 7). Similarly, interactions with similar people takes less effort and fosters the development of trust and learning (Fisher et al. 2014; Newig et al. 2010; Siciliano 2017).

Several studies empirically support the idea that trust facilitates both individual- and collective-

level learning. In aquaculture partnerships, participants who are trusting others reported an increased understanding of the issues related to aquaculture over time (Resh et al. 2014; Siddiki et al. 2017). In urban transport and planning, cities search for relevant lessons among their most trusted partners (Marsden et al. 2012). In the study of communication channels related to climate change governance in New York City, Temby et al. (2017) find that trust is a positive predictor of information use for decision-making. As far as collective learning is concerned, studies point out that trust reduces the cost of collaboration and supports the diffusion of ideas between actors. Trust therefore facilitates opinion convergence and collective action (Fischer et al. 2014; Gerlak and Heikkila 2011; Gunderson et al. 2006; Heikkila and Gerlak 2013).

In conclusion, the effect of social relations on learning in governance networks is a matter of balance. Actors in a strategic structural position are able to foster or inhibit individual and collective learning, depending on whether they diffuse information or excessively control its flow. Existing research suggests that social relations should be intense enough to facilitate individual and collective learning, but when interactions are too frequent, viewpoints can become overly similar, which provides no room anymore for learning new ideas. In this context, trust pops up as the key condition for facilitating individual and collective learning in governance networks. Admittedly, trust can lead to groupthink. However, this potential effect of trust on collective learning seems outweighed by its crucial role in processes of information exchange (Newig et al. 2010).

The structural conditions of learning

Thirty-two (80%) of the reviewed studies address the structural conditions of learning within networks, namely: its institutional context, its composition, as well as its overall relational pattern. The institutional context surrounding governance networks is a key condition for the emergence of learning: twenty-one (66%) of the studies looking at the structural conditions of

learning focus on the institutional context, with a scholarly debate opened about the impacts of formal versus informal institutions, that is, codified rules versus social norms shared by actors. According to several studies, informal institutions such as open membership, flexibility in roles, and negotiable rules enhance access to new knowledge and the development of collective learning (Dedeurwaerdere et al. 2015; Gunderson et al. 2006; Pahl-Wostl 2009). For instance, Levesque et al. (2017) show that flexibility in membership characterized by the regular inclusion of new members facilitates a shared understanding of the issue at stake. However, at the individual level, Montpetit (2009, 1190) does not find any relation between the “consensual policy style” of the European Union and the likelihood of changes in policy actors’ individual opinion regarding biotechnology applications over time. In the same vein, Resh et al. (2014) find that groups using consensus instead of formal voting procedures are less likely to report higher acquisition of information while Pattison (2018) does not find any relation between participation in consensus-based policy processes and belief changes. At the collective level, the lack of formal coordination can also impede information exchange and collective learning, such as in the large-scale conservation network examined by Wyborn (2015). In addition, informal institutions or consensual rules do not offer protection against tacit power relationships that hinder successful information exchange and obstruct individual learning (Fischer and Leifeld 2015) and collective learning (Benz and Fürst 2002; Pahl-Wostl et al. 2007).

Thirteen (41%) studies look at the effects of the composition of networks – i.e., their size and the diversity of their participants – on learning. Conceptually speaking, several reviewed studies suggest that larger networks bring more diverse ideas and opinions together, which is supposed to be beneficial for individual and collective learning (Fischer and Leifeld 2015; Newig et al. 2010). However, the same studies suggest large networks run the risk of increasing transaction costs for information sharing, limiting face-to-face interactions and, in turn, making learning more complex. This argument is empirically evidenced in a South-African governance network

about climate change which led to a stronger community of practice and supported collective learning as well as policy changes, more than in a larger, Indian network (Never 2012).

Similarly, the reviewed literature suggests that the diversity of participants can contribute to the variety of perspectives within networks. In turn, the chance for individuals to learn new information (Crona and Parker 2012; Hatmaker 2015) and for collective learning products to represent all interests (Benz and Fürst 2002; Cundill 2010; Yamaki 2016) can be increased too. Nonetheless, some authors also argue that too much diversity creates miscommunication and conflict, which is detrimental to individual cognitive learning (Fischer and Leifeld 2015; Henry and Vollan 2014). Empirically speaking, the diversity of participants and perspectives to a large-scale conservation program inhibited collective learning, defined as the emergence of shared understandings (Wyborn 2015). It is noteworthy that the negative effect of too much diversity in network members' affiliations and beliefs on individual learning was mitigated by trust in the context of ten collaborative governance partnerships in the United States (Sidikki et al. 2017).

The effect of the overall structure of relationships in governance networks, especially their centralization and density, is the concern of sixteen (50%) of the reviewed studies looking at the structural conditions of learning. Density refers to the number of existing relationships while centralization is higher when fewer network participants hold most of the relations (Newig et al. 2010). The reviewed studies suggest that both density and centralization have equivocal effects on individual learning and collective learning. Participants in dense networks know each other, which facilitates access to information and, in turn, individual learning (Henry and Vollan 2014) as well as collective learning (Bodin et al. 2006; Newig et al. 2010). Yet, the same studies also suggest that high density leads to knowledge homogenization and contributes to information distortion, which is detrimental to learning at both levels. In centralized networks, several studies argue that information is diffused more efficiently and at lower costs, which is positive for individual learning (Resh et al. 2014) and collective learning (Bodin et al. 2006; Pietri et al.

2015). However, again, the same studies also point out that excessive centralization isolates peripheral participants and reduces their opportunities to bring original information in the network as well as to learn from diverse sources of information, which is detrimental to collective learning (Bodin et al. 2006; Heikkila and Gerlak 2013; Pietri et al. 2015). Several studies resolve these ambiguities by suggesting a “small-world” network structure combining high centralization of dense subgroups (Fischer et al. 2014; Hileman and Lubell 2018; Pietri et al. 2015). As suggested by Hileman et al. (2018) in a study on water governance in Latin America, the efficacy of such structure is enhanced by the presence of bridging organizations acting as intermediaries between diverse actors.

To conclude, learning relies on a balanced configuration of structural characteristics, which means that several conditions must be present, but none of them must be overriding. Learning is most effective in governance networks when informal norms offer room for creativity and consensus, but also when formal rules control for power imbalances and ensure adequate information exchange. Similarly, a well-adjusted size as well as balanced levels of diversity, centralization, and density seem required. Trust as well as a small-world network structure seem to mitigate the negative effects of too much diversity, centralization and density on learning.

Conclusion and agenda for future research

Given the increasing complexity of the world, governance networks emerged to address public problems that could not be solved by one individual or one organization alone. The success of such governance model relies, among other things, on its potential to facilitate learning between diverse actors. Learning new information and different perspectives leads to the development of a common understanding of problems and to the generation of new knowledge which, in turn, supports alternative policy choices, joint action, and enhance the quality of policy outcomes (Torfing and Sørensen 2014). However, our understanding of how governance networks

facilitate learning remains limited (O'Toole 2015). This article has contributed to this issue by reviewing the individual, interpersonal and structural characteristics of governance networks that influence individual and collective learning in both public administration and environmental research, following the PRISMA approach.

At the individual level, the reviewed research suggests that network members' perception that other network members are knowledgeable teachers about public issues can foster individual learning within the network. At the same time, experienced actors may be reluctant to admit their lack of knowledge, which decreases their likelihood to learn. Collective learning is contingent on the presence of a leader that facilitates information exchange and synthesizes knowledge. At the interpersonal level, centrality facilitates information access, diffusion, and learning. At the same time, central actors can use their position to control information flows and hamper collective learning. Similarly, too much of homophily and of interaction confines the room for individual and collective learning from new information or original opinions. Only trust appears as an unconditional factor of learning. At the structural level, governance networks must be characterized by right proportions of formal and informal rules, a balanced number and diversity of participants, as well as a well-adjusted density and centralization, in order to support individual and collective learning. Trust, a small-world network structure, and the presence of bridging organizations can contribute to mitigate an excess of diversity, centralization, and density.

Those findings call for a balanced configurational approach. Networks seem to facilitate learning only if an equilibrium is reached for their different individual, relational and structural characteristics. Numerous conditions operate according to an inverted U-shape function: once the threshold value is reached, the positive effect of the condition decreases, and it finally becomes detrimental to learning. Hence, there may be multiple configurations that maximize the network's capacity to foster individual and collective learning, but the main conclusion drawn

by this review is that, with the noticeable exception of trust, too much of a single condition is harmful to learning. In other words, these findings are an important contribution to our understanding of the network configurations facilitating and impeding learning at the same time. This being said, as far as learning is concerned, there are configurational mixes that deserve more research attention than others, especially networks characterized by diversity and trust. At the structural level, diversity is needed to allow the actor to learn from different opinions and expertise. At the relational level, diversity can minimize groupthink resulting from intense relations as well as homophily. Yet, too much diversity constrains information exchange, creates miscommunication and conflict. Trust appears as a key condition to mitigate those negative effects (Siddiki et al. 2017). Trust explains the positive influence of strong ties and of homophily on learning. It facilitates information exchange between diverse actors and is a crucial element for both individual learning—e.g., acquisition of new knowledge—and collective learning—e.g., convergence of opinions. Yet, little is known about how trust emerges. Future research could further address this issue by looking, for instance, at the role of individual perceptions of expertise in the emergence of trust (see Mayer et al. 1995).

Similarly, actor centrality should be considered together with leadership skills. Central actors are able to diffuse the information between network members, which increases their learning opportunities. However, central actors can use their power to influence information exchange and shape learning according to their own benefit rather than to the common good (Pietri et al. 2015). To facilitate learning, central actors therefore need to be skilful leaders who care about others' interest, facilitate interaction and synthesize knowledge and understandings (Cundill 2010; Gerlak and Heikkila 2011). While the literature on leadership is usually structured around big models, such as “transformational” leadership (Bass 1990), this direction would help develop an integrated model of network leaders fostering learning processes.

Finally, at the structural level, there is still work to be done about right mixes of structural

network characteristics. For example, Fischer and Schläpfer (2017) identified a combination of rules leading to the production of a joint-position paper in a Swiss environmental policy forum. In this respect, research on learning in networks could cross-fertilize with research on metagovernance strategies (Klijn et al. 2010; Sørensen and Torfing 2017). The conditions for a small-world network structure (Given Hileman et al. 2018) seem also worth investigation.

This review points to other conceptual, theoretical and methodological challenges. Conceptually speaking, a variety of approaches to learning has been reported, with studies focusing on learning from a cognitive and/or behavioral point of views at the individual and/or collective levels. Such a variety is a sign of healthy research about learning in networks. That being said, the analysis of the reviewed studies has also suggested that the depictions of learning are not always that explicit, with studies defining learning without a clear reference to the focus or level of analysis and up to 20% of studies without any clear definition of learning at all. In the same vein, existing research does not provide a clear-cut vision about the threshold values beyond which network characteristics that are beneficial to learning become detrimental. This holds, e.g., for the amount of interaction among actors, their centrality, or the institutional formality of networks. In this respect, future research about learning in governance networks needs rigorous conceptual operationalizations that provide replicable conceptual frameworks and produce cumulative knowledge (Goertz 2006). For example, what is included in the two categories of “formal” and “informal” institutions is very fluctuating, from an article to another. Similarly, what are the exact attributes of “homophily” among network participants? Future research on learning should specify very carefully how concepts are defined and measured within studies and compared to similar concepts used in previous studies.

Theoretically speaking, the relationship between individual and collective learning remains unclear (Heikkila and Gerlak 2013). In a book chapter about learning dynamics within the UK Commons Transport Select Commons, for example, Witting and Moyson (2015) show that

institutional rules of policy networks can significantly influence the transformation of individual learning into collective learning. Specifying the relations between individual and collective learning will improve the understanding of how governance networks shape policy changes through learning (Dunlop and Radaelli 2017).

Methodologically speaking, our theoretical call for future research about the right network configurations for learning could be addressed with Qualitative Comparative Analysis (QCA: Rihoux and Ragin 2009), whose purpose is to infer, from combinations of independent variables (e.g., network characteristics), the “best” logical relations with the dependent variable (e.g., learning). The temporality of learning processes should also be considered more seriously in order to open new avenues about the study of learning within governance networks (Heikkila and Gerlak 2013). In particular, longitudinal studies would contribute to avoid biases (e.g., social desirability) in the measurement of learning (Moyson and Scholten 2018).

In the current political and administrative context where wicked problems have become the norm and call for collective thinking and joint action, there is an increasing need for learning within and across individuals. Governance networks support this process by facilitating information transmission, acquisition, and interpretation, as well as collective action. Hence, future policy research that further improves our common understanding of learning dynamics within such governance systems would be very worthwhile. It is our belief that the literature review reported in this article provides a solid basis in this prospect.

References

The reviewed studies are marked with a “*”.

Agranoff, R. 2006. “Inside collaborative networks: Ten lessons for public managers.” *Public*

administration review 66: 56–65.

Apostolopoulos, N., and P. Liargovas. 2018. “Unlock local forces and improve legitimacy: A decision making scheme in the European Union towards environmental change”. *European Policy Analysis*, 4 (1): 146–165.

*Baird, J., R. Plummer, C. Haug, and D. Huitema. 2014. “Learning effects of interactive decision-making processes for climate change adaptation.” *Global Environmental Change-Human and Policy Dimensions* 27: 51–63.

Bass, B. 1990. “From transactional to transformational leadership: Learning to share the vision.” *Organizational Dynamics* 18 (3): 19–31.

*Benz, A., and D. Fürst. 2002. “Policy learning in regional networks.” *European Urban and Regional Studies* 9 (1): 21–35.

Berry, F., R. Brower, S. Choi, W. Goa, H. Jang, M. Kwon, and J. Word. 2004. “Three traditions of network research: What the public management research agenda can learn from other research communities.” *Public Administration Review* 64 (5): 539–552.

*Bodin, O., B. Crona, and H. Ernstson. 2006. “Social networks in natural resource management: What is there to learn from a structural perspective?” *Ecology and Society* 11 (2).

Bouckaert, G., B. Peters, and K. Verhoest. 2010. “The Coordination of public sector organizations: Shifting patterns of public management.” London, UK: Palgrave Macmillan.

*Boyd, E., and H. Osbahr. 2010. “Responses to climate change: Exploring organisational learning across internationally networked organisations for development.” *Environmental Education Research* 16: 629–643.

*Crona, B., and J. Parker. 2012. “Learning in support of governance: Theories, methods, and a framework to assess how bridging organizations contribute to adaptive resource governance.” *Ecology and Society* 17 (32).

*Cundill, G. 2010. “Monitoring social learning processes in adaptive comanagement: Three case studies from South Africa”. *Ecology and Society* 15 (3).

De Vries, H., V. Bekkers. and L. Tummers. 2016. "Innovation in the public sector: A systematic review and future research agenda." *Public Administration* 94 (1): 146–166.

*Dedeurwaerdere, T. A. Polard. And P. Melindi-Ghidi. 2015. "The role of network bridging organisations in compensation payments for agri-environmental services under the EU Common Agricultural Policy." *Ecological Economics* 119: 24–38.

Dunlop, C., and C. Radaelli. 2013. "Systematising policy learning: From monolith to dimensions." *Political studies* 61 (3): 599–619.

Dunlop, C., and C. Radaelli. 2017. "Learning in the bath-tub: The micro and macro dimensions of the causal relationship between learning and policy change". *Policy and Society* 36 (2): 304–319.

Dunlop, C., and C. Radaelli. 2018. "The lessons of policy learning: types, triggers, hindrances and pathologies". *Policy & Politics* 46 (2): 255–272

Emerson, K., T. Nabatchi. and S. Balogh. 2012. "An integrative framework for collaborative governance." *Journal of public administration research and theory* 22 (1): 1–29.

*Ensor, J., and B. Harvey. 2015. "Social learning and climate change adaptation: Evidence for international development practice." *Wiley Interdisciplinary Reviews-Climate Change* 6 (5): 509–522.

*Fischer, A., and L. Jasny. 2017. "Capacity to adapt to environmental change: evidence from a network of organizations concerned with increasing wildfire risk." *Ecology and Society* 22 (1).

*Fischer, A., K. Vance-Borland, K. Burnett, S. Hummel, J. Creighton, S. Johnson, and L. Jasny. L. 2014. "Does the social capital in networks of 'fish and fire' scientists and managers suggest learning?" *Society & Natural Resources* 27 (7): 671–688.

*Fischer, M., and P. Leifeld. 2015. "Policy forums: Why do they exist and what are they used for?" *Policy Sciences* 48 (3): 363–382.

Fischer, M., and I. Schläpfer. 2017. "Metagovernance and policy forum outputs in Swiss environmental politics." *Environmental Politics* 26 (5): 870–892.

Gerlak, A., T. Heikkila, S. Smolinski, D. Huitema, and D. Armitage. 2017. "Learning our way out of environmental policy problems: A review of the scholarship." *Policy Sciences* 51 (3): 335–371.

*Gerlak, A., and T. Heikkila. 2011. "Building a theory of learning in collaboratives: Evidence from the Everglades restoration program." *Journal of Public Administration Research and Theory* 21 (4): 619–644.

Goertz, G. 2006. *Social science concepts. A user's guide*. Princeton University Press.

*Gunderson, L., S. Carpenter, C. Folke, P. Olsson, and G. Peterson. 2006. "Water RATs (resilience, adaptability, and transformability) in lake and wetland social-ecological systems." *Ecology and Society* 11 (1).

*Hatmaker, D. 2015. "Bringing networks in a model of organizational socialization in the public sector." *Public Management Review* 17 (8): 1146–1164.

Heclo, H. 1974. *Modern social politics in britain and sweden: From relief to income maintenance*. Yale University Press.

*Heikkila, T., and A. Gerlak. 2013. "Building a conceptual approach to collective learning: Lessons for public policy scholars." *Policy Studies Journal* 41 (3): 484–512.

*Henry, A. 2009. "The challenge of learning for sustainability: A prolegomenon to theory." *Human Ecology Review* 16: 131–140.

*Henry, A., and B. Vollan. 2014. "Networks and the challenge of sustainable development." *Annual Review of Environment and Resources* 39: 583–610.

*Hileman, J., M.T. Bastos, and M. Lubell. 2018. "Robustness and the paradox of bridging organizations: the exit problem in regional water governance networks in Central America." *Society & natural resources* 31: 683–697.

*Hileman, J., and M. Lubell. 2018. "The network structure of multilevel water resources governance in Central America." *Ecology and Society* 23 (2).

*Howlett, M., I. Mukherjee, and J. Koppenjan. 2017. "Policy learning and policy networks in

- theory and practice: The role of policy brokers in the Indonesian biodiesel policy network.” *Policy and Society* 36 (2): 233–250.
- Klijn, E. H., and J. Koppenjan. 2016. *Governance networks in the public sector*. London & New York: Routledge.
- Klijn, E., B. Steijn, and J. Edelenbos. 2010. “The impact of network management on outcomes in governance networks.” *Public administration* 88 (4): 1063–1082.
- Lecy, J., I. Mergel, and H. Schmitz. 2014. “Networks in public administration: Current scholarship in review.” *Public Management Review* 16 (5): 643–665.
- *Lee, T., and S. van de Meene. 2012. “Who teaches and who learns? Policy learning through the C40 cities climate network.” *Policy Sciences* 45 (3): 199–220.
- *Levesque, V., A. Calhoun, K. Bell, and K. Johnson. 2017. “Turning contention into collaboration: Engaging power, trust, and learning in collaborative networks.” *Society & Natural Resources* 30: 245–260.
- *Marsden, G., K. Frick, A. May. And E. Deakin. 2012. “Bounded rationality in policy learning amongst cities: Lessons from the transport sector.” *Environment and Planning A* 44 (4): 905–920.
- Mayer, R., J. Davis, and F. Schoorman. 1995. “An Integrative Model of Organizational Trust.” *The Academy of Management Review* 20 (3): 709–734
- Moher, D., A. Liberati, J. Tetzlaff, D. Altman, and Prisma Group. 2009. “Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement.” *PLoS medicine* 6 e1000097.
- *Montpetit, E. 2009. “Governance and policy learning in the European Union: a comparison with North America.” *Journal of European Public Policy* 16 (8): 1185–1203.
- Moyson, S., and P. Scholten. 2018. “Theories on policy learning: Existing approaches and future challenges”. In *Knowledge, Policymaking and Learning for European Cities and Regions*, eds. Dotti, N. F. Edward Elgar Publishing.

Moyson, S., N. Raaphorst, S. Groeneveld, and S. Van de Walle. 2018. "Organizational socialization in public administration research: A systematic review and directions for future research." *American Review of Public Administration* 48 (6): 610–627.

Moyson, S., P. Scholten, and C. Weible. 2017. "Policy learning and policy change: Theorizing their relations from different perspectives." *Policy & Society* 36 (2): 161–177.

*Never, B. 2012. "Who drives change? Comparing the evolution of domestic climate governance in India and South Africa." *Journal of Environment & Development* 21 (3): 362–387.

*Newig, J., D. Gunther, and C. Pahl-Wostl. 2010. "Synapses in the network: Learning in governance networks in the context of environmental management." *Ecology and Society* 15 (4).

O'Toole Jr, L. 1997. "Treating networks seriously: Practical and research-based agendas in public administration." *Public Administration Review* 57: 45–52.

O'Toole Jr, L. 2015. "Networks and networking: The public administrative agenda." *Public Administration Review* 75: 361–371.

Osborne, S. 2006. "Editorial: The new public governance?" *Public Management Review* 8: 377–387.

*Pahl-Wostl, C. 2009. "A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes." *Global Environmental Change-Human and Policy Dimensions* 19 (3): 354–365.

*Pahl-Wostl, C., M. Craps, A. Dewulf, E. Mostert, D. Tabara, and T. Taillieu. 2007. "Social learning and water resources management." *Ecology and Society* 12 (2).

*Papadopoulos, Y. 2018. "How does knowledge circulate in a regulatory network? Observing a European Platform of Regulatory Authorities meeting." *Regulation & Governance* 12 (4): 431–450.

*Pattison, A. 2018. "Factors Shaping Policy Learning: A Study of Policy Actors in Subnational Climate and Energy Issues." *Review of Policy Research* 35 (4): 535–563.

*Pietri, D., T. Stevenson, and P. Christie. 2015. "The Coral Triangle Initiative and regional

exchanges: Strengthening capacity through a regional learning network.” *Global Environmental Change-Human and Policy Dimensions* 33: 165–176.

Provan, K. G., and P. Kenis. 2008. “Modes of network governance: Structure, management, and effectiveness.” *Journal of public administration research and theory* 18 (2): 229–252.

*Reed, M., A. Evely, G. Cundill, I. Fazey, J. Glass, J., A. Laing, ... and C. Stringer. 2010. “What is social learning?” *Ecology and Society* 15 (4).

*Resh, W., S. Siddiki, and W. McConnell. 2014. “Does the network centrality of government actors matter? Examining the role of government organizations in aquaculture partnerships.” *Review of Policy Research* 31 (6): 584–609.

Rihoux, B., and C. Ragin. 2009. *Configurational comparative methods: Qualitative comparative analysis (QCA) and related techniques*. Sage.

Rodela, R. 2011. “Social learning and natural resource management: the emergence of three research perspectives.” *Ecology and Society* 16(4): 30.

*Siciliano, M. 2017. “Ignoring the experts: Networks and organizational learning in the public sector.” *Journal of Public Administration Research and Theory* 27 (1): 104–119.

*Siddiki, S., J. Kim, and W. D. Leach. 2017. “Diversity, trust, and social learning in collaborative governance.” *Public Administration Review* 77 (6): 863–874.

Sørensen, E., and J. Torfing. (2017). “Metagoverning collaborative innovation in governance networks.” *The American Review of Public Administration*, 47 (7): 826–839.

*Stöhr, C., C. Lundholm, B. Crona, and I. Chabay. 2014. “Stakeholder participation and sustainable fisheries: An integrative framework for assessing adaptive comanagement processes.” *Ecology and Society* 19 (3).

Suškevičs, M., Hahn T., and R. Rodela. 2019. “Process and Contextual Factors Supporting Action-Oriented Learning: A Thematic Synthesis of Empirical Literature in Natural Resource Management.” *Society & Natural Resources* 32(7), 731-75.

*Temby, O., J. Sandall, R. Cooksey, and G. Hickey. 2017. “Examining the role of trust and

informal communication on mutual learning in government: The case of climate change policy in New York.” *Organization & Environment* 30 (1): 71–97.

Torfin, J. 2016. *Collaborative innovation in the public sector*. Washington, DC: Georgetown University Press.

Torfin, J., and E. Sørensen. 2014. “The European debate on governance networks: Towards a new and viable paradigm?” *Policy and Society* 33 (4): 329–344.

*Van Herk, S., J. Rijke, C. Zevenbergen, R. Ashley, and B. Besseling. 2015. “Adaptive co-management and network learning in the Room for the River programme.” *Journal of Environmental Planning and Management* 58 (3): 554–575.

Witting, A., and S. Moyson. 2015. “Post-recession framing contests changing UK road policy sector.” In *Organizing after crisis*, eds. Schiffino, N. L. Taskin, J. Raone and C. Donis. New York: Peter Lang.

*Wyborn, C. 2015. “Cross-scale linkages in connectivity conservation: Adaptive governance challenges in spatially distributed networks.” *Environmental Policy and Governance* 25 (1): 1–15.

*Yamaki, K. 2016. “Role of social networks in urban forest management collaboration: A case study in northern Japan.” *Urban Forestry & Urban Greening* 18: 212–220.

Table 1. Definitions of learning in the reviewed studies

Learning categories (N=32)	Total N (%)	Example
Social	13 (40%)	“When individuals with common interests and goals come together in a learning network, they have the opportunity to engage in social learning, a process of developing collective knowledge and shared values, which spurs behavioral and attitudinal change (e.g., Keen et al., 2005)” (Pietri et al. 2015).
Policy	6 (19%)	“In this article, I adopt Sabatier and Zafonte’s (2001: 11566) definition of policy learning as ‘relatively enduring alterations of thought or behavioral intentions’” (Montpetit 2009).
Organizational	3 (10%)	“Learning in organizational settings is a social process in which individuals collectively acquire, create, and transfer knowledge and develop new organizational approaches based on this new knowledge (Garvin 1993; Argyris and Schon 1978; Nonaka 1994)” (Fischer et al. 2014).
Other	10 (31%)	“From this perspective, learning can be defined as the extent to which knowledge arising from social interactions occurring within bridging organizations is used to inform natural resource governance policies and practices” (Crona and Parker 2012).

Table 2. Conceptualizations of learning in the reviewed studies

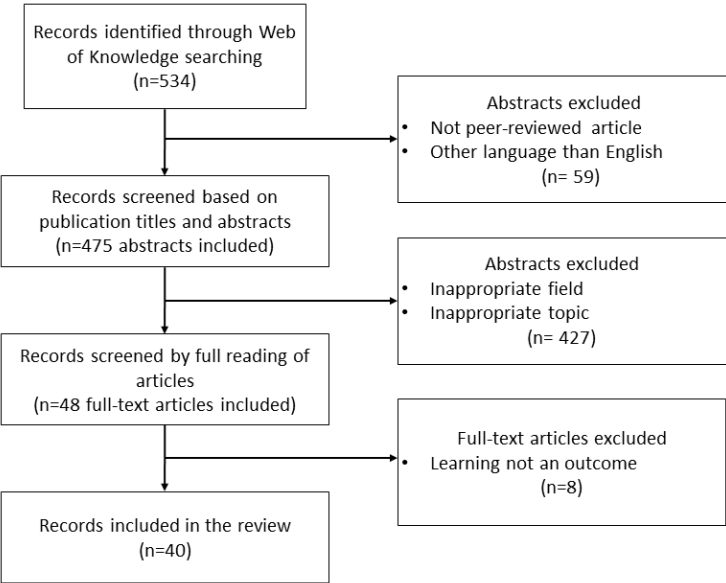
Level of learning (N=40)	Description	Total N (%)
Individual	Learning by individual actors, e.g., individual acquisition of knowledge or belief change	16 (40%)
Collective	Learning by a group or learning among individual actors, e.g., changes in shared understandings or opinion convergence	22 (55%)
Both	Learning by individual actors and by groups ¹ .	2 (5%)
Type of change (N=34)		
Cognitive	Learning as changes of mind	16 (47%)
Behavioral	Learning as changes of behaviour	7 (21%)
Both	Learning as changes of both mind and behaviour	11 (32%)

¹ This category does not include studies that focus on one level while recognizing the existence of the other.

Table 3. Conditions of learning in the reviewed studies

Conditions of learning	Examples	Individual learning	Collective learning	Both levels	Total
Individual conditions (N= 23)					
General participant characteristics	Expertise (Siciliano 2017)	8	7		15
Leadership	Process leadership (Pahl-Wostl et al. 2007)	3	12		15
Interpersonal conditions (N= 34)					
Structural position	Broker (Howlett et al. 2017)	5	4	1	10
Intensity of relations	Frequency of contact (Temby et al. 2017)	3	12	2	18
Homophily	Similar profession (Heikkila & Gerlak 2013)	11	9	1	21
Trust	Interpersonal trust (Siddiki et al. 2017)	3	7	1	11
Structural conditions (N=32)					
Institutional context	Voting rules (Resh et al. 2014)	8	12	1	21
Network composition	Diversity of actors, e.g., experts or agencies (Fischer and Leifeld 2015)	7	5	1	13
Network structure	Centralization (Newig et al. 2010)	4	11	1	16

Figure 1. PRISMA flow diagram



Appendix: Results of the literature review

Nr	Articles			Conceptualization of learning and governance networks		Conditions of learning in governance networks		
	Authors	Publication year	Source of the data*	Learning (type; level; change)	Function of governance Network	Individual conditions	Relational conditions	Structural conditions
1	Baird et al.	2014	Canada	Other; Individual; Cognitive & behavioral	Knowledge exchange	General participant traits		Composition
2	Benz & Fürst	2002	Germany	Policy learning; Collective; Behavioral	Knowledge exchange, influence	General participant traits, leadership style	Intensity of relations	Institutional context, network structure
3	Bodin et al.	2006	Conceptual	Other ; Collective ; Cognitive & behavioral	Coordination		Structural position	Network structure
4	Boyd & Osbahr	2010	UK	Organizational learning; Collective; unknown	Knowledge exchange	General participant traits, leadership style	Intensity of relations	Institutional context
5	Crona & Parker	2012	USA	Other (knowledge utilization); Individual; Behavioral	Knowledge exchange		Structural position, intensity of relations, homophily	Composition
6	Cundill	2010	South Africa	Social learning; Collective; Cognitive & behavioral	Knowledge exchange	General participant traits, leadership style	Intensity of relation, homophily, trust	Institutional context, composition
7	Dedeurwaerder et al.	2015	Belgium (Wallonia)	Social learning; Collective; Cognitive	Other (rule enforcement)	General participant traits	Intensity of relation	Institutional context, composition
8	Ensor & Harvey	2015	Conceptual	Social learning; Individual & collective; Cognitive & behavioral	Knowledge exchange	General participant traits, leadership style	Intensity of relation	Institutional context
9	Fisher & Leifeld	2015	Conceptual	Undefined ; Individual ; Cognitive	Policy development, coordination, knowledge exchange	Leadership style		Institutional context, composition
10	Fischer & Jasny	2017	USA	Other (generic); Collective; Cognitive	Policy development, coordination, knowledge exchange		Homophily	
11	Fisher et al.	2014	USA	Organizational learning; Individual; Cognitive	Knowledge exchange		Homophily	
12	Gerlak & Heikkilä	2011	USA (Everglades)	Other (collective learning); Collective; Cognitive & behavioral	Coordination	Leadership style	Intensity of relations, homophily	Network structure

13	Gunderson et al.	2006	USA & Sweden	Other; Collective; Behavioral	Policy development, coordination	Leadership style	Trust	Institutional context, network structure
14	Hatmaker	2015	Conceptual	Undefined; Individual; Cognitive	Other	General participant traits	Intensity of relation, homophily	Institutional context, composition, network structure
15	Heikkila & Gerlak	2013	Conceptual	Other (collective learning); Collective; Cognitive & behavioral	Policy development, influence	General participant traits , leadership style	Structural position, intensity of relation, homophily, trust	Network structure
16	Henry	2009	Conceptual	Other (generic); Individual; Cognitive & behavioral	Knowledge exchange, influence		Structural position	Institutional context, network structure
17	Henry & Vollar	2014	Conceptual	Social learning; Individual; Cognitive	Policy development, coordination		Structural position, homophily	Institutional context, composition, network structure
18	Hileman & Lubell	2018	Central America	Social learning; Collective; Cognitive	Policy development, coordination		Homophily	Network structure
19	Hileman et al.	2018	Central America	Undefined; Collective; Unknown	Policy formulation, coordination			Network structure
20	Howlett et al.	2017	Indonesia	Policy learning; Individual; Cognitive & behavioral	Influence		Structural position	
21	Lee et al.	2012	International	Policy learning; Individual; Behavioral	Knowledge exchange	General participant traits, leadership style	Homophily	Composition
22	Levesque et al.	2017	USA (Maine)	Social learning; Collective; Cognitive	Policy development		Homophily	Institutional context, network structure
23	Marsden	2012	Northern EU & USA	Undefined; Individual; Unknown	Knowledge exchange		Homophily, trust	Institutional context
24	Montpetit	2009	EU & USA	Policy learning; Individual; Cognitive	Other (European governance)	General participant traits	Homophily	Institutional context
25	Never	2012	India & South Africa	Social learning; Collective; Cognitive & behavioral	Knowledge exchange	General participant traits		Composition, network structure
26	Newig et al.	2010	Conceptual	Other (generic); Individual & collective; Cognitive & behavioral	Policy development, coordination, knowledge exchange		Structural position, intensity of relation, homophily, trust	Composition, network structure

27	Pahl-Wostl	2009	Conceptual	Social learning; Collective; Behavioral	Policy development, coordination	Leadership style		Institutional context
28	Pahl-Wostl et al.	2007	Conceptual	Social learning; Collective; Behavioral	Policy development, coordination, knowledge exchange	Leadership style	Intensity of relations, homophily	Institutional context
29	Papadopoulos	2018	European Union	Other (mutual learning); Individual ; Cognitive	Knowledge exchange	General participant traits	Homophily	
30	Pattison	2018	USA	Policy learning ; Individual ; Cognitive	Influence	General participant traits	Homophily	Institutional context
31	Pietri et al.	2015	East-Asia (Coral triangle)	Social learning; Collective; Cognitive	Knowledge exchange	Leadership style	Structural position, intensity of relation, homophily, trust	Network structure
32	Reed et al.	2010	Conceptual	Social learning; Collective; Cognitive	Coordination		Homophily	Institutional context
33	Resh et al.	2014	USA	Policy learning; Individual; Cognitive	Policy development, knowledge exchange	General participant traits	Structural position, homophily, trust	Institutional context, network structure
34	Siciliano	2017	USA	Organizational learning; Individual ; Behavioral	Knowledge exchange	General participant traits	Intensity of relations, homophily	
35	Sidikki et al.	2017	USA	Social learning ; Individual ; Cognitive & behavioral	Policy development, knowledge exchange	General participant traits, leadership style	Trust	
36	Stöhr et al.	2014	Sweden & Poland	Undefined ; Collective, Cognitive	Policy development	Leadership style	Intensity of relations, trust	Institutional context
37	Temby et al.	2017	USA (New York)	Undefined; Collective ; Behavioral	Knowledge exchange		Intensity of relations, trust	
38	Van Herk et al.	2015	The Netherlands	Social learning; Collective; Cognitive & behavioral	Policy development	Leadership style	Intensity of relations	Institutional context, network structure
39	Wyborn	2015	Australia	Undefined; Collective ; Unknown	Policy development, coordination.		Intensity of relations, trust	Institutional context, composition
40	Yamaki	2016	Japan	Undefined; Cognitive ; Unkown	Coordination		Structural position, Intensity of relations	Composition

* For the conceptual articles, we relied on the institutional affiliation of the first author.