What difference do networks make to teachers’ knowledge? Literature review and case descriptions

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Abstract

The paper investigates two – often disconnected – policy questions: how can we scale the use of evidence in teaching practice, and how can we generate and scale innovation? Both questions necessitate understanding how teachers and schools connect with each other, and with other organisations and professionals. The paper thus explores the role of networks in scaling evidence and innovation through a review of literature and a number of short case descriptions. Through the lens of networks, the analysis shows how the mobilisation, construction and diffusion of knowledge are of central importance in both policy issues. It suggests that scaling evidence and innovation should be treated as one ecosystem, in which mechanisms that allow effectively blending research and practical knowledge are key. Further, the paper proposes a framework for studying knowledge dynamics in networks to better understand how their context, characteristics and devices can contribute to facilitate these dynamics.

Résumé

Ce document de travail examine deux questions de politique public, souvent déconnectées : comment mettre l’utilisation des preuves à l’échelle dans la pratique de l’enseignement, et comment générer et mettre à l’échelle l’innovation ? Les deux questions nécessitent de comprendre comment les enseignants et les écoles se connectent entre eux, et avec d’autres organisations et professionnels. Ainsi, le document, explore le rôle des réseaux dans la mise à l’échelle des preuves et de l’innovation à travers une revue de la littérature et un certain nombre de brèves descriptions de cas. À travers le prisme des réseaux, l’analyse montre comment la mobilisation, la construction et la diffusion du savoir sont d’une importance centrale dans les deux questions politiques. Le document suggère que la mise à l’échelle des données probantes et de l’innovation devrait être traitée comme un écosystème, dans lequel des mécanismes permettant de mêler langue recherche et connaissances pratiques d’une manière efficace sont essentiels. En outre, le document propose un cadre pour étudier la dynamique du savoir dans les réseaux afin de mieux comprendre comment leur contexte, caractéristiques et dispositifs peuvent contribuer à faciliter ces dynamiques.
The author would like to thank the Academy of Poitiers, in particular Cécile Betermin and Vincent Planet, for their time, support and invaluable insights for the French case description. Special thanks are given to Alejandro Paniagua for contributing to the box on innovative networks. The author would also like to thank Gábor Halász and Frank Cornelissen, who reviewed and provided valuable suggestions for the draft of the paper. A further thanks to colleagues in the OECD Secretariat who have contributed to the preparation of this paper: Matthew Gill for language editing and for the beautiful design of many of the figures; Deborah Fernandez for providing support in the last phase of publication. Last but not least, the author expresses gratitude to Tracey Burns, who has supported the work and provided various comments and input throughout the different phases of this paper. The paper benefited from the financial support of the European Commission.
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1. Introduction

Teachers, schools and education systems need to continuously update and build their knowledge to respond to societal changes and contextual challenges. New evidence on teaching and learning is emerging from different fields such as the learning sciences, research on teaching and school practices, and so on. At the same time, innovative pedagogies are developing. Technology enhances and extends the learning environment, giving new opportunities for teachers and students, and many historically “alternative models”, such as gaming and experiential learning, are gaining new forms and spreading. Teachers need to acquire and integrate evidence and new models in their practice, while also contributing to the collective knowledge base through sharing and co-constructing knowledge in their local communities and networks. To achieve system-level change, it is crucial to understand teachers’ collective knowledge building within the teaching community of a school, but also across institutional boundaries.

Indeed, some of the key questions that have been troubling the education research and policy community in recent years are in one way or another related to the different types of knowledge dynamics. First, how can teaching become a research-based profession that systematically integrates emerging evidence into professional practice? Accumulating and systematising research to build a strong evidence-base on “what works” in teaching, i.e. what practices produce higher outcomes, has been an attractive narrative in the early 21st century’s political context (Hargreaves, 1996[1]; Goldacre, 2013[2]; Cain, 2015[3]). Governments in a number of countries have been concerned with safeguarding or increasing educational outcomes as public education became more decentralised (Hammersley, 2005[4]; Burns and Köster, 2016[5]). The evidence-based paradigm promised the solution: research establishes what works, teachers use this evidence base, and student outcomes will increase. Consequently, teachers as professional practitioners should be accessing and integrating this accumulating evidence continuously through initial training and professional development. This leads to the first policy question: How can we scale evidence use? For teachers’ knowledge, this question is often translated as: How can knowledge, emerging from research, be disseminated and mobilised among teachers?

A second issue is around innovation in education. Teachers today need to teach increasingly more diverse classrooms, keep up-to-date with technological development and develop ways in which these can enhance student learning. They also need to integrate and sometimes design new curriculum, respond to individual students’ needs, as well as to the expectations of parents, schools, local and national policies. To respond to this complex set of challenges, teachers and schools constantly develop local solutions, but also adopt innovations from others (Paniagua and Istance, 2018[6]; Vincent-Lancrin et al., 2019[7]). The second key concern of policy makers is how to generate and scale local innovations that seem to work well. As knowledge is a fundamental element of innovation (Dankbaar, 2004[8]; Salling Olesen and Ellström, 2010[9]; OECD, 2009[10]), this concern is frequently formulated as the following question: How can knowledge be constructed and diffused in the profession?

Both policy questions relate to understanding scaling through dissemination or diffusion, which requires analysing and understanding interactions between various actors. Mobilising research evidence involves activating a whole network of people and organisations from different communities and contexts (Best and Holmes, 2010[11]). Similarly, innovation is situated within complex networks of people and organisations.
(OECD, 2009[12]), and networks can play an essential role in scaling (Paniagua and Istance, 2018[6]). It thus comes naturally to study these phenomena through the lens of networks. More and more countries have been investing in establishing networks in education as forms of organisation to facilitate change (Brown and Poortman, 2018[13]; European Commission, 2017[14]). For example, networks of schools can develop and test new curriculum, or schools can work in partnership with teacher education institutions to train new teachers. Networks also emerge as a result of professional development programmes or around particular pedagogies (Paniagua and Istance, 2018[6]). While network research in the field of education has been growing over the last few decades, there is still a need to better understand what makes networks “knowledge-intensive”, that is, how knowledge is generated and diffused in networks to improve teaching and learning at a large scale.

This paper aims to support and strengthen the design of teacher and school policies to improve teaching and learning at a large scale. It intends to do so by exploring the role of networks in the dynamics of teachers’ knowledge. In particular, it looks at how networks can help understand and facilitate:

- the brokerage and mobilisation of knowledge, emerging from research, among teachers
- the construction of knowledge by teachers and its diffusion in the teaching profession.

The questions are explored through a review of literature, building on earlier work on teachers’ knowledge dynamics (Révai and Guerriero, 2017[15]; Révai, 2017[16]; Révai, 2018[17]). It is neither comprehensive nor systematic, but nevertheless it covers the most salient sources in several domains. Theories and empirical studies investigating the evolving, changing nature of teachers’ knowledge originate in distinct research branches. These include the sociological literature on teacher professionalism, economic studies on organisational management, and an increasingly growing and rather heterogeneous body of educational science research that often builds on sociological and psychological theories of learning and knowledge. Similarly, there is a developing body of literature on networks in a number of domains, including mathematics, natural sciences and economics, but also social sciences such as sociology and political sciences. The review deliberately does not take a specific theoretical stance, but rather attempts to identify relevant understandings and findings, and systematise these as they relate to the two policy questions.

The first part of the paper (Chapter 2.) presents theoretical understandings of the nature of teachers’ knowledge, and how these can be enhanced through a network perspective. The second part of the paper (Chapter 3.) provides a number of short case descriptions that demonstrate knowledge processes in selected networks from different countries. Most of these cases are based on available literature on the selected networks, with the exception of the French case, which is based on original data collected by the author. While this second part can be read separately, the theoretical review presented in the first part serves to better understand the cases. The paper ends with a discussion that links the policy questions and some points of consideration as conclusions.
2. Theories on teachers’ knowledge dynamics and networks

This chapter attempts to bring together two overlapping areas of work: one that explores the changing and evolving nature of teachers’ knowledge, and the other that investigates networks in education. The chapter starts with a short introduction of the network perspective and then explores its relevance for knowledge along the policy questions set out in the introduction.

2.1. Networks in the education context

In recent years, establishing networks has been considered as a collective solution to complex problems across organisational, geographic, professional or sectoral boundaries [Networks Leadership Summit IV, 2009, in: (Popp et al., 2014[18]). A general positive view on networks both as forms of governance and as facilitators of school improvement and innovation at scale has dominated the field of education (and more generally public) policy discourse (Grimaldi, 2009[19]; European Commission, 2017[14]; OECD, 2003[20]). An increasing amount of research on networks has contributed to questioning and deepening the general positive discourse in recent years.

Before looking into this rich field of network research, it is important to distinguish between discussing networks as forms of organisations as opposed to using the concept of network as an analytical tool. In the policy context mentioned above, networks are typically understood as forms of organisations, for example inter-organisational partnerships between schools or professional learning networks of teachers. Analyses of networks as forms of organisations focus on their governance and effectiveness with the aim of identifying factors of successful networks. These studies have helped understand issues around network effectiveness, governance and so on (Lima and Shewbridge, forthcoming[21]).

In parallel, the study of networks – originating from mathematics (see Box 2.1) – has been developing as an analytical tool to understand complex relational data in various disciplines. Network science today informs biology, physics, computer science, cognitive sciences and so on with a sophisticated apparatus of methods. This includes analysing structures of relationships, emerging patterns, fragility and robustness, among others (Barabási, 2015[22]; Newman, 2010[23]). The two approaches are not distinct: network analysis usefully informs the study of networks as social organisations, providing concepts and tools.

2.1.1. Network as an analytical lens

One of the most prominent approaches to studying networks in the field of social sciences is social network analysis. By analysing nodes and connections between them, this method allows for describing patterns of relationships among actors, the structure of these ties and can help identify their effects on people, organisations, interactions and collaboration (Wasserman and Faust, 1994[24]). A review of research in this area (Borgatti and Foster, 2003[25]) characterises network analytical approaches along the following dimensions:

- direction of causality: whether it is about the causes or the consequences of network structures
levels of analysis: whether it investigates the dyadic level, actor or network level – (micro and macro level network research are theoretically and methodologically similar)

explanatory goals/styles: whether it is directed at modelling variation in performance and other value-laden outcomes, or homogeneity in actor attitudes or practices

explanatory mechanisms: whether it is structuralist (e.g. looks at the configuration of ties) or connectionist (e.g. focuses on resources that flow through social ties).

Box 2.1. Mathematics and network theory

A network is defined as a set of objects (called nodes or vertices) that are connected. This general definition allows for a broad understanding, in which nodes can be persons, organisations, but also material objects or abstract concepts.

Historically, network analysis stems from mathematics with Leonhard Euler’s discussion on the Seven Bridges of Königsberg. Published in 1736, it can be considered as the first graph theory paper (Wikipedia, 2019[26]). The city of Königsberg in Prussia (now Kaliningrad, Russia) was set on both sides of the Pregel River, and included two large islands which were connected to each other, or to the two mainland parts of the city, by seven bridges. Euler posited the problem of devising a walk through the city that would cross each of those bridges once and only once (Euler, 1736[27]).

Graph theory is a branch of mathematics that studies structures consisting of vertices and edges connecting these. In network theory these structures model a real world situation, i.e. vertices – usually referred to as nodes – and/or edges have attributes such as such as names, types of relationships (Wikipedia, 2019[26]). Network theorists are thus mostly interested in questions that are relevant to the situations modelled by networks and use graph theoretical tools, among other methods, to answer these.

The Erdős number and co-authorship networks

Paul Erdős (1913–1996) was an influential Hungarian mathematician who made considerable contributions to graph theory. He has published more papers during his lifetime (at least 1 525) than any other mathematician in history, mostly co-authored with one or more of his over 500 collaborators around the world (Bollobás, 1996[28]).

One of the earliest forms of social network analysis originates in the so-called Erdős number that describes the distance between Paul Erdős and another person, as measured by authorship of mathematical papers (Oakland University, 2018[29]). The Erdős number of someone who co-authored a paper with Paul Erdős is 1, someone who did not directly collaborate with Erdős, but co-authored a paper with an author who published a paper with him, obtains the Erdős number 2, and so on.

Co-authorship networks have been studied since in many fields to analyse the structure and mechanisms that shape the knowledge networks of scientific communities (Kumar, 2015[30]).

Network ties between individuals can refer to relations such as similarities (membership in groups, attributes), social relations (friendship, collegial relationship), mental relations (likes, knows about), interactions (talks to, seeks advice from) or flows (information, belief)
(Borgatti and Ofem, 2010[31]). Ties between organisations such as schools, agencies and businesses can also refer to many kinds of relationships: sharing resources, selling or buying products, collaborating, etc. Network nodes are however not necessarily people or organisations, they can also be material objects or abstract concepts, such as events, websites and documents. In this case, connections are sometimes described at multiple levels, for example, describing which people are engaging with which artefacts, or which people are members of which organisations. Some key concepts of network analysis (Hanneman and Riddle, 2005[32]) are:

- **Density**: the ratio of the number of ties (or if ties have values such as “strengths”, the sum of all values) to all possible ties. It can give insight into the speed at which information diffuses among the nodes, and the extent to which actors have high levels of social capital and/or social constraint.

- **Connectivity**: the number of nodes that would have to be removed in order to have isolated node(s), i.e. one or more actors that are not connected to any other. Point connectivity can help understand dependency and vulnerability.

- **Sub-structures**: e.g. number of cliques, where a clique is a sub-set of a network in which the actors are more closely and intensely tied to one another than to other members of the network.

- **Centrality**: measure of how close an actor is to the “centre” of the action in a network. Several measures exist, the simplest is the number of ties an actor has. Centrality can indicate how powerful an actor is.

- **Centralisation**: measure of the (un)equality of distribution of resources, such as knowledge, across the network.

2.1.2. **Networks as social organisations**

There exists numerous definitions and typologies of networks based on the purpose and object of analysis [e.g. (Muijs et al., 2011[33]; Provan and Kenis, 2008[34]; Suarez Estrada, 2017[35]). De Lima (2010[36]) offers a general framework to characterise networks along four dimensions: composition (network of individuals, organisations or a mix of these), substance (goals and relationships), ownership (voluntary or mandated) and structure (size, density, connectedness and centralisation). Examples in education include networks of individual teachers such as professional learning networks (Brown and Poortman, 2018[13]), online networks (Trust, 2016[37]; Kelly et al., 2015[38]), and networks of schools and research institutions. Networks of organisations – perhaps the most extensively studied form – are usually defined as three or more autonomous organisations that are working together to achieve a collective goal (Popp et al., 2014[18]; Provan and Kenis, 2008[34]). More specifically, the European Commission (European Commission, 2017[14]) understands networks as having established connections and relationships that maintain the network; “collective intelligence”, i.e. members exchange knowledge, skills and resources for the mutual benefit of all, and alliances working towards a particular common or shared goal(s). Networks are thus distinguished from clusters and partnerships that do not necessarily maintain long-term relationship, share resources or have common goals. Similarly to de Lima, Muijs and colleagues (Muijs et al., 2011[33]) also build on network theory concepts to establish a typology of education networks based on the 11 dimensions described in Table 2.1.
Table 2.1. Typology of education networks

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Description</th>
<th>Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals and activities</td>
<td>Goals: school improvement and learning, or broader scope involving collaboration with other types of organisations; Activities: short-term, medium term or long term timescales</td>
<td>School improvement / Broadening opportunities / Sharing resources</td>
</tr>
<tr>
<td>Voluntarism or coercion</td>
<td>Collaboration is voluntary or coerced (at least to one partner) e.g. through government grant, or obligation by local authority</td>
<td>Voluntary / Intermediate / Coercive</td>
</tr>
<tr>
<td>Power relations</td>
<td>Relationships are based on equality or domination by one or more partners</td>
<td>Equal / Intermediate / Domination</td>
</tr>
<tr>
<td>Network density</td>
<td>Level of engagement of the members of partner organisations: e.g. only school heads engaged in collaboration, or the whole staff of each partner school is engaged</td>
<td>Low / Medium / High density</td>
</tr>
<tr>
<td>External involvement</td>
<td>Involvement of organisations other than schools and non-educational organisations</td>
<td>Low / Medium / High external involvement</td>
</tr>
<tr>
<td>Time frames</td>
<td>Permanent or very long term networks versus networks established for a specific timeframe (e.g. under a grant)</td>
<td>Short / Medium / Long term</td>
</tr>
<tr>
<td>Geographical spread</td>
<td>Local, cross-local, regional, national, international</td>
<td>Proximity / Medium / High distance</td>
</tr>
<tr>
<td>Density of schools</td>
<td>The number of schools involved and the number of connections between them (both can change over time)</td>
<td>Small / Intermediate / Large</td>
</tr>
<tr>
<td>Vertical or horizontal</td>
<td>The extent to which collaboration is within schools (vertical) or between schools (horizontal)</td>
<td>Vertical / Horizontal / Horizontal and vertical networking</td>
</tr>
<tr>
<td>Network diffuseness</td>
<td>Composed of a loose collection of actors and shifting memberships or fixed group of actors connected through formal mechanisms</td>
<td>Loosely connected to fixed or formally connected actors</td>
</tr>
<tr>
<td>Network formalisation</td>
<td>Relationships and collaboration based on trust and good faith or on formalised agreements and management structures</td>
<td>From informal, flexible, trust-based to defined by formal structures and agreements</td>
</tr>
</tbody>
</table>

Source: Adapted from (Muijs et al., 2011[33])

Both policy questions laid out in the introduction necessitate understanding how teachers and schools connect with each other and with other professionals. Connections among actors such as teachers, teacher educators and researchers, or organisations (schools, research or teacher education institutions) help understand how knowledge is generated, transformed and diffused. The way teachers connect with their environment such as textbooks and technology, or how they access information is also necessary to grasp the dynamics of their knowledge.

In order to understand the relevance of network structures and processes for teachers’ knowledge dynamics, this paper makes use of both network approaches.

2.2. The relevance of networks in teachers’ knowledge and its dynamics

Knowledge is dynamic in nature as it is evolving through acquiring new knowledge, is constructed through reflection and practice, shaped through social interactions and so on (Révai and Guerriero, 2017[15]). Traditionally, research has studied such dynamics from the perspective of teachers’ learning. Paavola, Lipponen and Hakkarainen (2004[39]) summarise three metaphors for learning:

- **Learning as acquisition** – based on cognitive theories, in which knowledge is a property or capacity of the individual mind, and learning corresponds to
construction, acquisition and outcomes, that happen through the process of using and applying knowledge in new situations.

- **Learning as participation** – based on social constructivist and situated learning theories, in which knowledge is not an individual property, nor an outcome. Rather, knowledge can only be interpreted as part of the situations where it “takes place”. The focus here is on activities (“knowing”), and learning is a process of participation in these shared cultural practices and activities.

- **Learning as knowledge-creation** – giving equal emphasis to both cognitive, individual and socially situated processes. This model conceptualises “learning and knowledge advancement as collaborative processes for developing shared objects of activity” such as products, practices and artefacts (p. 569[39]) (Paavola, Lipponen and Hakkarainen, 2004[39]).

All three metaphors demonstrate the inherent connection between learning and knowledge dynamics. Indeed, knowledge dynamics and teacher learning could be seen as two sides of the same coin: any form of learning results in some change in knowledge, and any change in teachers’ knowledge can be interpreted as a form of learning. However, just as the two sides of a coin show us different images, studying learning or knowledge dynamics can also reveal different information (Amin and Roberts, 2008[40]). In particular, when focusing only on learning, one can miss out on some important aspects. First, the concept of learning often places the teacher in the centre as the principle actor of the “action of learning”, even though learning is not always conscious and deliberate. Second, some phenomena such as the dynamics between tacit and explicit knowledge, knowledge building (Paavola, Lipponen and Hakkarainen, 2004[39]; Nutley, Walter and Davies, 2003[41]) or that between the personal knowledge of a teacher and the global knowledge base of the profession cannot easily be described as learning. The concept of “knowledge dynamics” – i.e. all forms of its evolution, transformation and creation – allows for studying such phenomena more comprehensively (Amin and Roberts, 2008[40]).

This paper discusses teachers’ knowledge in a broad sense, referring to all types of understanding of content that can be relevant for teaching. Adopting such a broad description from the economics literature (Hess and Ostrom, 2007[42]; Davenport and Prusak, 1998[43]) is useful when studying changes in knowledge, as it can include different types of knowledge gained formally or through experience, personal or social, explicit or tacit, and so on. It is important to note however, that the question of knowledge dynamics is explored in different strands of research, which understand knowledge in very different ways. As Fenwick and Farrell (2017[44]) point out, it is not clear what “knowledge moving” means: studies can sometimes refer to knowledge as evidence or best-practice, sometimes to innovation such as the knowledge of new products, services, but it can also have philosophical interpretations. Narrower definitions of knowledge will therefore be stated throughout the paper in relation to specific arguments and strands of research on the dynamics of knowledge.

Identifying the different types of knowledge dynamics is another difficulty. First, a proliferation of terms characterises the literature, partly because of the variety of fields contributing to this literature (e.g. health, education, economics), partly because of the different conceptual frames that exist across various countries and traditions (Levin, 2008[45]; Fenwick and Farrell, 2017[44]). Second, as with any social science typologies, the different categories almost always overlap. For example, the various dynamics could be captured through identifying “what happens to knowledge”. In this sense we could speak about knowledge diffusion (or dissemination), i.e. a linear interpretation of how knowledge
spreads, knowledge transformation – how its nature, content and structure changes as a result of social processes – and knowledge creation (or generation), i.e. how new knowledge is created. However, knowledge almost always transforms as it is diffused, partly because new knowledge is added/created along the way. It is thus difficult to identify distinct categories of the different dynamics.

The next sections identify the most important dynamics along the two main policy issues set out in the introduction.

2.2.1. Knowledge dynamics for scaling evidence

The first policy issue – how can we scale evidence – refers to ensuring that all teachers regularly and systematically integrate knowledge emerging from research in their practice. The issue of evidence use is related to reflections on professions and professionalisation. An influential line of thought compares teaching to the medical profession, and characterises the former, contrary to the latter, as a semi-profession because it lacks some of the attributes of a profession. The most often cited characteristic lacking is the existence of a systematic knowledge base that draws on underlying disciplines and constitutes the basis for professional practice and decision-making (Howsam, Corrigan and Denemark, 1985[46]; Hoyle, 1995[47]). It is Hargreaves’ seminal lecture (1996[1]) that set the grounds for the research-based profession paradigm that served as the basis of education policy in many countries. What has since become the “evidence-informed practice agenda” has been the most fiercely taken on board in Anglo-Saxon countries (e.g. Australia, the United Kingdom [England in particular] and the United States), which set out to reshape both the education research agenda and professional practice (Hammersley, 2005[4]; Biesta, 2007[48]).

The term evidence refers to “the available body of facts or information indicating whether a belief or proposition is true or valid” according to the Oxford English Dictionary. The nature and source of evidence has however been largely debated (Nutley, Walter and Davies, 2007[49]; OECD, 2007[50]; Nutley et al., 2010[51]). The main object of this debate is what should be considered as high quality evidence. A hierarchy of evidence based on its quality was established in the health sector, according to which systematic reviews and evidence syntheses represent the highest level, followed by randomised control trials (RCT), then cohort studies, case studies and eventually expert opinion is the lowest (Glover et al., 2006[52]). Considering RCTs as the golden standard has also been adopted by some in education (Goldacre, 2013[2]), while others believe in much wider interpretation of quality evidence and point to the complexity of the issue (Hiebert, Gallimore and Stigler, 2002[53]; OECD, 2007[50]; Nutley, Powell and Davies, 2013[54]). Sharples defines evidence-informed practice as “integrating professional expertise with the best external evidence from research to improve the quality of practice” (Sharples, 2013, p. 7[55]). This suggests that evidence-informed practice is underpinned by formal and academic knowledge of the research available in a field.

The ultimate goal in terms of knowledge dynamics in this paradigm is therefore to establish effective mechanisms to disseminate formal research knowledge and align teaching practices to this at a large scale. The evidence-informed practice model gave rise to a rich field of studies looking into the dynamics of knowledge. These have been described by many different terms: knowledge transfer, dissemination, exchange, knowledge to action,
knowledge mobilisation and so on (Levin, 2008[45]). In the following, we will refer to it as knowledge mobilisation.

Knowledge mobilisation models and networks

Knowledge mobilisation from the perspective of policy can be defined as “intentional efforts to increase the use of research evidence […] in policy and practice at multiple levels of the education sector” (Cooper, 2014[56]). More generally, knowledge mobilisation can include any process that increases the use of research evidence in teaching practice whether intentional, strategic or not. For example, when teachers look up research in an ad-hoc manner to find an answer to their contextual challenge, or when a school inspector recommends research evidence or evidence-informed teaching resources to teachers or schools. The questions in this sense are: what characterises knowledge mobilisation processes and how can networks facilitate these.

Knowledge mobilisation directly implies a need for bridging the gap between research and practice. Levin (2013[57]) captures the phenomenon as an interplay between knowledge production, use and mediation, which he sees as functions of knowledge, emphasising that some individuals and organisations can operate in several of these contexts. Best and Holmes (2010[11]) identify three models of knowledge mobilisation:

- **Linear model** – making research available for users, focusing on “getting the right information to the right people in the right format at the right time” as it was previously defined in the health sector (Levin, 2008[45]).

- **Relationship model** – incorporating linear models but focusing on strengthening the relationship among stakeholders through partnerships and networks to facilitate the link between research and practice. Here knowledge can come from multiple sources (research, theory, policy, practice).

- **Systems model** – building on linear and relationship models, but recognising that agents are embedded in complex systems, and the whole system needs to be activated to establish connections among its various parts.

In a linear model that focuses on disseminating research evidence to teachers, teachers were seen as passive recipients of knowledge. In research, understandings of knowledge mobilisation have increasingly moved away from linear interpretations towards interpreting it as a dynamic and iterative process involving social interactions, feedback loops and co-creation (Campbell et al., 2017[58]). Nevertheless, linear associations often still dominate the education policy discourse and characterise some of the existing practices (Fenwick and Farrell, 2017[44]).

The relationship model translates into understanding knowledge dynamics through networks, in that it looks at the research-practice link in terms of the connection between actors. Social network studies that examine network structures to understand their impact on the use of research in teaching are built on relationship models. Using the concept of network as an analytical lens, this approach is described as a structural capital approach, i.e. one that explains variations in performance outcomes based on network structure (Borgatti and Foster, 2003[25]). Such an approach is particularly relevant for studying formal and explicit forms of knowledge (Cornelissen, de Jong and Kessels, 2012[59]). Cornelissen, de Jong and Kessels propose the following relevant questions:

- How does the position of an individual (e.g. a teacher) in a network impact on the extent to which they can integrate research evidence into their teaching practice?
• How do we identify the key players who are in the best position to lead the required knowledge development?
• What positions can, for example, schools or networks offer individuals to increase their access to relevant information? (Cornelissen, de Jong and Kessels, 2012[59])

Social network studies also look at the inverse impact, for example, how top-down reform initiatives that intend to introduce new knowledge in the teaching profession influence teachers’ social networks. The relationship model underlies networks that were specifically established to further the evidence-informed practice agenda in some countries. Studies of such networks (as social organisations), although still in an early phase, have started to investigate the factors that facilitate or hinder the effectiveness of these – often government supported – networks with regards to knowledge mobilisation.

Brokerage and networks in the linear and relationship models

In both the linear and relationship models, a strong emphasis is placed on mediation, i.e. intermediary actors and processes that bridge the gap between the communities of research producers and users. Again, a multiplicity of terms and definitions are used sometimes interchangeably, for people who have a specific role in bridging the knowledge gap between communities. These include:

• Translators: “individuals who can frame the interests of one community in terms of another community’s perspective” (Brown and Duguid, 1998, p. 103[60]).
• Brokers: individuals who participate in multiple communities and who facilitate the transfer of knowledge between these (Brown and Duguid, 1998[60]; Haas, 2014[61]).
• Gatekeepers: individuals within one community who collect, understand and interpret external information, and translate and diffuse this information to other members of the community (Haas, 2014[61]) often playing a quality assurance role (OECD, 2007[50]).
• Boundary spanners: individuals who represent the interface between areas (within, at the periphery/boundary of or outside a community/organisation) and make intergroup exchanges possible (Haas, 2014[61]).

The term knowledge brokerage has been the most widely adopted by education policies that put the evidence-informed practice agenda at their forefront. In some countries, educational knowledge brokerage has been institutionalised, most often by governments, through establishing agencies dedicated to such efforts (OECD, 2007[50]). Some knowledge brokerage agencies established in the early 2000s still bear the signs of a linear knowledge transfer model. For example, the What Works Clearinghouse’s (WWC) mission – to “provide educators with the information they need to make evidence-based decisions” (Institute of Education Sciences, n.d.[62]) – reflects a linear transmission view. The agency reviews research, determines which studies meet rigorous standards, and summarises the findings (Institute of Education Sciences, n.d.[62]). Products of such agencies are based on the idea of “translation”, i.e. transforming researchers’ knowledge products into products accessible for practitioners. For example, in addition to detailed technical reports, the WWC publishes user-friendly evidence snapshots and practice guides targeted at teachers, administrators and policy makers. This transmission approach assumes that teachers and other actors seek out and mobilise the evidence produced, and little attention is dedicated to establishing direct relationships.
However, most brokerage initiatives today are moving towards a relationship model. A recent study on 44 educational brokerage agencies in Canada identified networks as one of the brokering strategies, in addition to research product, capacity building and support, and event and media strategies (Cooper, 2014[56]). Yet, the study showed that organisations tend to focus on creating research products such as summaries and briefs, more than on organising events or facilitating networks. As the author points out, producing and passively disseminating products is less powerful for changing teaching practice, and a shift towards building stronger networks will be needed in the future (Cooper, 2014[56]). Such a shift is demonstrated by England’s Education Endowment Foundation’s Research School Networks (see section 3.1). To make the best use of such established networks, it is important to understand how knowledge mobilisation is amplified through brokerage, what interactions take place, and how knowledge is exchanged and transformed through these.

The phenomenon of brokerage translates into network science in a straightforward manner: brokers are nodes that act as bridges between sub-groups or cliques of a network (Hanneman and Riddle, 2005[32]). Social network theory (using networks as an analytical lens) studies knowledge mobilisation and brokerage as a function of the attributes of nodes (actors), the nature of ties between them, and the structures and sub-structures of networks.

Critiques of knowledge mobilisation and networks as system models

The evidence-informed practice paradigm and its implications and implementations opened up a strong debate around teacher professionalism, with a key focus on understanding what this means with regards to teachers’ knowledge and teaching practice. Drawing on Cain’s review (2015[3]), some of the major concerns for critics of this paradigm are the following:

- **Research findings cannot be converted into recipes for practice.** Education is a more complex endeavour than research: research findings are by nature narrowly focused, they need to be linked to other findings and contexts, and integrated into a coherent educational theory (Dewey, 1929[63]). Research evidence based on experimentation (such as RCTs) can only show what has happened in the past, not what might happen in the future (Biesta, 2010[64]).

- **Educational means and ends are inter-dependent.** Selecting the most effective means, such as a particular teaching method, depends on the purpose, which in turn can be complex and multiple (Dewey, 1929[63]; Biesta, 2007[48]; Biesta, 2010[64]). “What works” type of research findings tend to have a narrow understanding of the purpose, in terms of academic achievement, learning gain.

- **Educational practice is inherently value-based.** Practitioners must rely on their own experience and judgement, informed by their own values, to make decisions as teachers (Hammersley, 2005[6]). Viewing education as a purely technical matter of achieving an aim underrates the importance of values. Therefore, “what works” research is not an appropriate basis for educational practice, which is fundamentally moral, not simply technical (Biesta, 2007[48]).

- **Research knowledge and teachers’ knowledge differ by nature.** What researchers and what practitioners consider to be well-founded knowledge is very different (Hammersley, 2005[6]). Research knowledge is generalised, propositional, impersonal, abstract and theoretical; it is evaluated for its clarity, coherence and validity; it is narrowly focused and generated by rigorous and rational thinking. On the other hand, teaching is personal in nature, and teachers’ pedagogical knowledge
is context-specific, propositional and practical; its application is focused on complex, multidimensional and unpredictable situations (McIntyre, 2005[65]).

The most prominent critiques of evidence-informed practice criticise the “what works” perspective, and the view that “what works” evidence can be put to practice directly. However, the understanding of evidence- or, perhaps more broadly, research-informed practice has evolved considerably.

First, numerous scholars have suggested more inclusive conceptualisations of evidence (OECD, 2007[50]). Nutley, Powell and Davies (2013[54]) argue that the type and quality of evidence depends on the question, which is not necessarily an instrumentalist view of “what works”. For example, practitioners and decision-makers could be interested in why, when and for whom something works, how much it costs, what the risks are. They may also wish to understand the nature of social problems, why they occur, and which groups and individuals are most at risk. The authors suggest that mapping what kind of evidence can answer what kind of question is more useful than defining a hierarchy of evidence types that does not take the question into account. For example, there are a number of questions, such as “how does it work” and “does it matter”, that qualitative research can answer, whereas RCT evidence cannot (Petticrew and Roberts, 2003[66]). Therefore, insights from systematic reflection of practices or case studies also constitute evidence that can inform practice (Epstein, 2009[67]).

Second, a number of scholars contributed to understanding what we mean by using evidence, or “evidence-informed” in more subtle ways. Research and other sources of evidence are often not used directly, but they shape attitudes and ways of thinking in indirect and subtle ways (Nutley, Powell and Davies, 2013[54]). Kvernbekk (2015[68]) argues that the main function of evidence is support. By examining in-depth the process of teachers’ decision-making and the role of evidence in that, the author points out that evidence is used indirectly, as “backing” to justify the warrant for a decision. In this sense, evidence does not by any means replace professional judgment, nor does it prevent a value-based decision.

The various critiques of using evidence in practice therefore do not mean that research evidence cannot or should not shape teachers’ thinking and teaching practice. They do imply however that knowledge mobilisation is not simply about transferring and translating a narrow set of “codes” from one community to the other. Rather, it involves more complex dynamics through which knowledge transforms. Cain (2015[3]), for example, describes three elements of the process of transformation: conceptual development, reflection on cases drawn from personal experience and the diffusion of research knowledge into areas beyond the original research focus. The transformation process therefore involves a dialogue between different knowledge types (McIntyre, 2005[65]), a selection of and critical reflection on relevant findings based on teachers’ values, knowledge of context, as well as an interpretation of research and its applicability.

It is the systemic view of knowledge mobilisation that best captures the complexity of knowledge dynamics by:

- taking into account the nonlinear, dynamic interactions between a large number of elements
- understanding context and acknowledging that due to the constantly changing nature of external conditions and systems, evidence on the past does not imply evidence about the future
• looking beyond individual cause-and-effect relationships, and focusing rather on emerging patterns
• realising that people in the system both shape and are influenced by the system
• valuing innovation and change, and integrating new knowledge into the system (Best and Holmes, 2010[11]).

This view also means that researchers and research evidence are not the unique facilitators of systemic change. Rather, all actors in the system shape the knowledge creation-synthesis-application process through their interactions, collaboration and co-creation (Van De Ven and Johnson, 2006[69]; Van De Ven, 2007[70]). In line with this view, facilitating teachers’ engagement in and with research has come to be seen as a major element of successful knowledge mobilisation (Hargreaves, 1996[1]; Levin, 2011[71]; Gibbons et al., 1994[72]; Cordingley, 2016[73]). In some countries, central governments have been investing considerable efforts in this by introducing incentives for teachers to mobilise knowledge produced in research as well as actively participate in producing research (Cain, 2015[3]). Universities (in particular, teacher education institutions), regional and local authorities (school boards/districts), as well as schools themselves also launched initiatives (see Chapter 3. for examples).

Understanding knowledge mobilisation as a system model with complex knowledge dynamics also has implications for understanding the role of networks. As complex systems are characterised by multiple elements and their interactions at multiple levels, networks can be a useful analytical lens to study such systems. In this sense, networks are not constant, rather constantly changing, and the focus of attention is on emerging patterns. Network ties are not purely structural “channels” through which knowledge flows, because knowledge transforms in these interactions. The nature and quality of ties (relationships) thus matter for understanding the system. Therefore, examining the nature of ties and the exact processes that characterise interactions is fundamental in this view. Such an “interpersonal relationships” view is a dominant social network research strand that looks at factors such as trust, expertise, engagement in collaborative activities, value of knowledge and reciprocity of knowledge exchange (Cornelissen et al., 2015[74]).

In parallel, networks as social organisations are believed to be powerful strategies for effective knowledge mobilisation under the systems view (Best and Holmes, 2010[11]). A review of literature suggests that the following six factors are central for networks to maximise their benefit:

1. clear common aims
2. trust
3. collaborative leadership
4. sensitivity to power issues
5. shared understanding of membership structures
6. action learning through feedback loops and reflective shared learning (Best and Holmes, 2010[11]).

In sum, this section highlighted the relevance of using networks as an analytical lens to understand knowledge mobilisation. The contribution of network analysis to this field is discussed in section 2.3. It also pointed to the numerous networks that have been established in many countries, and more and more internationally, in service of scaling the
use of evidence in teaching. A handful of these are presented in Chapter 3. The next section discusses knowledge dynamics related to innovation.

2.2.2. Knowledge dynamics for scaling innovation

The second policy issue – how can we generate and scale innovation – has relevance both in the public and private sector and has been studied in a number of fields including economics, communication studies and sociology. How we define innovation depends partly on the perspective and scale. Many general definitions take the point of view of the object of innovation. The new edition of the Oslo manual, for example, defines innovation: “a new or improved product or process (or combination thereof) that differs significantly from the unit’s previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)” (OECD/Eurostat, 2018[75]). In the education context, product innovation can refer to new educational resources such as textbooks, teaching materials and tools. Whereas process innovation incorporates new pedagogies – or existing ones combined and used in new ways –, novel ways of organising schools’ and teachers’ activities, as well as new relations to partners and external organisations (Vincent-Lancrin et al., 2019[71]; OECD, 2014[76]). In this sense, innovation is a function of learning and the creation of new knowledge (Ellström, 2010[77]). Knowledge creation is therefore a driver of innovation (OECD, 2004[78]).

At the scale of an organisation, innovation can be defined as “a process in which the organisation creates and defines problems and then actively develops new knowledge to solve them” (Nonaka, 1994, p. 14[79]). For Nonaka, organisational knowledge creation is a form of innovation itself, therefore understanding the processes of knowledge creation is crucial to understanding innovation. The organisational perspective of innovation has also been dominant in education as well. In particular, the concept of schools as learning organisations has developed as part of the agenda to facilitate organisational change and innovation in education (Kools and Stoll, 2016[80]). Teachers’ knowledge is a fundamental element of all dimensions of learning organisations, and knowledge creation is what brings the collective meaning to organisational learning (Kools and Stoll, 2016[80]).

When defined from the perspective of adopters, an innovation can be “anything that potential adopters perceive to be new, inclusive of new ideas and beliefs, explicit and tacit knowledge, processes and protocols, tools and technologies, even value belief systems” (Larson and Dearing, 2008[81]). In this sense, knowledge is also the outcome of innovation created as a result of the innovation process. This perspectives considers the diffusion of knowledge as central to innovation. Diffusion is “the process by which an innovation is communicated through certain channels over time among the members of a social system” (Rogers, 1962, p. 5[82]). Similarly to knowledge mobilisation, in its early interpretations diffusion was mostly perceived as a linear process of information transmission from a source to a receiver. Rogers (1962[82]) seminal work describes diffusion as a convergence model, in which communication involves creating and sharing information between participants to reach mutual understanding.

Common to all definitions is the intimate link between innovation and knowledge. Understanding innovation systems requires studying knowledge processes such as its creation, transfer and diffusion, absorption and application (OECD, 2009[12]). Dankbaar (2004[8]) represents knowledge processes as a learning cycle (Figure 2.1), emphasising the mutual interactions between each of them. He argues that the contexts of application, innovation and creation together can be regarded as the social contexts of knowledge.
creation; while transfer, diffusion, acquisition and absorption grouped together form the contexts of knowledge diffusion.

Figure 2.1. The four knowledge processes in the learning spiral

Source: Adapted from (Dankbaar, 2004[8]).

Understanding innovation as a system implies that innovation does not happen in isolation, rather, it is an interactive and collective process involving a wide range of actors (OECD, 2009[12]). Collaboration among schools, authorities, professional organisations, and businesses allows access to different sources of knowledge, skills and resources, and it also creates a space for creative thinking and experimentation (OECD, 2009[12]). Relationships, and therefore networks, are central to understanding the generation and the diffusion of innovation (Edquist, 1997[83]).

Knowledge creation models and networks as an analytical lens

Knowledge creation involves generating ideas, designing new approaches, but also combining existing knowledge to solve new problems. It involves converting different types of knowledge, dialogue and learning conversations, collaboration and practice (Kools and Stoll, 2016[80]). For example, when teachers design a pedagogical practice, they create a knowledge base that is comprised of understanding the contexts in which it can be applied, how it can be applied, the support and evaluation mechanisms, etc. The question is then, how knowledge is created, what types of knowledge interact in this process, and how networks can help understand it.

The concept and analysis of knowledge creation originates in theories on learning and human activity proposed by scholars from different disciplines (e.g. psychology, organisational theory, sociology). Three dominant models for knowledge creation that go
Beyond the acquisition and participation metaphors (see section 2.2) are described by Paavola, Lipponen and Hakkarainen (2004[39]): Nonaka and Takeuchi’s SECI model (Box 2.2), Engeström’s model of expansive learning (Box 2.3) and Bereiter’s knowledge building model. These are also relevant from a network perspective, because they all emphasise both the importance of the social process – i.e. “new ideas and innovations emerge between rather than within people” (2004, p. 564[39]), and that of the individual – i.e. its attributes and activities as part of the social system – in knowledge creation.

**Box 2.2. Knowledge management for innovation – Nonaka and Takeuchi’s SECI model**

This knowledge management model aims at understanding how firms innovate, taking Polányi’s (1962[81]) concept of tacit (personal) knowledge as its theoretical basis. Nonaka and Takeuchi (1995[85]) describe knowledge creation as a spiral on four levels: starting at the individual level, then “ascending” to the group, organisational, and inter-organisational levels. The basic source of innovation in this model is tacit knowledge. This needs to be made explicit in order to be transformed into knowledge that is useful at the levels of the group and the whole organisation. Nonaka and Takeuchi (1995[85]) identify four phases of the “knowledge spiral”, each of which represents a transformation of the type of knowledge (Figure 2.2).

**Figure 2.2. SECI model with examples in the education context**

Source: Adapted from (Nonaka and Takeuchi, 1995[85]).
The centrality of interactions and collaboration in Nonaka and Takeuchi’s knowledge spiral (Box 2.2) can be translated into a network perspective by taking the school as an organisation with its sub-structures of teacher groups, or wider education networks as the unit of analysis. The object of analysis is then the connection between members and the processes through which they create common understanding and exchange ideas.

Engeström and his colleagues study work-based learning based on activity theory (Box 2.3). They have used a formative intervention method, called the “change laboratory” or “boundary-crossing laboratory”, to guide the reflection of members of a workplace community on their activities as teachers, health professionals, librarians, etc. (Engeström, 1994; Engeström, Engeström and Kärkkäinen, 1995; Engeström, Rantavuori and Kerosuo, 2013). Boundary crossing means that practitioners seek out and give help to others from a different organisational, epistemological, professional community. Appropriate tools (“boundary objects”) such as forums, knowledge repositories and visual models, as well as discursive methods and activities were shown to be important for successful knowledge dynamics through boundary crossing (Engeström and Sannino, 2010).

### Box 2.3. Activity theory – Engeström’s model of expansive learning

This model is based on cultural-historical activity theory (CHAT), a theory widely used by researchers to understand the relationship between the human mind and activity. It originates in Vygotsky’s (first generation) activity theory, which posits that human behaviour cannot be understood independently of the socio-cultural context in which they are embedded, and the society cannot be understood without the agency of the individuals (Engeström, 2001). Leontiev’s (second generation) activity theory added the notion of collective activity, and shifted the focus from the individual to the interrelations between the individual and the community (Engeström, 2001). Engeström’s (third generation) theory tackled the issue of cultural diversity with new conceptual tools to understand dialogue, multiple perspectives and networks of activity systems (Engeström, 2001). His major concept, particularly relevant to professional learning, is “expansive learning”.

The idea of expansive learning is based on the observation that what people (e.g. teachers) learn, is most often not something fixed and pre-defined. Therefore, learning cannot simply be acquisition- or participation-based, as it involves not only the construction of new objects and concepts, but also the transformation and creation of culture (Engeström and Sannino, 2010). His expansive learning cycle (Figure 2.3) consists of seven stages, starting with individuals questioning their existing activity, analysing it, then developing a new solution, testing and implementing it, and finally reflecting on the process and consolidating practice (Engeström and Sannino, 2010).
Another socio-material approach closely related to activity theory, is actor-network theory (ANT), which provides a network analytical lens to explore the ties between human actors and material objects. ANT – developed in the early 1980s by science and technology studies scholars and sociologists – helps understand how interactions between humans and objects influence actors’ knowledge in particular contexts (Carroll, Richardson and Whelan, 2012[91]; Mulcahy, 2012[92]). It posits that things and people act upon other objects or humans when they participate in the same network, without which their actions are meaningless (Fox, 2002[93]). For example, an interactive whiteboard can act upon students when the teacher uses it in the lesson, and this forms a temporary network of the teacher, students and the board. The object of analysis in this theory is the emergence of new networks and the collapse of old ones, and it looks at learning as an aspect of this process (Fox, 2002[93]; Fenwick and Nerland, 2014[94]). ANT has been increasingly applied in the field of education, including to understand teachers’ knowledge building (Mulcahy, 2012[92]).

Several network analytical approaches can be applied to knowledge creation processes: including social network analysis to examine boundary crossing, or ANT to explore the emerging configurations between not just human actors, but different elements of the innovation system. The next section explores various network concepts and configurations that have emerged from research on professional practice, knowledge and learning.

**Knowledge creation and networks as social organisations**

A rich field of practice-based studies explore knowledge as a process taking place within situated practices (Gherardi, 2009[95]; Gherardi, 2008[96]). Within this vast field, Lave and
Wenger’s situated learning theory (Lave and Wenger, 1991[97]) together with Brown and Duguid’s work on organisational learning (Brown and Duguid, 1991[98]) were among the most influential in education by establishing the notion of communities of practice (CoP). Originally CoPs were defined as a group of people with shared concerns who deepen their knowledge about a topic collectively and create knowledge together (Wenger, 1998[99]; Enthoven and de Bruijn, 2010[100]). From the perspective of knowledge creation in networks, Brown and Duguid’s work is particularly relevant, as it understands communities of practice as informal networks that work on finding new solutions to problems (Cox, 2005[101]). A closely related concept is that of professional learning community (PLC), to which, similarly to CoPs, multiple definitions exist (Cox, 2005[102]; Enthoven and de Bruijn, 2010[100]). Stoll and colleagues (2006) define PLC as: “a group of people sharing and critically interrogating their practice in an ongoing, reflective, collaborative, inclusive, learning oriented, growth promoting way, operating as a collective enterprise” (Enthoven and de Bruijn, 2010[100]). Finally, the term professional learning networks (PLN) has become increasingly more popular to describe “individuals from one or more schools and/or other interested organisations, who have come together from outside of their everyday community of practice to focus on achieving specific goals” (Brown and Poortman, 2018, p. 3[13]). An OECD study of 27 educational innovation networks established a typology based on the main purpose of such networks (see Box 2.4) (Paniagua and Istance, 2018[6]).
An OECD study of 27 educational innovation networks established the following typology based on the main purpose of such networks.

**“Pedagogical Approach Networks”**

Network of schools woven together by a common approach that is made up of a complex set of elements including a philosophy of learning and pedagogy. The approach is often deliberately constructed to rectify certain shortcomings apparent in mainstream schooling. As these networks encourage building coherence around the approach, they work towards developing shareable knowledge. These emerge within a range of variations, while it remains easy to identify the underlying approach.

Examples:
- Art of Learning (Scotland)
- Lumiar Institute International (Brazil).

**“Innovation Promotion Networks”**

The emphasis in these networks is on sharing and discussing diverse innovations that are built around a common pedagogical core. The networks themselves are conceived as “spaces” in which teachers are connected by their desire and experience in innovating, for example within the same subject or in similar contexts. In these networks, there is no specific collective knowledge privileged and shared, rather various knowledge elements come together, are questioned, compared and further developed through such confrontations. Reflection on and evaluation of practices are key in network processes. Teacher forums or conferences are typical mechanisms to facilitate such networks.

Examples:
- OPEDUCA Project (Netherlands/International)
- Red Escuelas Lideres (Chile).

**“Professional Learning Networks”**

Similarly to Innovation Promotion Networks, the main mission is the dissemination and sharing of innovative practices among teachers and schools. However, these are informal networks that developed from a professional development initiative. The specific teacher training programme/initiative relates to a particular pedagogical approach, and the main source of knowledge is originally provided by the leading organisation – typically an external organisation, such as a teacher association, university unit or third sector organisation. The programme is the initial context, in which participating teachers start to develop relationships among each other and their respective schools. Over time, these relationships develop into an informal network, through which teachers can share their experiences and knowledge.

Examples:
- Galileo (Canada)
- Computing at Schools (United Kingdom).

Source: (Paniagua and Istance, 2018).
Several studies have demonstrated the complexity of knowledge dynamics in professional communities and networks. A review of over 300 studies on communities of practice in different contexts (craft workers, task specialists, public sector professionals, online communities, creative artists, scientists and technicians) by Amin and Roberts (2008[40]) identified different knowledge types relating to various CoP activities. These include kinaesthetic and embodied knowledge, specialised expert knowledge, the epistemic knowledge of standards and codes, tacit and codified knowledge. In contrast, Enthoven and de Bruijn (2010[100]) focus on the interplay of two types of knowledge: local practical knowledge produced by practitioner research – also referred to as Mode 2 knowledge (Gibbons et al., 1994[72]) – and generic or public knowledge. The former is defined by its practical value in a particular context with a particular use, while the latter should be more universally applicable, for example knowledge originating from research on learning.

Enthoven and de Bruijn (2010[100]) consider PLCs and CoPs as networks within and between schools that aim at collective learning and knowledge creation. The authors’ question – highly relevant to this paper – relates to scaling local knowledge, i.e. exploring the mechanisms that enable the creation of generic practice-based knowledge in such networks. Their review of three books on PLCs and CoPs reveal that:

- Networks lack clarity regarding their objectives, intended products and mechanisms: professional learning as one common objective is not operationalised into an intended product; lack of clear collective understanding of the sort of knowledge to be created and the mechanisms enabling knowledge creation.
- Practitioner research in networks aim at practical innovations and changes through teacher learning instead of through evaluations of innovations.
- While networks claim the objective of inducing change beyond the local context, they do not create generic (public) practical knowledge.
- To create generic practical knowledge, external research resources such as mentors or coaches are required.

**Nuancing knowledge creation: the role of research**

New knowledge is not created out of nothing, it originates in experience, practice and existing knowledge sources. Lieberman (2000[103]) highlights the importance of these knowledge sources that are often heterogeneous in a network that brings together different communities. In order that teachers feel as equal partners, their experiential knowledge needs to be valued and balanced with research knowledge (Lieberman, 2000[103]). This balance is reflected in the various forms of knowledge creation in schools. Action research or practitioner research, collaborative enquiry and design-based research have developed as tools or strategies for school improvement and innovation through knowledge creation.

- **Action research** is a “systematic process of practitioner problem posing and problem solving” (Kuhne and Quigley, 1997, p. 23[104]). Its main goal is to better understanding the teaching and learning related problem and improve the practice. The practitioner is both the researcher and the teacher. It is a trial-and-error approach that consists of four key stages: planning, acting, observing and reflecting (Kuhne and Quigley, 1997[104]).

- **Collaborative enquiry** is an adaptation of action research, in which teams of educators explore and answer questions about their professional practice (Townsend and Adams, 2014[105]). It has been described as “a process of knowledge
generation, occurring when researcher and practitioner knowledge meet in particular sites, aimed at producing new knowledge about ways in which broad values might better be realised in future practice” (Ainscow et al., 2016, p. 10[106]).

- **Design-based research** is a methodology in which an intervention is developed as a solution to a practical teaching and learning related problem. The intervention is then tested and adapted in iterative cycles of design, enactment, analysis and redesign. It has a double goal of designing learning environments and developing theories of learning with relevant implications to practitioners, and these goals are intertwined. It is realised through a collaboration between researchers and practitioners (Design-Based Research Collective, 2003[107]).

These methods are rooted in teacher professionalism: they share pragmatism and innovation as a problem-solving process that aims to address the challenges of a classroom (Paniagua and Istance, 2018[6]). At the same time, they are strongly research-based: they involve data collection and analysis, and research documentation. Collaborative enquiry often directly builds on available research knowledge, while design-based research also aspires to contribute to the wider learning sciences. Clearly, knowledge creation for innovation cannot be interpreted independently of education research.

Innovation-oriented research methods can also be directly linked to research evidence. The Design-Based Research Collective (2003[107]) points out that, by linking processes to outcomes in particular settings, design-based research generates causal accounts while recognising the complexity of the context. They further suggest that design-based research can serve as a valuable complement to controlled laboratory experiments or randomised control trials. In particular, it can help identify the relevant contextual factors and mechanisms (beyond relationships), and enrich the understanding of the nature of the intervention (Design-Based Research Collective, 2003[107]).

In sum, knowledge creation, use and diffusion can be seen as conditions for professional networks to achieve their potential of innovation and change at scale (OECD, 2003[20]). Yet, the literature on teachers’ knowledge processes in innovation networks and how they relate to network outcomes on teaching practice and student learning is still limited. The next section looks at the ways in which social network analysis can help understand the impact and role of networks on teachers’ knowledge dynamics.

### 2.3. Network analysis to understand knowledge dynamics

There is a growing number of social network studies that investigate the relationship between teachers’ networks and educational change (Daly, 2012[108]). Emerging findings suggest that social policies can not only influence the structure of networks, but also mobilise resources that teachers access and introduce new types of interactions among teachers (Coburn, Mata and Choi, 2013[109]). The foci of these studies include investigating the relationship between teachers’ social networks and various change processes. These latter – often dependent on the primary concerns of the education systems – can be the implementation of particular reforms (e.g. in the United States), professional development, school improvement initiatives (e.g. in the United Kingdom and the United States), the use of research (e.g. the People’s Republic of China, United Kingdom) and the use of data in schools (e.g. in the Netherlands, Sweden).

The following sections highlight a number of network characteristics studied as well as their role in teachers’ knowledge mobilisation, and the creation and diffusion of knowledge. Since only few studies look specifically at integrating research knowledge in teaching
practice, knowledge mobilisation is interpreted here slightly more broadly than in the previous section. For example, a number of studies using network analysis have been conducted on the use of data to inform teaching practice. Data-based decision-making consists of collecting and organising quantitative or qualitative data and information of students, teachers and teaching, parents and schools and use this for a strategic improvement of education (Lai and Schildkamp, 2013[110]; Hubers et al., 2017[111]). The implementation of reforms is also relevant as it typically includes integrating new knowledge such as that of a new curriculum in the system. Concerning knowledge creation and diffusion, a large number of network studies have been focusing on innovation diffusion and the “contagion” of social behaviours. Although many of these relate to either private sector innovations or focus specifically on the health sector within public services, they are relevant for education and can be translated to the diffusion of teachers’ knowledge and practices.

2.3.1. Network structure
The distribution of ties in a network can influence access to new ideas and information as well as sustainability of change. For example, “closed networks” that are characterised by a large number of strong internal ties may have less access to new ideas, and may be less prone to innovation (Granovetter, 1973[112]; Baker-Doyle and Yoon, 2011[113]). On the other hand, networks that demonstrate a lack of ties and generally low connectivity have fewer opportunities to exchange knowledge and might find it difficult to disseminate new knowledge and sustain change (Baker-Doyle and Yoon, 2011[113]). Centralised networks, in which one or a few actors have many ties, whereas the majority only few, can however be effective in disseminating codified knowledge such as formal research knowledge.

The main assumption behind knowledge mobilisation is that there is a lack of connection between research and practice, and hence between researchers and practitioners. Granovetter (1973[112]) argued that communities with strong internal links tend to lead to an overall fragmentation of the macro network, such as disconnected cliques. This phenomenon has also been described as “structural holes”, referring to a lack of direct contact between entities (Burt, 1992[114]). Sub-groups in education form not only along the different stakeholder groups, but cliques can also exist within the community of practitioners. Too many cliques can reduce the ability to take risks or make big changes (Daly et al., 2010[115]). The same holds for too centralised networks (Daly et al., 2010[115]).

The network structure plays a crucial role in the generation and diffusion of innovation as well. Research has shown that while networks with many structural holes are conducive to generating new ideas, they are the least appropriate to integrate innovation (Long, Cunningham and Braithwaite, 2013[116]). A network with closely tied sub-groups linked by weak ties is the ideal structure for generating and producing innovation, while evidence also suggests that increasing the number of structural holes eventually becomes counterproductive (Long, Cunningham and Braithwaite, 2013[116]). Diffusing new knowledge about teaching and learning can be described as “complex contagion”, meaning that one simple interaction is not enough to transmit them (Centola and Macy, 2007[117]). Cohesive (high density) networks are more effective in spreading such complex and often tacit knowledge than sparse networks (with more structural holes) (Long, Cunningham and Braithwaite, 2013[116]).
2.3.2. Network nodes

The position of actors in a network – whether they are isolated, embedded or centralised – can influence not only their perceptions, but also the overall dynamics of knowledge in a network (Baker-Doyle and Yoon, 2011). A study specifically looking at the influence of network characteristics on research use in schools showed that teachers who have more frequent and useful interactions with their colleagues on teaching and learning are also more positive about the research use climate in their school (Brown, Daly and Liou, 2016).

The individual attributes of members are however equally important. For example, teachers’ prior knowledge of research on a topic, their attitudes towards the use of research or data, and their reasons for participating in collaborative activities may all influence the overall effectiveness of knowledge mobilisation within a network (Lai and Schildkamp, 2013). Knowing who in the network has expertise in various fields or topics can also be crucial in ensuring effective knowledge mobilisation (see also below) (Coburn, Choi and Mata, 2010).

How the positions and attributes of members are matched matters greatly for effective knowledge mobilisation. When central actors are those who have the knowledge or access to external knowledge, and positive attitudes towards research evidence on teaching, the network has a greater capacity for knowledge mobilisation (Baker-Doyle and Yoon, 2011). On the other hand, the network will not be able to benefit from highly knowledgeable individuals who are isolated. Such members are sometimes described as “silent experts” (Mueller-Prothmann and Finke, 2004).

Studying the behaviour and characteristics of brokers who bridge structural holes is one key area of social network theory. Granovetter argued that weak ties play a crucial role in connecting different communities (Granovetter, 1973). For knowledge mobilisation in education, this implies that the role of brokers who do not belong to either the community of researchers or that of teachers can be important in linking this structural hole.

Brokers in education could be teacher educators who provide professional development, coaches and mentors, and school inspectors for example. Social network studies have shown that while coaches and outside contacts can function effectively as knowledge brokers who bring outside information and materials into teachers’ social networks, this role is sensitive to support (e.g. from the school district). However, after initial external brokering, teachers can also become brokers (Coburn et al., 2012; Coburn, Mata and Choi, 2013; Coburn, Choi and Mata, 2010). It has also been widely emphasised that brokers need to be equipped with special skills that enable them to diffuse their own knowledge (Akkerman and Bakker, 2011). For example, Lomas (2007), who studied 400 knowledge brokers in the health sector, identified the following skills:

- entrepreneurial (networking, problem solving, innovating)
- trusted and credible
- clear communicator
- understands the cultures of both the research and decision-making environments
- able to find and assess relevant research in a variety of formats
- facilitates, mediates and negotiates
- understands the principles of adult learning (Lomas, 2007, p. 130).
In addition, brokers need support in order to function optimally, as their role of accessing and transferring specialised knowledge can easily be overwhelming (Long, Cunningham and Braithwaite, 2013).  

2.3.3. Network ties

Relationship between actors often develop based on homophily, i.e. between members with similar characteristics, or proximity, i.e. physical or geographical closeness. In a school for example, teachers teaching the same subject or same grade, those who have similar teaching and learning related beliefs, or those who share an office tend to form stronger connections. If such sub-groups are too closed, they have limited opportunities to external influences and knowledge (Baker-Doyle and Yoon, 2011). For example, closed same subject or same grade teacher cliques can inhibit the circulation of knowledge that could be relevant across disciplines such as general pedagogical knowledge, or across age groups and grade-specific curriculum.

Centola and Macy (2007) have also shown that while weak relational ties, such as more distant acquaintances and less frequent contacts, are important to access new ideas, such ties do not facilitate the spread of complex knowledge or behaviours. The authors demonstrated the importance of the width of bridges, i.e. the number of ties connecting two distant nodes. For effectively spreading and integrating new knowledge, a higher number of connecting ties between the various sub-groups (such as cliques of same subject teachers or the teacher and researcher communities) is more favourable (Centola and Macy, 2007).

Aral and van Alstyne (2011) examine the relationship between network diversity and the “bandwidth” of ties (the volume of communication between nodes) (Figure 2). They conclude that in an environment in which actors hold homogeneous knowledge, have a large scope of knowledge (e.g. many topics) and the knowledge environment changes rapidly with frequently appearing new information, high bandwidth is more favourable for providing access to new information. In the context of education, this can be the situation when teachers work in an intense reform period (e.g. changing curriculum, changing requirements). In this case, closely tied teacher networks (e.g. same subject or same grade teachers within a school) have a higher potential to access and mobilise new knowledge. On the other hand, if actors have relatively heterogeneous knowledge, with a limited knowledge scope (e.g. fewer topics), but the overall knowledge base is fairly constant, network diversity has a greater impact on access to new information. This might hold for knowledge mobilisation and brokerage across the researcher and teacher communities.

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2 Diverse networks here refer to networks in which an actor generally has many non-redundant contacts, two actors are rarely connected to the exact same nodes and the network is rich in structural holes (Aral and van Alstyne, 2011).
2.3.4. Network context

A number of contextual characteristics have been found important for the exchange and flow of resources in a network. First, school leadership plays an important role in enabling the use of research and data among teachers (Schildkamp, Smit and Blossing, 2017[125]). Formal leaders have the power to provide resources such as time or access to facilities. They can also encourage and support teachers, for example by acknowledging the importance of their work and efforts of mobilising knowledge (Schildkamp, Smit and Blossing, 2017[125]). As part of the leadership culture of a school, a clear vision, norms and goals related to the use of research and data is important to facilitate their use among teachers (Schildkamp, Smit and Blossing, 2017[125]).

Second, school climate, and in particular, trust matters. For example Brown, Daly and Liou (Brown, Daly and Liou, 2016[118]) showed that teachers who report a positive school climate regarding learning, experimentation and valuing new ideas, also report more use of research and evidence. This means that a school focused on organisational learning will be more able to integrate research evidence in teaching practice. The same holds for trust: higher levels of perceived trust in the school are associated with higher levels of research use (idem.).

Third, training and support directed specifically at the use of research is important. Some studies showed that coaches can support the use of data by transmitting specific expertise,
modelling behaviours and supporting teachers in the process (Schildkamp, Smit and Blossing, 2017[125]).

Finally, where the interactions take place is an interesting question with the increasing use of online spaces for networking. In general, social ties on the internet mirror real-world situations. For example, people occupy similar positions in real-world and online networks (Yeh and Luo, 2001[126]). A study looking at how parallel real-world and virtual interactions played a role in a research collaboration of teachers found that online collaboration both extended and complemented weak collaborations in the real world. Online interactions can overcome the constraints of time and space by expanding the breadth of interaction and dissemination (Lin et al., 2016[127]).

2.3.5. Summary

Overall, research has consistently shown that the extent to which knowledge permeates a network such as teachers in a school or the professional teaching community as a whole, is shared and used across the members depends largely on the network characteristics (Baker-Doyle and Yoon, 2011[113]). The social context of teachers needs to be recognised and considered in any knowledge mobilisation effort. A mapping of the existing network characteristics, such as who the central actors are, what the cliques are, how ties are formed, where ties lack, etc. can usefully inform such efforts. Vice versa, network characteristics can change as a result of explicit attention and effort (Coburn, Choi and Mata, 2010[119]; Hubers et al., 2017[111]). Such influence includes building leadership capacity, introducing trained coaches, building collaborative structures, and developing specific competences of knowledge brokerage and change agents (Hubers et al., 2017[111]).

As demonstrated above, networks are relevant for understanding knowledge dynamics as these relate to evidence and innovation scaling. The next chapter will illustrate this through a selection of specific networks.
3. Understanding the dynamics of teachers’ knowledge in networks: Selected cases

There are numerous networks aiming at scaling evidence and/or innovation in education, and their number is growing (Hargreaves, 2003[128]; Paniagua and Istance, 2018[6]; OECD, 2003[20]). This chapter describes knowledge dynamics in a number of selected networks and analyses these (as social organisations) in terms of their structures and processes. The examples have been selected either because they are historically important (reflecting early efforts and long-lasting activity), or because research has been conducted to understand their impact on teachers’ knowledge. The selection also aimed to illustrate different scales from small to large networks with a national and international scope. Some of them have a stronger focus on scaling evidence, others on generating and scaling innovation.

3.1. Networks created by knowledge brokerage agencies – England (United Kingdom)

Knowledge brokerage agencies have the mission to systematise research evidence by producing systematic reviews for example. They are also tasked with making research accessible for teachers, i.e. translating the results for a non-research audience, reaching and engaging teachers in using these. Beyond simply producing products, achieving these objectives involves increasingly more actively building relationships between the researcher and practitioner communities.

An emphasis on bringing together researchers and practitioners is manifest for example, in the strategic commitments of the Teaching and Learning Research Programme (TLRP) running in England (United Kingdom) between 2000 and 2011 (OECD, 2007[50]). Two of the six commitments – user engagement for relevance and quality; partnerships for sustainability – relate to engaging teachers and making links. The intended knowledge dynamics are expressed in three other commitments:

- knowledge generation by project teams
- knowledge synthesis through thematic activities
- knowledge transformation for impact (OECD, 2007[50]).

The sixth commitment, “capacity-building for professional development”, can be regarded as an enabler of the intended knowledge dynamics. It is important to note that knowledge dynamics is not limited here to knowledge mobilisation (in the sense mobilising existing formal research knowledge), but includes also generating knowledge and transforming it. In fact, an evaluation of the TLRP reveals that partnerships have been a key enabler of impact: projects in which research institutions collaborated with partner schools in co-conducting research or testing findings showed greater impact on teaching practice (Parsons and Burkey, 2011[129]). This suggests that there is a link between extending the scope of knowledge dynamics and incorporating partnerships and relationship building in the central activities.

The new generation of the United Kingdom’s brokerage effort, the Education Endowment Foundation / Sutton Trust (EEF), broadened the scope even further by applying an “evidence ecosystem” model. In this model, the evaluation, synthesis, translation and use of research, as well as innovation are explicitly linked (Gough, Maidment and Sharples,
The activities include synthesising evidence, generating new evidence and supporting schools in using this evidence (EEF, 2019[131]). This latter is realised through a strategic approach to scaling up evidence that involves the “Research Schools Network”. This network of schools, launched in 2016 and comprised of 39 schools in 2019, supports the use of evidence to improve teaching practice (EEF, 2019[131]). Member schools – appointed through a competitive application process – work with other schools in their region to help them use evidence to inform their teaching through:

- “encouraging schools to make use of evidence-based programmes and practices through regular communication and events
- providing training and professional development for senior leaders and teachers on how to improve classroom practice based on the best available evidence
- supporting schools to develop innovative ways of improving teaching and learning and provide them with the expertise to evaluate their impact” (EEF, 2019[131]).

In this network, knowledge brokers are teachers and school leaders themselves, whose activities are situated in a space between the brokerage agency (EEF) and schools. Due to the special mission of brokering, network members themselves need to excel in using research knowledge in teaching. However, knowledge dynamics in the network goes beyond knowledge mobilisation. It involves knowledge creation (“generating new evidence”), manifesting in innovation being facilitated in schools. Innovation is specifically related to improving teaching and learning, and the focus on evaluating impact suggests that these innovations can in turn feed back into the evidence that EEF synthetises. Indeed, the Innovation Evaluation Handbook makes this explicit:

_The goal of the innovation evaluation fund is to increase the evidence base of what works in education by conducting evaluations of innovations in teaching and learning approaches, communicating the findings across the Research Schools Network and beyond, and encouraging applications for larger, rigorous evaluations of promising approaches (IEE, 2017, p. 1[132])._

The EEF measures the efficacy of its own strategies in terms of the outcome stated in their mission – the attainment of disadvantaged pupils – using experimental trials (Gough, Maidment and Sharples, 2018[130]). Nevertheless, since the Research Schools Network is a relatively recent initiative, network related effects haven’t yet been extensively explored.

Overall, brokerage agencies generally undertake little evaluation of the impact of their work on ultimate beneficiaries (Gough, Maidment and Sharples, 2018[130]; OECD, 2016[133]). Challenges include the limitation of research methods and the subjectivity of outcome measures that are based on self-reported impact (Gough, Maidment and Sharples, 2018[130]). Future research could be directed at identifying network characteristics and approaches that facilitate (or hinder) teachers’ knowledge dynamics.

### 3.2. Research Learning Networks – England (United Kingdom)

As part of the knowledge mobilisation efforts in the United Kingdom, the University College London (UCL) established Research Learning Networks – funded by the EEF – to facilitate evidence-informed teaching practice at scale (Brown, 2018[134]). Brown (2018[134]) presents a case study of two small networks realised in one of England’s Teaching School Alliances (TSA). Both networks focused on enhancing the evidence use in two areas of interest identified in the TSA: growth mindset and assessment for learning. The following
description of how the networks facilitated knowledge dynamics is based on Brown’s (2018) case study. The approach to achieve the goals was based on three core ideas that can be translated to the following:

- **Knowledge creation**: Mobilising research knowledge starts with knowledge creation, a carefully constructed activity that brings together researchers and teachers, and allows for the combination of formal and practical knowledge.
- **Change agents**: Selecting “the right people” from the member schools, i.e. those who have the most potential to promote research use and bring about change among teachers in the school.
- **Capacity building**: Equipping selected change agents with specific competences to lead change.

The knowledge creation activity is grounded in Nonaka and Takeuchi’s (1995) model (see Box 2.2) to take into account the evolution of tacit and explicit knowledge. It also draws on Flyvbjerg’s (2012) theory that emphasises the importance of practical application in developing expertise. The activity consisted of “learning conversations” between researchers and teachers, in which researchers brought in the formal research knowledge on the topic, and teachers contributed with the knowledge of their context, and experience of effective practices. Rather than a consecutive sharing of the two types of knowledge by the two communities, “learning conversations” followed an established protocol that allowed for continuous blending of research and practitioner knowledge, and meaning making.

Two change agents were selected from each member school: the school leader and an opinion former, i.e. a person to whom teachers turn to for expertise and who has a central position in other areas as well. The opinion former was identified through social network analysis. By identifying the most central teacher in the school with regards to the criteria, the network analytical approach informed the research network as an organisation.

A cycle of enquiry was employed to build evidence-informed practice across the network. The cycle consisted of four workshops for the change agents, each followed by within-school “inter-sessional” activities facilitated by these (Table 3.1).

### Table 3.1. Cycle of enquiry in research learning networks

<table>
<thead>
<tr>
<th>Workshop</th>
<th>Inter-sessional activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand the research and network held knowledge, and what impact looks like</td>
<td>Share new knowledge, refine research questions, collect baseline evidence</td>
</tr>
<tr>
<td>Develop research-informed approach to improve practice</td>
<td>Trial approach, collect data on effectiveness</td>
</tr>
<tr>
<td>Refined approaches, introduce idea of whole school change, change tools and approaches</td>
<td>Roll out initiative across the school</td>
</tr>
<tr>
<td>Examine impact and how to share knowledge across and beyond network</td>
<td>Share impact data to further promote take-up</td>
</tr>
</tbody>
</table>

*Source: Adapted from (Brown, 2018)*
The impact of the Research Learning Network approach was found to be positive: it helped participants engage with research, better understand the focus area, and develop strategies based on their own knowledge and the knowledge brought in through the network. It also facilitated intra-school learning communities.

With regards to the network approaches and characteristics that were put in place to facilitate knowledge dynamics, the following should be noted:

- The focus was limited to specific areas that were identified based on the needs within the Teaching School Alliance.
- Targeted knowledge dynamics were more than simply transferring formal knowledge. It involved knowledge construction that consisted of combining formal and practitioner knowledge.
- The approach to brokering is similar to the Research School Networks: selected practitioners – school leaders and teachers – became brokers themselves. These brokers were purposefully selected as high-potential change agents. Their selection was informed by teachers’ existing social network characteristics.
- Knowledge dynamics processes were anticipated and a carefully constructed approach was put in place to facilitate these (learning conversations, cycle of enquiry).
- There were clear pre-established measures of impact.

While this study reports on the impact of a specific approach, little is known on comparing the impact of different network approaches. In order to identify what factors, approaches, structures and processes are more impactful, there is a need to systematise evidence on the different network approaches.

### 3.3. Knowledge Network for Applied Education Research (KNAER) – Canada

Fostering research collaboration through networking and partnerships, and mobilising well-validated bodies of knowledge to shape education policy and practice are among the key components of the Ontario Research Strategy. As part of this strategy, the Ministry of Education launched the Knowledge Network for Applied Education Research (KNAER) in 2010 (Campbell et al., 2017[58]). Campbell and colleagues’ (2017[58]) research analyses the knowledge mobilisation approaches applied in KNAER, and has particular relevance to this paper as it also describes the evolution of the network as a result of monitoring and evaluation processes. The following description of the KNAER is based on this research.

The KNAER was governed by a partnership consisting of the Ministry of Education of Ontario, the University of Toronto and Western University. To operationalise knowledge mobilisation in the region, a committee of this partnership published a call for proposals, as a result of which 44 projects (networks) were funded. The projects fell in one of the four categories of knowledge mobilisation (Table 3.2). Using Best and Holmes’ typology (see section 2.2.1), the authors point out that although exploiting research and visiting world experts seem to be built on a linear conceptualisation of knowledge mobilisation, in practice, many projects put emphasis on relationship building and engagement. In fact, building and stimulating networks is a success factor common across all categories.
The research also showed an evolution of the concept of knowledge mobilisation in KNAER over time. While the first phase was focusing on linear transmission of research knowledge towards practice, an evaluation of the interim reports revealed a lack of knowledge and skills across the projects in realising effective knowledge mobilisation. To address this, the KNAER team started to provide support and capacity building in this area to the projects, which then adopted a more complex, relationship focused approach. Campbell and colleagues’ conclude by emphasising the importance of a systemic approach to knowledge mobilisation that recognises the importance of quality products, collaborative relationships, developing capacity on knowledge mobilisation and addressing challenges system-wide.

Although the impact of the KNAER initiative on teaching practice was not examined in this research, a number of project examples are mentioned related to this. The examples suggest that the following factors made knowledge mobilisation in networks more impactful or successful:

- facilitating professional learning among teachers
- involving multiple perspectives and understandings, including those of teachers’, in the process of knowledge mobilisation
- using action research to involve both researchers and teachers in collaborative work.

Source: Based on (Campbell et al., 2017[58]).
Regarding the last point, knowledge mobilisation through collaborative (action) research has been recognised for enabling network members to develop knowledge for practice (Cornelissen et al., 2011{[136]}). The next example looks at a network focusing on this type of activity.

3.4. School-university research network – the Netherlands

Conducting research in schools can be a powerful way of knowledge mobilisation. A typology of school–university research networks identified three types of networks based on the relationship between schools and universities:

- Service relationship:
  - with school-set research agenda: schools determine the research agenda and the university serves this e.g. by providing teachers with research training
  - with university-set research agenda: schools serve the university’s agenda e.g. by allowing university researchers to collect data.

- Complementary relationship: research agendas can co-exist, research can be initiated by either the school or the university, and can be conducted in parallel. Mutual engagement with each other’s research is limited.

- Collaborative relationship: the research agendas, methods and outcomes are negotiated and collective research activities are undertaken, high degree of mutual engagement. (Cornelissen et al., 2011{[136]}).

A specific form of such networks aiming to develop, share and use research-based knowledge to increase evidence-based practice is realised in the framework of postgraduate Master’s programmes for in-service teachers (Cornelissen et al., 2011{[136]}). Such a network established in the Netherlands is described by Cornelissen and colleagues (2011{[136]}; 2015{[74]}), and is presented below.

The school–university research networks consist of students enrolled in a master’s programme for in-service teachers, their supervisors at the university, the students’ colleagues (teachers and school leaders) in the schools where they work as teachers, and colleagues and management of the university. The network studied by Cornelissen and colleagues focused on special educational needs, which was the object of students’ practice-oriented research. The network demonstrated the characteristics of a service relationship with a school-set research agenda, in that teachers who enrolled in the programme chose their research topics, and the university played a support role. Students and their supervisors formed a collaborative learning and enquiry group. A specific purpose of the network was to connect schools through the research conducted by their teachers (master’s students) to develop useful knowledge across the schools. The network offered a possibility for the university to better understand how their programme can support such development, while for the schools it offered a form of professional development.

The study is particularly relevant to this paper as it proposed a framework for network characteristics with regards to knowledge mobilisation. Table 3.3 shows this framework with characteristics of network members, their relationships and the context of events (knowledge processes in which network members participate). Overall, the framework was found relevant for exploring knowledge development, sharing and use, and the authors suggest that it could serve as guidance to schools and universities in creating conducive environments for effective knowledge dynamics. They also pointed to the need to further
research how the various elements play out in different types of school-university research networks.

Table 3.3. Network characteristics and knowledge mobilisation

<table>
<thead>
<tr>
<th>Members</th>
<th>Relationships</th>
<th>Context of events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trust</td>
<td>the belief of network members that the other members are benevolent, reliable, competent, open and honest</td>
<td>Purpose</td>
</tr>
<tr>
<td>Activities</td>
<td>how they develop, share or use knowledge</td>
<td>Power</td>
</tr>
<tr>
<td>Cognitions</td>
<td>their thoughts and considerations before, during or after processes of knowledge development, sharing and use</td>
<td>Collaboration</td>
</tr>
<tr>
<td>Meta-cognitions</td>
<td>their thoughts and considerations before, during or after knowledge processes referring to the regulation of knowledge development, sharing and use</td>
<td>Engagement</td>
</tr>
<tr>
<td>Emotions</td>
<td>their feelings before, during or after knowledge development, sharing and use</td>
<td>Expertise</td>
</tr>
<tr>
<td>Accountability</td>
<td>the use of knowledge processes during events to account for developments in the school (e.g. for within school monitoring or outside school communication)</td>
<td>Leadership</td>
</tr>
<tr>
<td>Capacity</td>
<td>the way events are supported and conditions, opportunities and experiences are used for knowledge processes (e.g. promoting PD, providing resources)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Based on (Cornelissen et al., 2011[136])

Cornelissen and colleagues (2015[74]) conducted social network analysis to compare this Dutch network to a similar network in the United States, and understand how the different social network structures and interpersonal relationships relate to differences in developing, sharing and using knowledge. Findings suggest that:

- Denser (more connected) networks better enable collaborative knowledge development and sharing.
- Extending both the duration and scope of the relationship between university supervisors and their (in-service teacher) students can improve knowledge
development, sharing and use. In terms of duration, extensions refers to beyond the duration of the master’s programme. In terms of scope, it refers to a stronger embeddedness of university staff in the school environment, which helps them better understand the knowledge teachers value and use.

- A high quality relationship (equal, collegial, high levels of trust and engagement) between university supervisors and their students support knowledge development and sharing. No relationship was found with regards to knowledge use.

Interestingly, the study also found little evidence for the actual use of research knowledge in the schools. The authors suggest that this might be due to a lack of network competences (i.e. creating meaningful collaborative relationships) of the students. Another explanation proposed relates to the service-oriented nature of such partnerships, which correspond to more of a push approach from one side rather than real mutual engagement (Cornelissen et al., 2015[74]). These explanations are related to the power-relation issues – a key dimension of network characteristics identified by Muijs and colleagues (see Table 2.1) (2011[33]).

3.5. Lesson study professional learning network – the Netherlands

The Dutch Ministry of Education launched a pilot project for cross-school professional learning networks applying the Japanese lesson study model. As a result, 23 PLNs focusing on improving instruction as a form of innovation were running between 2014 and 2017 in the Netherlands. The present description is based on a case study of one of these PLNs by de Vries and Prenger (2018[137]).

The lesson study PLNs set three ways of improving instruction: induce change in teachers’ (subject content and pedagogical) knowledge and beliefs, in the professional community (e.g. motivation and capacity to improve instruction) and in teaching and learning resources (e.g. tasks, data collection protocols on teaching and learning). They consisted of teachers from various schools who were guided by a university (teacher education institution) based teacher educator. The role of the teacher educator was to facilitate the work, coach the team and bring in external, research knowledge in the topic the PLN chose to work on. For example, the presented case study PLN was a group of Dutch as first language teachers who worked on student activation and differentiation. The PLN followed the four stages of the American version of the lesson study model:

- investigation: considering students’ characteristics in the context, long-term goals for student learning, studying relevant research in the content area
- planning: selecting and developing a “research lesson” (defining goals, instructional plan, anticipated student reactions, data collection)
- research lesson: one team member conducts the lesson, others observe
- reflection: sharing and discussing data, developing implications, redesigning lesson, consolidating teacher learning.

After four lesson study cycles that were completed in two consecutive school years, teachers generally perceived positive changes in their knowledge and beliefs. In particular, they felt that their teaching became more theory-based. The authors however also report that teachers were the most critical about the investigation stage. Being exposed to external knowledge by the teacher educator coach made them feel like “back in the school again… keep being corrected”. This power-relation phenomenon (Muijs et al., 2011[33]) is
interesting from the perspective of the dynamics of different knowledge types. De Vries and Prenger note a lack of research-based attitude among participating teachers and report that one teacher educator proposed a positive attitude to research as a selection criterion to participate in the PLN in a future round. It could also be interpreted as a conflict between teachers’ experiential knowledge and the research knowledge coming from an external source. Following Lieberman’s (2000) argument cited above, all different types and sources of knowledge should be valued in the process of knowledge creation.

The PLN paid deliberate attention to scaling new knowledge. First, the various lesson study teams were reshuffled from time to time, to increase the applicability of the output produced. This is a first step in the process of transforming the new knowledge locally created into public knowledge described by Enthoven and de Bruijn (2010). Second, regular update meetings were held for the school leaders, and a conference for all teacher colleagues of the PLN schools. Whether the new knowledge successfully permeated the whole community is not reported in the case study.

Network factors reported to be important in achieving the goals of the PLN – improving instruction – were: leadership support, the attitudes and skills of the teacher educator to coach the teams (goal-oriented, flexible, open-minded, capable), motivation of participants, and collaboration (shared ownership, contrasting different ideas, trustful atmosphere).

3.6. KIP – Complex Instruction Programme network – Hungary

KIP (Complex Instruction Programme) is one of the “Pedagogical Approach Networks” described in a recent OECD volume (Paniagua and Istance, 2018). KIP began in a single primary school in Hejőkeresztúr – a rural area in Hungary with high proportions of disadvantaged and minority students – in 2000. The teaching staff – having collectively participated in a conference presentation on the Complex Instruction Programme developed at Stanford University – decided to introduce the programme. Instead of a direct adoption, this was a process of adaptation that lasted three years in the school. Initially, only a few teachers from the school joined, half a year later one third of the teaching staff used it in their teaching practice, later it spread to the entire staff (K. Nagy, 2015). KIP started to spread to other schools in 2009, and by early 2017, the network consisted of 71 schools, 15,000 pupils and 1,400 teachers (Paniagua and Istance, 2018). The network is particularly interesting for understanding knowledge dynamics, because it is about the scaling of a complex innovation that has involved deep transformation and co-creation of knowledge across the schools (Halász, 2016). The following short description is based on the “habilitation” thesis of the school’s principal, K. Nagy Emese (K. Nagy, 2015).

3.6.1. Knowledge construction of first adopters – or rather, adapters

The process of adaptation started with intensive knowledge mobilisation, in which teachers studied the original Complex Instruction, and sought out, read and collectively interpreted international and Hungarian studies (K. Nagy, 2015). A deep adaptation of the original programme followed, that resulted in the current KIP. This contextualisation included transforming the purpose of the programme: while originally it was aiming to improve the language skills and successful integration of Latino students in the United States through primarily extra-curricular activities, in Hungary it became part of the core classes of students (K. Nagy, 2015). Clearly, such a substantial adaptation involved considerable construction of new knowledge. Later, the teaching staff complemented KIP with a number of completely new elements as well.
Knowledge construction has become an integral part of this innovation process. A new professional learning culture has formed, characterised by regular peer observations, mutual support, intensive reflection and communication among the staff. The school turned into a learning organisation with a strong leader who provided strategic directions while also recognising the distributed nature of leadership (Halász, 2016[139]; K. Nagy, 2015[138]). The school can also be described as a knowledge intensive organisation (Halász, 2016[139]). This latter has the following key characteristics:

- the presence of intensive teacher learning
- an organisational climate that supports teacher learning
- intensive horizontal collaborations
- shared leadership
- organisational openness
- leadership that supports knowledge sharing
- regular use of data (Fazekas, 2014[140]).

3.6.2. Knowledge transfer to other schools and further knowledge construction through the network

Following the positive impact of the KIP programme on students’ outcomes including academic achievement as well as affective and motivational factors (K. Nagy, 2015[138]), other schools became interested in adopting the innovation. The transfer process was carefully constructed and led by the first adopter school. It involved the following elements:

- Teacher training: a 30-60-hour training programme for larger groups of teachers of a single school, to get familiar with the KIP methodology.
- Mentoring provided by KIP trainers for a whole academic year for participants who start applying KIP in their daily routines. This includes bilateral visits.
- Professional learning support for the school for additional four years.

As Halász (2016[139]) notes, adopting such a complex technology involves acquiring new knowledge, as well as a shift in teachers’ beliefs about the effective organisation of teaching and learning. It also implies a change in the routines associated with daily practice. As these new routines do not only relate to individual teachers, but also to the collective teaching community, and so change is only possible if the community as a whole accepts and supports these (Halász, 2016[139]).

The transfer process included another layer of knowledge construction in the KIP network, namely the construction of new knowledge about knowledge transfer itself. Building on the same organisation intelligence required for the original adaptation of the innovation, the Hejőkeresztúr school built an impressive knowledge base on innovation transfer (Halász, 2016[139]). For example, this involved placing the teachers in the host schools in the role of students during simulated KIP lessons, developing new forms of horizontal communication and networking between the host schools, and the involvement of (primary school) students in training the host institution’s teachers (i.e. students becoming teacher educators) (Halász, 2016[139]).

The KIP network developed organically as more and more schools started to adapt the programme. It is in a sense a truly self-organising network, in which ties are formed based
on schools’ and teachers’ direct contacts through the transfer process. However, while the transfer process involves natural tie formation, this was not the only process through which network members were connected (Halász, 2016). KIP leadership as well as adopter schools soon recognised the need for horizontal collaboration between adopter schools. Adopter schools shared similar experiences about the difficulties of individual and organisational adaptation, and their own local knowledge construction, something which the first (seed) school did not have (Halász, 2016). This resulted in new ways of knowledge sharing among adopter schools.

3.7. Teaching School Alliances – England, United Kingdom

Teaching School Alliances are an English national network of schools founded as part of the “self-improving school-led system” (SSIS) agenda of the British government. The network was created following the model of teaching hospitals: schools identified as outstanding lead the initial training, professional development of teachers and head teachers in a local network of schools and facilitate school-to-school support (Department for Education, 2010). The TSA model was conceived to facilitate mutual improvement across the system based on local collegial co-construction (Hargreaves, 2010; Hargreaves, 2012). Co-construction involves teachers and school leaders co-interrogating teaching through shared rounds of evaluation and innovation (Hargreaves, 2012). Beyond local knowledge creation, leading schools also had the responsibility to support schools in innovation and knowledge transfer across the national networks (Harris and Jones, 2012).

Collaborative enquiry was seen to play a key role in extending, expanding and creating new professional knowledge, and the National College for School Leadership developed a resource to assist teaching schools in leading collaborative enquiry (Harris and Jones, 2012). Enquiry in this document is seen as a process that supports the research and development (R&D) work of the teaching schools. Knowledge creation is described as an enquiry cycle that consists of implementation, innovation and impact. In the implementation phase, the TSA defines its enquiry focus based on an analysis of data and relevant research evidence; they map existing knowledge within the alliance, set out methods to collect more information; develop the collective knowledge base. In the innovation phase, they develop and choose instructional strategies that address the focus, they trial them, gather data on their effectiveness. In the impact phase, the data is analysed, the TSA evaluates the outcomes and adjusts strategies. Particular attention is also given to knowledge transfer. Testing the validity of new knowledge and applicability of new practice, and transferring these within and between, are key responsibilities of leading schools (Harris and Jones, 2012).

Making use of research knowledge is explicitly present in the idea of TSAs. This is evident, for example, in the description of effective pedagogy:

Great pedagogy develops when outstanding teachers make active use of the research and knowledge-base for teaching. There is a robust research-base which helps to identify the ingredients of great pedagogic practice. Truly successful pedagogy depends on making connections between ideas from the research-base in systematic and sophisticated ways (Harris and Jones, 2012, p. 41).

3 Replaced in 2013 by the National College of Teaching and Leadership that existed until 2018.
Yet, how teachers in TSAs are supported in accessing and mobilising research knowledge is not straightforward. A number of alliances recognised the need to involve universities in their research and development work to obtain this support. In parallel, some universities also saw the potential in working with schools. As a result, several networks developed that included both TSAs and higher education institutions (Ainscow et al., 2016[106]; Maxwell et al., 2015[145]).

Maxwell and colleagues (2015[145]) report on the R&D work of five TSAs. They describe three models of collaboration:

- Discrete R&D projects: located within a single school or academy trust, with significant within-school collaboration but limited cross-school collaborative work.
- Multi-strand partnerships for R&D: multiple schools with a common overarching project focus and specific foci for individual schools within this. Characterised by some common data collection and cross-school collaboration to share learning.
- Collaborative model for R&D: jointly developed focus and a common approach to investigate this. Characterised by high levels of cross-school collaboration, decision-making and evaluation of learning.

The report suggests that the collaborative model had the most impact on teachers, the quality of evidence generated and degree of wider knowledge mobilisation. It also acknowledges the potential effect of the strong engagement from a local higher education institution (HEI) in achieving this impact. In terms of knowledge dynamics, the authors note varying perceptions: some alliances stress having adapted existing knowledge from elsewhere, others having deepened their understandings, yet others creating new knowledge. Participants also felt that the work enhanced their thinking about evidence-based practice and research, and reported to have developed research skills.

While several studies reported positive impacts on knowledge dynamics, Greany and Higham (2018[146]) also identified tensions and inequalities in the system of TSAs. Some of these represent threats to the original goal of closing the gap between high- and low-performing schools. The study found that many TSAs developed in a way that only one or a few high-performing schools benefited most of the opportunities the alliance provides, while lower performing schools were either excluded or had limited opportunities for development. This demonstrates that networks are not automatically inclusive and balanced, and a number of contextual factors matter for their success in facilitating knowledge dynamics equally across all members.

3.8. eTwinning – a European online teacher network

The eTwinning network is an online network of teachers across Europe, facilitated through a digital platform available in 28 languages. The platform was established in 2005 and is funded by the European Commission under the Erasmus+ programme (Vuorikari et al., 2015[147]). Its purpose is not specifically linked to innovation or evidence scaling, rather it is defined by a range of activities and actions provided for the community through the platform and the Erasmus+ programme. These include joint projects for schools at national and international level, collaborative spaces and professional development for teachers.

The main area of eTwinning, called eTwinning Live, is restricted to registered users, mainly teachers, and comprises of a range of communication and collaboration features such as:

- finding and interacting with other members of the community
• professional development activities: online courses (lasting six weeks), learning events (lasting two weeks) and online seminars (one hour webinars)
• collaborating and exchanging best practices in thematic groups
• finding partners for projects in the partner forums (Pateraki, 2018[148]).

eTwinning is an inclusive network, in which participation is completely voluntary and possible for any teacher from the eligible countries (Vuorikari et al., 2015[147]). The network involves more than 600 000 teachers working in almost 200 000 schools in one of the 36 European countries (eTwinning) or 8 neighbouring countries (eTwinning Plus). More than 80 000 projects have been run, involving more than 4 500 000 students across the continent (Pateraki, 2018[148]).

Discussing online networks related to the diffusion of innovation is increasingly more relevant today, when such platforms proliferate. Vuorikari and colleagues (2015[147]) discuss eTwinning as an ICT-enabled innovation for learning and highlight the role of teacher collaboration through networks in fostering the diffusion of innovative pedagogical practices. Opportunities to share pedagogical know-how and educational content, such as those provided by eTwinning, can foster educational change and play a role in scaling pedagogical innovation at the system level (Vuorikari et al., 2015[147]).

Digital platforms provide a fertile ground for various network analyses. Learning analytics of the eTwinning platform has shown that on average 27% of eTwinners engage in deeper forms of professional collaboration (such as participation in learning events, project collaboration or writing project diary), and this proportion is the highest for those who have been on the platform for longer than three years (Vuorikari and Scimeca, 2013[149]). It has also demonstrated how the dynamics of horizontal (between school) and vertical (within school) networking can change as a result of specific attention. In 2009, almost two out of three eTwinners were the only ones from their school, whereas after a campaign year of “eTwinning school teams” in 2012-13, the number of schools with a single eTwinner decreased by 12 percentage points (Vuorikari et al., 2015[147]). In a survey of eTwinners conducted in 2011, 64% of respondents reported that they had involved colleagues from their school in eTwinning activities (European Commission, 2013[150]).

As part of the Teachers’ Lifelong Learning Network, a group of researchers conducted social network analysis on eTwinning to explore the underlying mechanisms for the transfer of good practices and innovation from eTwinning projects (Berlanga et al., 2012[151]; Pham, Cao and Klamma, 2012[152]). They used user interaction data gathered from the platform over 6 years. Data shows that the eTwinning network has evolved into a scale-free network4. Such a degree distribution indicates that the network has a few hubs (very highly connected nodes). Hubs have been shown to play an important role in ensuring connectivity, information spread and behaviour cascading in networks (Barabási, 2009[153]). Hubs also have more power and control over the network than the other nodes. Pham and colleagues (2012[152]) also show that the network has a strong community structure, i.e. a high number of clusters with densely connected nodes inside the cluster. Strong communities are important for scaling change in pedagogical beliefs, norms of social interaction and pedagogical principles (Coburn, 2003[154]). A large-scale survey conducted by the European Commission in 2011 confirms this:

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4 The proportion of nodes with $k$ connections is inversely proportionate with a (positive) power of $k$. 

Unclassified
74% of responding eTwinners report to have improved their personal knowledge, competences and skills.

58% report to have developed their teaching skills through reflection and dialogue with other teachers.

Around 70% of members who participated for longer than 6 years had gained 15% more benefit from their participation in the network than those with 2 years or less experience (European Commission, 2013[150]).

3.9. ECLORE⁵ – a “supra-network” for evidence and innovation – France

The ECLORE⁶ networks were conceptualised by the Academy of Poitiers⁷ in 2013, in an effort to strengthen local collaboration among actors (Académie de Poitiers, 2014[155]). In their first iteration (2014-2016), in line with national policy in France, the ECLORE networks focused on student pathways. Their objective was to seek coherence and complementarity of learning, and to make transitions smoother by promoting networking among elementary, lower and upper secondary schools (Académie de Poitiers, 2014, p. 2[155]). This objective requires knowledge co-ordination and dynamics across school levels. In 2016, the new leadership of the Academy renewed the mandate for the networks reformulating some of its objectives. The focus has shifted towards teachers: innovation, experience sharing and professional development have become the key objectives, although student pathways still remain one of the central elements of the project (Académie de Poitiers, 2017[156]). The networks are thus seen as:

- a “territorial incubator”, promoting innovations consistent with educational policies
- a support system for professional development and reflection on practice
- a synergy among actors, to allow for sharing problems encountered and solutions identified across different disciplines
- a special professional development space, a proximity-based implementation (Académie de Poitiers, 2017, p. 3[156]).

In addition to the local networks of schools, the second iteration also set out to facilitate collaboration among the networks (“inter-networks”). In this sense, the ECLORE initiative has become a “supra-network” or “meta-network”, i.e. a network of networks, in which each network is a distinct actor (de Lima, 2010[36]).

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⁵ This case description is based on a case study conducted in the framework of the doctoral studies of the author at the University of Strasbourg under the supervision of Professor Romuald Normand. It is based on document analysis and a number of interviews and a focus group corresponding to exploratory data in the framework of the doctoral studies.

⁶ ECLORE stands for "Ecoles, collèges, lycées pour l’orientation et la réussite des élèves” (Elementary, lower and upper secondary schools for student orientation and achievement). The word “éclore” in French means “hatch”.

⁷ “Académie de Poitiers” – One of the 30 sub-regional authorities, so called “Academies” (académie) in France. The Academy of Poitiers is one of the most rural regions in France with 20.5% of students in public education attending a school in a rural municipality, and with a large proportion of isolated, small schools (Académie de Poitiers, 2017[163]).
3.9.1. Knowledge sharing and construction

A number of social devices were put in place to drive knowledge dynamics in the networks (see Annex A for more details):

- Locally initiated professional development: professional development based on teachers’ needs, organised by the Academy.

- Sharing workshops: “research and development groups” to share and reflect on practices among teachers within a school, or across local schools based on teachers’ local challenges.

- Steering committee meetings: steering committee members (representatives of each school level [primary, lower and upper secondary] and the inspectorate) establish territorial diagnosis (challenges, needs, strengths) and plan for action.

- Network co-ordinators’ meetings: organised by the Academy, network and country level co-ordinators meet to discuss local challenges and share practices. Also serves to transmit national and regional objectives and strategies.

3.9.2. Network characteristics and context

The overall structure of the networks and its nodes are defined by the mandate. Regarding its nodes, ECLORE networks strictly speaking consist of schools of different levels that have different knowledge elements. This is consciously valorised through the various network devices. For example, in the co-ordinators’ meeting, primary and secondary school heads made their special knowledge base explicit (e.g. primary teachers knowing how to teach basic read skills) and discussed how such knowledge can be shared to help the other school level (e.g. secondary teachers who still have some students struggling with such basic skills). At the same time, this seemed to be limited to specific content knowledge. Blending more formal research knowledge is more difficult when actual members do not have that knowledge.

Considering that the intended knowledge dynamics includes supporting teachers in mobilising and using research evidence, it is a question why knowledge brokers or researchers are not formally part of the networks. Key co-ordinators did stress that the ECLORE networks are about developing a local ecosystem involving various stakeholders such as research institutions and training providers. If these actors were recognised as members of the networks, they could also play a role in supporting teachers and school leaders in defining their knowledge needs.

In terms of network context and governance, balancing tensions between hierarchy and horizontality, bureaucracy and effective information sharing seems to be the biggest challenge for maximising the knowledge dynamics potential of ECLORE. The following are some of the key aspects of this challenge:

- **Navigating the space between national priorities, bureaucracy and local needs.** The Academy is accountable to national authorities, and its main mission to transmit national priorities. It centrally steers the ECLORE networks, while it also intends to generate local initiatives. Parallel centralisation and decentralisation in some cases can create tensions.

- **Reconciling incompatible timeframes.** Realising ECLORE’s knowledge dynamics potential requires a long timeframe of several years. However, regional leadership (the Academy’s rector) changes very frequently. This implies a constant fight for
the legitimacy of the networks by its central co-ordinators, as well as a regular re-definition of ECLoRE’s scope that might not favour longer term objectives.

- **Accommodating effective knowledge dynamics in a bureaucratic culture.** Some of the mechanisms such as organising professional development and reporting to higher levels involve a considerable administrative burden and rigid processes. These may inhibit ECLoRE in fulfilling its knowledge dynamics potential.

Exploratory data suggests that ECLoRE’s central co-ordinators have been consciously and continuously addressing these challenges, and the social devices put in place have a high potential to facilitate teachers’ knowledge dynamics in the region (see also Annex A).

### 3.10. Summary

The selected examples reflect different approaches to knowledge dynamics. They show that successfully mobilising formal research knowledge requires recognising teachers' social context, and in particular their knowledge and experience in teaching practice. At the same time, knowledge creation almost always involves knowledge mobilisation. In addition, the diffusion of knowledge can again generate new knowledge on several layers.

The examples also demonstrate that various network characteristics, such as leadership, the broader network context, members’ capacity and tie formation, matter for knowledge dynamics. Despite the growing popularity of networks, only little research has been focusing on understanding the exact impact of such characteristics on knowledge processes.
4. Connecting the dots: knowledge dynamics in the evidence-innovation ecosystem

The above literature review and case descriptions attempted to reveal the knowledge dynamics underlying two policy questions – how can we scale evidence use, and how can we generate and scale innovation – and understand the role of networks in these. At a superficial level, scaling evidence may seem to relate primarily to the mobilisation and brokerage of research knowledge, whereas generating and scaling innovation is often discussed in terms of creation and diffusion of knowledge in the community of practitioners. However, a deeper analysis of the issues point to the problematic nature of this knowledge dynamics divide. This chapter sets out some lessons learnt from the literature and the cases presented in Chapter 3.

4.1. Evidence and innovation are inherently linked through the dynamics of teachers’ knowledge

The cases described in Chapter 3. demonstrated that in several of the networks, evidence and innovation go hand in hand, and knowledge mobilisation and creation are often intertwined. Table 4.1 shows the explicit goals of the different networks, the most dominant knowledge processes and the types of knowledge involved based on available sources.

<table>
<thead>
<tr>
<th>Networks</th>
<th>Goals – evidence-innovation relations</th>
<th>Knowledge processes</th>
<th>Theoretical grounds - Knowledge types involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 EEF Research School Networks – UK</td>
<td>Scale evidence and generate evidence through innovation</td>
<td>Mobilisation and brokerage, but also construction and diffusion</td>
<td>Formal knowledge on “what works”, focusing on RCT</td>
</tr>
<tr>
<td>3.2 Research Learning Networks – UK</td>
<td>Scale evidence</td>
<td>Knowledge mobilisation and creation</td>
<td>Formal research knowledge and practitioners’ knowledge</td>
</tr>
<tr>
<td>3.3 KNAER – CAN</td>
<td>Scale evidence</td>
<td>Knowledge mobilisation and brokerage</td>
<td>Shifting over time: from research knowledge towards recognising practitioners’ knowledge</td>
</tr>
<tr>
<td>3.4 School – university Research Network – NLD</td>
<td>Scale evidence</td>
<td>Knowledge mobilisation, brokerage, knowledge creation</td>
<td>Both formal research knowledge and practitioners’ knowledge</td>
</tr>
<tr>
<td>3.5 Lesson study professional learning network – NLD</td>
<td>Generate innovation based on evidence</td>
<td>Knowledge mobilisation, creation, diffusion</td>
<td>Both formal research knowledge and practitioners’ knowledge</td>
</tr>
<tr>
<td>3.6 KIP network – HUN</td>
<td>Scale innovation</td>
<td>Knowledge creation and diffusion</td>
<td>Theory-based knowledge (of the original innovation) and practitioners’ knowledge (created)</td>
</tr>
<tr>
<td>3.7 TSA – UK</td>
<td>Scale innovation</td>
<td>Knowledge co-creation and transfer</td>
<td>Research knowledge and practitioners’ knowledge</td>
</tr>
<tr>
<td>3.8 Etwinning – Europe</td>
<td>Generate and scale innovation</td>
<td>Knowledge diffusion and through that construction</td>
<td>Mostly knowledge of practitioners</td>
</tr>
<tr>
<td>3.9 ECLORE – FRA</td>
<td>Scale evidence and generate and scale innovation</td>
<td>Knowledge mobilisation, creation and diffusion</td>
<td>Research knowledge and professional knowledge</td>
</tr>
</tbody>
</table>
From the perspective of the question on evidence, modern knowledge mobilisation and brokerage initiatives contain an innovation element and make explicit links between innovation and evidence. Linear knowledge transfer models (in which research knowledge is isolated from practice) were rejected already in the late 70s/early 80s by theorists who developed a view of learning as social construction (Lave and Wenger, 1991[97]; Brown and Duguid, 1991[98]). The debate around knowledge conceptualisation led to discourses that link research and practice in more nuanced ways. Better understanding these links requires a closer look at the knowledge processes taking place in efforts directed at scaling evidence use.

The process of supporting teachers in mobilising evidence starts with the teachers identifying their challenges and needs – as seen in examples 3.2 and 3.4. This can involve, for example, teachers sharing their experience, perhaps observing each other and/or brainstorming about issues. Next, teachers formulate issues explicitly, and also examine what they already know about the identified issue and what knowledge they would still need. Sometimes brokers can facilitate this process, as their explicit knowledge gives access to the terms with which they can describe the questions and can also help identify missing knowledge areas.

Once the question is explicit, researchers or brokers (that could themselves be teachers or school leaders as we saw in example 3.2) can bring in external explicit (research) knowledge. In some of the examples, the next phase consists of combining various knowledge types and sources, including practitioners’ knowledge of the context, their experiences and so on. The “learning conversations” used in example 3.2 pay particular attention to blending research and practical knowledge by recognising both as equals. But similar blending processes take place in almost all of the examples. In design-based research, researchers do not transfer formal research knowledge explicitly. Instead, their theoretical knowledge and experience supports practitioners to solve their specific problems (Design-Based Research Collective, 2003[107]). To further nuance this discussion, we must note that the boundaries between formal research knowledge and practical or experiential knowledge are sometimes blurry from the start. Teachers acquire formal knowledge in their initial training and through professional development, which they gradually integrate, with part of it becoming tacit. When they formulate their problems and discuss their existing knowledge, it is at least partly built on formal knowledge already. This phase, which should perhaps be called “blending”, allows for teachers to understand how the formal knowledge can address their original issue, and make meaning together.

Last, both as part of and as a result of the blending phase, teachers negotiate and translate the new knowledge into practice, and adapt it to their context. An ideal outcome of this phase is the creation of new knowledge. Therefore, knowledge mobilisation actually involves the creation of new knowledge, solving a practice-based problem, and as such it involves innovation.

From the perspective of the question on innovation, recent efforts to generate and scale innovation almost always make clear references to the use of evidence. Just as the early knowledge transmission models ignored the situated nature of teachers’ knowledge, early scaling models were not concerned with the “emergence of transnational knowledge cultures and interrelated circuits of knowledge” (Fenwick and Nerland, 2014[94]). Increasingly more discussion is however dedicated to understanding how locally constructed knowledge is linked to “generic, public” knowledge (Enthoven and de Bruijn, 2010[100]). Again, an analysis of the knowledge dynamics of innovation efforts built on the examples discussed helps understand the ways in which this link is operationalised.
In all the examples reviewed here, and in most modern innovation models more generally, innovation is rooted in a practical problem or question. Understanding innovation in education as a problem-solving process directed at improving teaching practice, and ultimately student learning, calls for the use of available knowledge. Whether the process of innovation is operationalised through lesson study, collaborative enquiry, expansive learning cycles (change laboratories) or other mechanisms, teachers mobilise existing knowledge in the process (Earl and Timperley, 2015\(^{[157]}\)). This, in most cases is not exclusively research evidence, but (sometimes dominantly) includes practitioners’ knowledge based on experience, observations, data collected locally, etc.

The innovation cycle (Earl and Timperley, 2015\(^{[157]}\); Engeström and Sannino, 2010\(^{[89]}\)) typically continues with designing new materials, methods or processes that are then trialled. In this phase, the mobilised knowledge is discussed and negotiated and new knowledge is created. Trialling ideally involves collecting data on the impact such as students’ or teachers’ perceptions and outcomes. The observations and data analysis again adds to the process of knowledge creation and can lead to a modification of the innovation product or process. The knowledge is then consolidated and – again ideally – can be further generalised. Making this locally created knowledge public and available to the whole profession requires an effort of diffusing this knowledge for example through brokers as in example 3.1. It also requires systematising knowledge and integrating it in the existing knowledge base as is proposed by the EEF in the UK for example.

This discussion demonstrates that evidence and innovation in education cannot be discussed in a disconnected way. It also challenges the initial, superficial characterisation of knowledge dynamics around evidence and innovation, showing a more complex ecosystem of these dynamics (Figure 4.1). While at first sight it may seem that the dominant dynamic of knowledge in the former is knowledge mobilisation, i.e. accessing and using “the global knowledge/evidence base”, and knowledge construction in the latter, i.e. producing new knowledge in response to a local challenge, in reality, all types of knowledge processes are present in both policy issues.
The idea of merging the questions of scaling evidence and scaling innovation is not new. Looi and Teh (2015) treat them as perfectly synergetic in their book on “Scaling educational innovation”. In fact, innovation in their interpretation includes adopting and applying research evidence in teaching practice at scale. An ecosystem view suggests that innovation and evidence should be inherently connected, and this is realised through blending different knowledge types and sources throughout the various knowledge processes. The intersection of evidence and innovation can for example refer to innovative processes in accumulating and systematising evidence. This view however also implies that collaborative processes are at the heart of making the ecosystem work. The network perspective of the paper looks into these collaborative processes.

4.2. Networks do not automatically facilitate knowledge dynamics

As the boundaries between organisations are becoming increasingly more blurred, networks and networking emerge as a new paradigm for scaling evidence and innovation. The key focus of this paper is discussing if and how such an evidence-innovation ecosystem can be made more effective through networks. Intuitively, as networks can bring together different stakeholders, they have the potential for facilitating the blending of different knowledge types and sources and therefore also the transformation of knowledge. While a general positivism is still dominant in the policy discourse around networks, research is clear in that knowledge does not “automatically flow” through a network, facilitating knowledge dynamics requires explicit attention and deliberation (Hubers et al., 2017). The following key network dimensions are built on the review of literature presented in Chapter 2. Annex B contains a summary of these dimensions for the cases described in Chapter 3.

4.2.1. How does the network context influence knowledge dynamics?

The global context of the network is important to understand knowledge dynamics. For example, knowledge dynamics will not be the same in a competition-driven policy context.
(Greany and Higham, 2018[140]). The governance and leadership of networks also matter for the various processes taking place. For example, whether a network is co-governed by its members (shared governance), one of its members plays a leading role in governance, or is governed by an external body influences its dynamics (Provan and Kenis, 2008[34]). Similarly, the degree of ownership by members, the level of trust, and whether and to what extent the objectives are shared have an impact on network effectiveness. The timeframe of the network can strongly influence its success in achieving its knowledge dynamics related goals.

In the cases presented in Chapter 3, in most networks that were more strongly oriented towards scaling evidence, a research institution played a key leadership role, whereas the more innovation-focused networks were mostly led by a school or school partners had shared leadership. The lesson study professional network (3.5), which more clearly reflects an innovation-evidence ecosystem view, was led by a university-based teacher educator. Some of the findings related to the cases suggest that a more balanced leadership role of schools and research institutions could lead to a more successful blending of different knowledge types – necessary for a dynamics evidence-innovation ecosystem.

In terms of network timeframes, interestingly most innovation-focused networks presented here are long term, whereas several of the more evidence-focused networks are funding-dependent, and therefore shorter term initiatives. If the network goal is to facilitate an evidence-innovation ecosystem that builds both local and global knowledge base, it is important to recognise the need for stability and long term investment.

4.2.2. What network characteristics facilitate knowledge dynamics?

An overall comprehension of the network as a whole, its structure, the attributes of its members, and the nature of the ties between them can contribute to its success in terms of facilitating knowledge dynamics. Network analytical approaches such as social network analysis can help understand these characteristics. However, this requires specialised knowledge and skills from the part of those that steer the network. A good example for this was shown in the Research Learning Network (3.2) case study by Brown (2018[134]), in which social network analysis was used to select change agents, who then received specific training related to change.

Many scholars argued that teachers and researchers should work together in order for knowledge mobilisation to be effective (Hargreaves, 1996[11]). Some also proposed – drawing a parallel with other professions such as medicine or engineering – that this collaboration should not be one-directional. Rather, teachers themselves should be involved in the production of research. Yet, to date, in most countries the perception is that this is not, or only sporadically, happening (Edwards, Sebba and Rickinson, 2007[159]). Data from the Teaching and Learning International Survey (TALIS) shows that in 2013, on average 37% of teachers reported to have participated in a network of teachers formed specifically for professional development, while 31% reported that they engage in research (OECD, 2014[160]). Some scholars argue that this is because teachers as a group do not have any institutionally recognised collective power over the knowledge produced (Dupriez and Cattonar, 2019[161]).

In addition to teachers and researchers, the review showed that other actors (such as school leaders, teacher educators [a group that often but not always overlaps with researchers], representatives of local authorities and professionals from related sectors) can play an important role. In particular, they can bridge communities and facilitate brokering. For this to happen however, knowledge brokers, network facilitators, change agents and coaches
need specific competences. These involve the knowledge of various mechanisms that allow for effectively blending different knowledge types and sources, being able to translate academic into practical language and vice versa, being able to engage people, the knowledge of change processes and how to facilitate them, and so on.

4.2.3. What network activities and tools can facilitate knowledge dynamics?

The examples illustrated a wide range of activities to facilitate teachers’ knowledge dynamics. Action research or collaborative enquiry were used effectively in various networks as techniques to facilitate the blending of different knowledge types and sources. However, while these forms allow for merging research and practice, their outcome is often restricted to local knowledge creation relevant for practice in a particular context. Further testing, refining and generalising such locally created knowledge is rarely part of the process (Bryk, Gomez and Grunow, 2011[162]). Designing mechanisms that support the systematisation of locally produced knowledge remains a particular challenge. Promising examples suggest that networks do have the potential to bridge research evidence and practice-based innovation in both ways, but appropriate activities, tools and mechanisms are necessary for them to fulfil this potential.

4.3. Important research gaps remain

Despite the strong efforts invested in developing networks for scaling evidence and innovation, empirical research only recently started to investigate the dynamics of teachers’ knowledge within these. As a result, many questions remain open (Cain, 2015[3]; Cornelissen et al., 2015[74]; Muijs et al., 2011[33]; Brown and Poortman, 2018[13]). In particular, there is still a need to build a knowledge base on how exactly the various network characteristics and mechanisms can support the systematic use and accumulation of professional knowledge. Table 4.2 proposes a framework for studying this.

<table>
<thead>
<tr>
<th>Network dimensions</th>
<th>Sub-dimensions</th>
<th>Knowledge dynamics dimensions</th>
<th>Sub-dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network context</td>
<td>• Policy context</td>
<td>• Brokerage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Governance &amp; leadership</td>
<td>• Mobilisation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Voluntarism or coercion</td>
<td>• Creation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Time frames</td>
<td>• Systematisation and consolidation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Geographical spread</td>
<td>• Integration and diffusion</td>
<td></td>
</tr>
<tr>
<td>Network characteristics</td>
<td>• Structure (density, sub-structures)</td>
<td>• Underlying theories</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Nodes (attributes, roles)</td>
<td>• Types of knowledge involved: their role and value</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ties (quality, tie formation)</td>
<td>• Theoretical and methodological grounds</td>
<td></td>
</tr>
<tr>
<td>Network devices</td>
<td>• Activities</td>
<td>• Evidence-innovation relations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Tools</td>
<td>• Local – global knowledge base</td>
<td></td>
</tr>
<tr>
<td>Knowledge dynamics goals and outcomes</td>
<td>• Evidence-innovation relations</td>
<td>• Local – global knowledge base</td>
<td></td>
</tr>
</tbody>
</table>

Importantly, only very few networks have been evaluated, their impact on teachers’ knowledge and practice, and ultimately student outcomes is rarely reported. Going further, comparative and systematic evaluation of different networks within and across countries is almost inexistent. While a few frameworks have been developed to tackle this issue, no attempt has been made so far to apply them internationally. Such a comparative analysis could potentially constitute a major breakthrough in advancing the issue of teachers’ professional knowledge base.
5. Conclusions: knowledge in networks and networks for knowledge

The paper attempted to address the two policy questions – how can we scale evidence use, and how can we generate and scale innovation – by looking at the knowledge processes involved and the role of networks in these. The following are some key conclusions that can be drawn from the analyses.

First, an analysis of the literature demonstrated that the knowledge dynamics underlying these questions are complex. Contrary to the traditional discourses, scaling evidence is not simply about brokering and mobilising research knowledge, and generating and scaling innovation involves more than creating and diffusing practical knowledge. The main incentive for teachers to engage with research is its promise that it will give a response to their challenges. Therefore, a deep engagement with evidence almost always involves knowledge construction and innovation – whereby this latter is interpreted as a problem-solving process. Similarly, in the process of generating innovation, teachers mobilise available knowledge, which can include both local, practical knowledge and formal research knowledge. They interpret, translate and transform this to answer their needs. Scaling a particular innovation necessarily involves adaptation, re-interpretation and consolidation.

Second, a closer look at specific networks showed that in these forms of organisations, evidence and innovation are most often intertwined by the knowledge processes described above. Therefore, treating evidence and innovation scaling as one ecosystem, rather than two distinct processes, seems more appropriate for educational networks. An analysis of knowledge dynamics in networks also showed that different types and sources of knowledge, such as formal research knowledge on education, and local practical knowledge, can play an equal role. This paper argues that the evidence-innovation ecosystem works most effectively when these types and sources of knowledge are recognised, valued, and deliberate attention is paid on mechanisms and tools that allow for blending them. It is also important to mention here that one major obstacle to such blending is that teachers do not have free access to research in many OECD countries.

Third, network analytical approaches can help understand and design networks to deliberately facilitate the evidence-innovation ecosystem. This involves understanding the overall context of the network (policy and social context, leadership, timeframes, etc.), its characteristics (structure, composition, ties between the actors), as well as the various devices (activities, tools) that animate them. Several tools and methodologies exist to gather and analyse this information with a view to enable effective knowledge dynamics. In addition to networks of teachers, schools and other educational actors and organisations, the evidence-innovation ecosystem view can also help better understand knowledge governance in “governance networks”, i.e. networks of individuals and organisations that govern an education system.

Last, it is important to underline some of the limitations of this paper. The review set out to tackle a number of disparate issues, each of which has its own body of literature. The literature on both educational networks and various network analytical approaches have been steadily growing in recent decades. In parallel, literature on teachers’ knowledge and learning, and teacher professionalism is considerable. In addition, scholarship on innovation extends today to a vast number of studies in different disciplines. It was clearly beyond the scope of this paper to systematically analyse and synthesise this enormous
amount of literature. Moreover, there was no clearly pre-defined criteria for selecting the specific networks in Chapter 3. In particular, some Asian systems, such as the People’s Republic of China, Japan and Singapore, have strongly developed teacher networks and various mechanisms that incentivise and support teachers in carrying out and using research. These networks could be an interesting field of investigation in the future. Due to these limitations, it is not possible to draw far-reaching conclusions on what network characteristics facilitate knowledge dynamics. Therefore, the main value of the insights offered here is the attempt to link these various fields of study, and point to the relevance of further studying networks and teachers’ knowledge dynamics for improving education policies.

As networks are becoming a policy tool to address the questions around evidence and innovation in education worldwide, there is a growing need to understand their role and impact in the dynamics of teachers’ knowledge as described above. Yet, very few networks have been studied over time and in depth, let alone, systematically evaluated through measures of impact on teachers and ultimately students. It thus seems necessary to build a more coherent knowledge base on the role of networks in teachers’ knowledge dynamics drawing on multiple fields and knowledge sources. A first step could be to establish an internationally applicable framework and test it by a comparative analysis of national and international networks. This would have great potentials to inform policy, research and practice, and advance the issue of building teachers’ professional knowledge base both locally and globally.
References


Bollobás, B. (1996), *Paul Erdős (1913-96)*.


Dankbaar, B. (2004), “Embeddedness, context, proximity and control”, European Planning Studies, Cycle of 4 knowledge processes are described:<br>knowledge creation,&nbsp;<br>knowledge transfer,&nbsp;<br>knowledge absorption and&nbsp;<br>knowledge application, pp. 692-701, http://dx.doi.org/10.1080/0965431042000220020.


Glover, J. et al. (2006), *Evidence-based medicine pyramid*.


Haas, A. (2014), *Crowding at the frontier: knowledge brokers, gatekeepers, boundary spanners and marginal-intersecting individuals*.


Vuorikari, R. and S. Scimeca (2013), *Social learning analytics to study teachers’ large-scale professional networks*, [http://dx.doi.org/10.1007/978-3-642-37285-8_3](http://dx.doi.org/10.1007/978-3-642-37285-8_3).


Annex A. Social devices in the ECLOR E network, their potentials and challenges

Table A A.1. Social devices in ECLOR E, their potentials and challenges

<table>
<thead>
<tr>
<th>Social device</th>
<th>Description</th>
<th>Potential for knowledge dynamics</th>
<th>Challenges</th>
</tr>
</thead>
</table>
| Locally initiated professional development        | Teachers from a school collectively identify their challenges and related professional development needs. Network committees gather this information at the network level and transmit their requests to the county-level network co-ordinators, who pass them on to the Academy. The Academy identifies a suitable trainer such as a researcher of the specific topic or a teacher educator, and organises the PD corresponding to the scale of interest. | • Can help connect the actors in the field to the evidence base they need to address their challenges.  
• The Academy is well connected and has the capacity to play a brokering role.                                                                                     | • Lack of vertical (within school) collaboration can impede the integration of new knowledge at a larger scale, not only by participants of the PD.  
• An authentic (needs-based) “pull approach” is at risk because:  
  o Setting up a PD involves a complicated and long bureaucratic process  
  o Following national priorities, the Academy is pushing on knowledge transmission in particular fields such as neurosciences. |
| Sharing workshops                                  | Modalities that allow for teachers to form a research and development group around a particular professional practice, and discuss this among themselves without the presence of institutional actors (inspectors, authority).  
Forms: within or cross-school workshops.  
Can be initiated by teachers or network co-ordinators. The county-level co-ordinator can help connect teachers with similar interests, needs. | • The “research and development” group concept can foster cycles of collective knowledge creation as described by Nonaka and Takeuchi.  
• The Academy’s intention to broader partnerships involving e.g. research labs, can facilitate the blending of research and professional knowledge.  
• Exploratory data suggests strong interest in sharing workshops at different levels and by different actors. | • Lack of gatekeepers and quality assurance: Only teachers with similar knowledge coming together raises concerns with regards to the validity of the new knowledge constructed, and weather that adequately address the problems identified.  
• Potential lack of capacity and appropriate mechanisms for “boundary crossing”, in case the workshops involve collaboration with researchers.  
• A reported lack of culture of peer-observation among teachers in France might hinder questioning and deeply reflecting on practices. |
| Steering committees’ meetings                     | Role of network steering committees:  
• conduct diagnosis (strengths, weaknesses focusing on the acquisition of basic skills) within the network and the territory  
• identify the needs with regard to the diagnosis and the objectives of the network  
• set out actions for concertation and sharing practices  
• identify key partners; co-ordinate, animate and evaluate network activities. | • Strengthen cross-level links: As the committees have members from each school level (primary, lower and upper secondary) and include the inspectors  
• Collecting and aggregating school level needs at the network level can constitute the basis for professional collaboration and exchange across schools. |                                                                                                                                                                                                                                                                   |
| Network co-ordinators’ meetings                   | Leaders of the network steering committees and county level co-ordinators meet 2-3 times a year. This is organised by central co-ordinators (at the Academy) to:  
• spread and reinforce national and regional objectives (e.g. through presentations on national reforms and the regional strategy)  
• provide space for sharing local challenges and practices, and generating ideas (e.g. through workshops). | • ECLOR E becoming a key lever for territorial cohesion: The multi-level governance structure can facilitate the systematisation and diffusion of locally constructed knowledge by allowing for the central co-ordination to have more visibility on local activities. | Navigating the space between national priorities, bureaucracy and local needs implies tensions: The Academy is accountable to national authorities, and has as its main mission to transmit national priorities. It centrally steers the ECLOR E networks, while it also intends to generate local initiatives. |

Source: Based on exploratory data collected by the author and (Académie de Poitiers, 2017[156]).
Annex B. Key network dimensions in the cases presented in Chapter 3

The following framework of analysis builds on Muijs and colleagues’ (2011[33]) network typology and the literature review on social network analysis provided in this paper. It provides a concise picture of the characteristics of the networks described in Chapter 3, along the key dimensions.

Table A B.1. Network and knowledge dynamics dimensions in the cases presented in Chapter 3

<table>
<thead>
<tr>
<th>Networks</th>
<th>Goals in terms of evidence and innovation</th>
<th>Leadership</th>
<th>Voluntarism or coercion</th>
<th>Time frames</th>
<th>Geographical spread</th>
<th>Network devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 EEF - RSN - UK</td>
<td>Strongest focus is on scaling evidence use, innovation appears as input to generating new evidence.</td>
<td>Domination between Research Schools and other schools, but equal between Research Schools? The project is overseen by an Advisory Board which provides support and guidance. It comprises members from the EEF and IEE, as well as independent members.</td>
<td>Intermediate: there was a call and research schools that were selected through a competitive tendering process</td>
<td>Long term, but funding dependent</td>
<td>England</td>
<td>RSN member schools organise events and training for school leaders and teachers that are not part of the RSN; provide expertise to develop and evaluate innovations; through EEF's evidence toolkit; RSN newsletter; grant</td>
</tr>
<tr>
<td>3.2 EEF - RLN - UK</td>
<td>Facilitate evidence-informed teaching practice</td>
<td>Intermediate: Research institution dominates by being the leader of horizontal networking and designer of the network approach, but brokers have a role in self-organising within school (vertical) networking activities.</td>
<td>Intermediate: TSA (school network) expressed interest; research institution (UCL) established the network, schools identified their needs.</td>
<td>Fixed short term</td>
<td>local TSA (within England)</td>
<td>“Learning conversations” between researchers and teachers; cycle of enquiry: 4 workshops followed by in-school activities</td>
</tr>
<tr>
<td>3.3 KNAER - CAN</td>
<td>Fostering research collaboration through networking and partnerships, and mobilising well-validated bodies of knowledge</td>
<td>Not reported, probably varying within the individual networks themselves.</td>
<td>Intermediate: the &quot;supra-network&quot; is governed by a partnership (MoE, 2 universities); through a competitive call for proposals 44 projects (networks) were funded. Volunteerism is not reported, can be varying within the individual networks themselves.</td>
<td>Formally: fixed short term; not reported beyond the funding period</td>
<td>Provincial within Ontario (the extent to which it expanded beyond the province is not reported)</td>
<td>Types of activities: Exploiting research; building or extending networks; strengthening research brokering; expert visits. Processes and tools: &quot;Knowledge products&quot; (toolkits, briefs, etc.), relationship building (including the development of trust between partners), action research</td>
</tr>
<tr>
<td>Networks</td>
<td>Goals in terms of evidence and innovation</td>
<td>Network context</td>
<td>Network devices</td>
<td></td>
<td></td>
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<tr>
<td>3.5 LS PLN - NLD</td>
<td>Improving instruction as a form of innovation: induce change in teachers' (subject content and pedagogical) knowledge and beliefs; the professional community and resources</td>
<td>Leadership: Led by university-based teacher educator; Voluntarism or coercion: Voluntary, project-based; Time frames: Fixed short term; Geographical spread: Local</td>
<td>Activities, tools, processes: Lesson study (4 stages); reshuffling LS teams; updating meetings; conference</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.6 KIP - HUN</td>
<td>Scaling of a complex innovation</td>
<td>Leadership: Led by one school where the innovation was first implemented and constructed. The school principal plays a leading role; Voluntarism or coercion: Voluntary in a first phase; later government induced in the Budapest area; Time frames: Long term; Geographical spread: National (increasingly growing from local)</td>
<td>Activities, tools, processes: Professional development</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.7 TSA - UK</td>
<td>Lead the initial training, professional development of teachers and head teachers in a local network of schools and facilitate school-to-school support; support schools in innovation and knowledge transfer</td>
<td>Leadership: Led by one school identified as &quot;high-performing&quot; school based on external evaluation; sometimes dominated by high-performing schools with limited opportunities for lower performing ones; Voluntarism or coercion: Coerced by local education authority; Time frames: Long term; Geographical spread: TSAs are local but the full TSA system covers England</td>
<td>Activities, tools, processes: Collaborative enquiry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.8 eTwinning - EUR</td>
<td>Innovation diffusion</td>
<td>Leadership: Equal; Voluntarism or coercion: Completely voluntary; Time frames: Long term overall with shorter term networks forming organically; Geographical spread: International: Europe</td>
<td>Activities, tools, processes: Professional development; pedagogical projects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.9 ECLORE - FRA</td>
<td>Innovation, experience sharing and professional development</td>
<td>Leadership: Equal; Voluntarism or coercion: Coerced by regional education authority; Time frames: Long term (although dependent on changing regional leadership); Geographical spread: Local networks the supra-network covers the region</td>
<td>Activities, tools, processes: Professional development; pedagogical projects; Locally initiated professional development, sharing workshops, co-ordinators' meeting</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table A.B.1 Network and knowledge dynamics dimensions in the cases presented in Chapter 3 (continued)

<table>
<thead>
<tr>
<th>Networks</th>
<th>Network characteristics</th>
<th>Knowledge dynamics</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 EEF - RSN - UK</td>
<td>Relatively large: 39 schools</td>
<td>&quot;What works&quot; - RCT</td>
</tr>
<tr>
<td></td>
<td>Not reported</td>
<td>Mobilisation and brokerage, but also construction and diffusion</td>
</tr>
<tr>
<td></td>
<td>Mostly horizontal (between schools)</td>
<td>Formal knowledge on &quot;what works&quot;, focusing on RCT</td>
</tr>
<tr>
<td></td>
<td>Not reported</td>
<td>Connecting global and local knowledge in both directions</td>
</tr>
<tr>
<td>3.3 KNAER - CAN</td>
<td>Not reported, probably varying within the individual networks themselves</td>
<td>&quot;What works&quot; - Evidence-based teaching practice</td>
</tr>
<tr>
<td></td>
<td>High and explicit: 1. collaboration between the university and schools; 2. collaboration within schools that participate in one of the networks (projects)</td>
<td>Knowledge mobilisation and brokerage</td>
</tr>
<tr>
<td></td>
<td>Quite formal: following funded project proposals</td>
<td>Shifting over time: from linear transmission of research knowledge towards recognising professional knowledge</td>
</tr>
<tr>
<td></td>
<td>Intermediated: established (mandated) networks, but membership within each network is more flexible and shifting (extendable)</td>
<td>Connecting global and local knowledge in both directions</td>
</tr>
<tr>
<td>3.4 Univ RN - NLD</td>
<td>High and explicit: the university is an equal partner</td>
<td>Evidence-based practice and knowledge creation</td>
</tr>
<tr>
<td></td>
<td>Fixed actors defined by the supervising university and schools; participation within the school is voluntary</td>
<td>Knowledge mobilisation, brokerage, knowledge creation</td>
</tr>
<tr>
<td></td>
<td>Both horizontal and vertical. Forms of horizontal: 1. collaboration between the university and schools; 2. collaboration between the schools</td>
<td>Both formal research knowledge and practitioners' knowledge</td>
</tr>
<tr>
<td></td>
<td>Measured by SNA measures. Relatively low at the school level, medium at the student-supervisor level</td>
<td>Connecting global and local knowledge in both directions</td>
</tr>
<tr>
<td></td>
<td>Both horizontal and vertical. Forms of vertical: 1. collaboration between the &quot;supra-network&quot; (KNAER governing partners) and the networks (projects)</td>
<td></td>
</tr>
<tr>
<td>Networks</td>
<td>Structure: density of nodes (organisations - schools)</td>
<td>Structure: density of nodes (individuals)</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>3.5 LS PLN - NLD</td>
<td>Low-Medium: schools involved in the PLN</td>
<td>Not reported specifically; probably low due to the nature of lesson study groups (involving only a few teachers)</td>
</tr>
<tr>
<td>3.7 TSA - UK</td>
<td>Low/Medium: typically a handful of schools</td>
<td>Not reported; probably depending on the TSA</td>
</tr>
<tr>
<td>3.8 eTwinning - EUR</td>
<td>Very large with a high number of smaller clusters evolving organically</td>
<td>Scale free network with power law distribution: some highly connected hubs with many strongly linked clusters</td>
</tr>
<tr>
<td>3.9 ECLORE - FRA</td>
<td>Large: approx. 50-70 schools/network</td>
<td>Varying</td>
</tr>
</tbody>
</table>