2021-10

Exploring and Exploiting the Dynamics of Networks in Complex Applied Research Projects: A Reflection on Learning in Action

Paul Coughlan
Trinity College Dublin, Ireland

David Coghlan
Trinity College Dublin, Ireland

Clare Rigg
University of Liverpool

See next page for additional authors

Recommended Citation

Coughlan, P., Coghlan, D., Rigg, C. and O'Leary, D. (2021), Exploring and Exploiting the Dynamics of Networks in Complex Applied Research Projects: A Reflection on Learning in Action. Brit J Manage, 32: 1440-1455. DOI: 10.1111/1467-8551.12482

Exploring and Exploiting the Dynamics of Networks in Complex Applied Research Projects: A Reflection on Learning in Action

Paul Coughlan, David Coghlan, Clare Rigg, Denise O'Leary

British Journal of Management · February 2021
DOI: 10.1111/1467-8551.12482

Coughlan, P., Coghlan, D., Rigg, C. and O'Leary, D. (2021), Exploring and Exploiting the Dynamics of Networks in Complex Applied Research Projects: A Reflection on Learning in Action. Brit J Manage, 32: 1440-1455. https://doi.org/10.1111/1467-8551.12482

Exploring and exploiting the dynamics of networks in complex applied research projects: A reflection on learning in action

Introduction

Since 1984, the European Union has supported research and development activities covering almost all scientific disciplines through a series of multi-annual Framework Programmes. The current programme is Horizon 2020. Prior research programmes had engaged with practitioners but more often as research subjects. This focus shifted in Horizon 2020 onto facilitating Europe's industrial leadership, supporting innovation in small and medium enterprises (SMEs), and addressing societal challenges. Horizon 2020 now sponsors a wide array of research and concentrates on applied research. Common across the key indicators of research project performance have been actions by companies to introduce and test innovations new to the company or the market. Initiatives to achieve these objectives require researchers to generate knowledge in the context of application. Further, that context may not fit within a single disciplinary domain. So, the resulting public–private relationships have cast transdisciplinary researchers as co-researchers in partnership with practitioners.

As we see it, the applied research called for and funded by the European Union (EU) is identifiable as Mode 2 knowledge production, a distinction proposed by Gibbons, Limoges, Nowotny, Schwartzman, Scott and Trow (1994). Mode 2 knowledge production can be deployed usefully to address grand challenges (McGrath, Horvath, Baruch, Gunashekar, Lu, Culbertson, Pankowska and Chataway, 2014). This mode of research imposes particular demands on researchers which we explore in this article. We frame these demands in terms of the dynamics of diverse networks engaged consciously in learning in and from action. We build our exploration around questioning of and reflection upon our own first-hand

experiences in five research projects, funded under FP4, FP7 and Inter-Reg programmes. Common across these projects has been our active engagement with practitioners as co-researchers in shared exploration and exploitation of new knowledge in such areas as improvement of manufacturing operations, innovation in food, and environmental sustainability of water production and distribution. While the particular characteristics of the individual Framework Programmes guided their design, implementation and evaluation, many of these programmes required collaboration, not just to be eligible for funding but also as a pragmatic and practical mode of engagement and enquiry. This collaboration was cross-border, inter-institutional (e.g. universities, research centres, firms and sectoral associations) and between academics and practitioners.

Collaboration between academics and practitioners has long been flagged as a complex engagement (e.g. Bartunek and McKenzie, 2017). The complexity is expressed frequently in terms of a gap or divide between the two groups, for example, that academics are interested in scientific knowing and practitioners in practical knowing and how both work from different logics, time dimensions, communication practices, rigour and relevance, interests and incentives. However, in order to understand and to improve upon the way in which such collaboration can generate knowledge in the context of an application in the sector that the funded research is located, we require theory-based guidance which links a set of related concepts - network forms, roles, and network action learning. Correspondingly, our objective in this article is to guide those who design and implement applied research projects, those who approve and provide funding, and those who exploit and build upon the resulting research. Towards this end, as we have reflected on our first-hand experiences of five EU-funded research projects, we pose the following questions:

> How can collaboration between academic researchers and practitioners, with their respective dual concerns and orientations toward knowledge production, enable them

to work together in transdisciplinary networks to generate knowledge in the context of application?

How is learning directed, developed and deployed in these project networks?

What roles are played by key actors in the design and implementation of the research process?

The article is structured as follows. First, we introduce the theory and practice of action learning that underpinned the design and implementation of the five EU-funded projects in which we were involved. Second, we present an overview of the five projects. Third, we reflect on the projects in terms of an approach to knowledge production known as Mode 2. Fourth, we bring the action learning approach into the network setting and introduce the notion of network action learning. Fifth, we explore the various roles evident in this setting of research in networks. Finally, we make a strong theoretical statement linking network action learning and Mode 2 knowledge production. We visualise this insight as a framework, embedded within which are three propositions, applicable as a set to the design and implementation of complex applied research projects in networks. We present these propositions to guide those who design and implement such projects, those who approve and provide funding, and those who exploit and build upon the resulting research. These propositions aim to facilitate framing and realisation of applied research objectives, co-development in networks and contribution of deep transdisciplinary and actionable knowledge both across disciplinary boundaries and in the wider community.

We now introduce action learning as the foundational method through which the five projects were conducted. The projects were explicitly designed to be implemented through action learning in networks, an approach in which each of us has expertise and extensive experience.

Action Learning

Action learning is a term used with a wide range of meanings. Some usages see it as an equivalent term for experiential learning, so that any learning process that includes some experiential activity is considered to be action learning. For others, action learning has a more restricted meaning and refers to a philosophy of learning that is embedded in the fields of management learning and development and organization problem resolution (Coghlan and Rigg, 2012; Pedler, 2011). Action learning, as developed by Revans (1971, 1998), grew from a mid-20th century disenchantment with positivism and prevailing cultural beliefs in the dominance of expertise. Revans held the conviction that, except where an issue can be addressed by a purely technical solution, there is more learning to be had through action being taken by those involved with the issue. His key idea was of a synergy between learning and action: 'there can be no learning without action and no (sober and deliberate) action without learning' (1998: 71). In other words, praxis is fundamental to action learning in the sense that learning through activity or work is essential.

At the heart of action learning is a distinction between and among different kinds of issue which Revans (1998) characterised as puzzles and problems. Puzzles are those difficulties for which a single solution exists and which are amenable to specialist and expert advice. Problems, on the other hand, are difficulties where no single solution can possibly exist. Most complex organizational change projects fall into the category of a problem, as there is no single solution and there are likely to be many views as to what the preferred course of action might be. Puzzles can be solved through engagement with outside experts. Problems, on the other hand, are more difficult to sort out and are more amenable to learning in action because, in the process, different people can advocate alternative courses of action reflecting their own value systems, past experiences and intended outcomes.

What does action learning involve and what are the constituent elements or components? While different authors frame the core components of action learning slightly differently, six distinct interactive components may be identified.

1. A *problem* or *opportunity*– whereby complex organizational issues which touch on different parts of the organization and which are not amenable to expert solutions are selected and worked on. This is contrasted with the notion of a puzzle which is where there is an expert solution, if only it can be found.
2. A *group* of people (typically 5-9, though this can be more or less) who focus on an issue that they are grappling with in their own setting and which they have the power to do something about. The group works together in sets of peers and members act as critical friends to challenge and support each other's learning.
3. A *commitment to taking action* – Action learning is based on the premise that no real learning takes place unless and until action is taken. Implementation, rather than recommendations to others, is central.
4. The *commitment to learning* – Action learning aims at going beyond merely solving immediate problems. An increase in the knowledge and capacity to adapt to change more effectively are the ultimate outcomes.
5. The participants engage in a *questioning and reflective process* whereby the current situation, assumptions, strategies, actions and outcomes are questioned, explored and reflected on, new ideas are presented, actions reported on and new actions planned. The search for fresh questions and questioning insight is seen as more helpful than access to expert knowledge. Learning happens through asking questions, investigation, experimentation and reflection, rather than through reliance on external expertise.

6. Learning coach or *facilitator* – A facilitator can play a variety of roles for the group, coordinator, catalyst, observer, climate setter, communication enabler, learning coach, process consultant among many. Their role is to model the peer challenge/critical friend behaviours, to help the group establish ground rules and develop questioning, reflective and inclusive team practices.

How might action learning be applied to the network setting, in effect, to create network action learning? The notion of organizational learning has been extended to encompass the inter-organizational setting (Holmqvist, 2003; Gibb, Sune and Albers, 2016; Peters, Pressey and Johnson, 2016; Snow, Miles and Coleman, 1992) and learning in and by networks (Knight, 2002; Knight and Pye, 2004; Mariotti, 2012). Knight (2002) suggests that there is a difference between inter-organizational learning, which is about learning *within* networks, and network learning, which is about learning *by* networks. 'Network learning is about learning by a group of organizations as a group' (p. 428). She argues that if a group of organizations, through its interaction as a group, changes its behaviour or cognitive structures, then it is the group that is the learner and not simply the individual organizations that make up the group.

In order to give meaning to the notion of network action learning, the six interactive components may be adapted for the network setting. In this setting, the *problem* is one shared by organizations and the corresponding *group* comprises representatives from the participating organizations. This interorganizational action learning group then, with a *commitment to action* and a *commitment to learning*, engages in a *questioning and reflective process* with the help of a *facilitator*/learning coach.

In summary, action learning is concerned with praxis (Coghlan and Rigg, 2012). It is rooted philosophically in theories of learning from experience, as practiced collaboratively

with others through some form of action-oriented inquiry. Participants take responsibility for and control of their own learning and, so, there is minimal use of experts. The overriding value that guides the action learning approach is a pragmatic focus on learning for the sake of more effective problem solving, systems improvement and the cogeneration of actionable knowledge. It is with this foundation in mind that we now introduce the five EU-funded projects.

Five Complex Applied EU-Funded Research Projects in Networks

This article provides a reflection on five EU-funded projects, funded under the FP4, FP7 and Inter-Reg programmes, in which we participated first-hand. Common across these projects has been an active engagement of multidisciplinary researchers with practitioners as co-researchers in the production of new knowledge. The particular projects selected illustrate the challenges faced in different thematic areas: improvement of manufacturing operations, innovation in food and environmental sustainability of water production and distribution.

Table 1 summarises the five projects. The funding for each project was provided under an EU programme. Each project had a different objective and, correspondingly, the mix of participants and the associated disciplines differed. The participating firms included small and medium-sized enterprises (SMEs), multi-national enterprises (MNEs), public enterprises and a conservation charity. Governance and management of the networks and task structures included mechanisms to enable active collaboration among all participants as co-researchers.

	NALP	**CO-IMPROVE**	**TRADEIT**	**HYDRO-BPT**	**Dwr Uisce**
Dates	1997-2001	2001-2004	2013-2016	2011-2015	2016-2021
Funding Programme	European Commission	FP4	FP7	Inter-Reg: Ireland-Wales Fund	Inter-Reg: Ireland-Wales Fund
Domain/area	Indigenous Manufacturing and Service	International Manufacturing	Indigenous Artisan Food production	Water production and distribution	Water production and distribution
Objective/challenge	Learning and operations improvement towards World Class Manufacturing	Collaborative improvement in the supply chain	Innovation, entrepreneurship and collaboration	Energy recovery and carbon reduction	Energy recovery, carbon reduction, demonstration and diffusion
Participants	One university / research institution, one membership institution, six firms One country	Four universities / research institutions Nine firms Five countries	Four universities/ research institutions Nine clusters Three sectors 30+ firms Eight countries	Two universities / research institutions Two water authorities (Public enterprise) One conservation charity Three firms Two countries	Two universities / research institutions Two water authorities (Public enterprise) One conservation charity 60 firms Two countries
Disciplines in the research project team	• Operations Management • Organization Development	• Operations Management • Organization Development • Engineering Management	• Food science (dairy, bakery, meat) • Operations Management • Organization Development	• Engineering • Environmental Science • Geography • Operations Management	• Engineering • Environmental Science • Geography • Operations Management
Team and task structures	Project leader Theme coordinators Interactive workshops	Partner group Three sets of firms Defined workpackages	Partner group Regional Hubs Defined workpackages	Partner group Defined workpackages	Partner group Three technology platforms Defined workpackages

Table 1: Project descriptions

We present a brief description of each project, followed by a comparison of the key attributes.

EC: National Action Learning Programme (NALP)

Organized as a management development programme, the National Action Learning Programme (NALP) ran in Ireland from 1998 to 2000. The key objectives of this project were to assist Irish firms, through their managers and workforce to change, upgrade and become world class in their operations. As a learning network, senior representatives from six firms participated voluntarily in an inter-organizational action learning set and shared their improvement initiatives with each other. One Irish university and a membership institution facilitated the interactions and learning.

FP4: CO-IMPROVE: Collaborative Improvement for the Extended Manufacturing Enterprise

The development of CO-IMPROVE was informed by experience from the NALP project. The key objectives of this project were to enable and enhance ongoing collaborative efforts to improve new product development and order fulfilment performance of extended manufacturing enterprises. CO-IMPROVE engaged with four European universities and nine firms in five countries. The project developed implementation guidelines supporting the situational design, implementation and ongoing development of collaborative extended manufacturing enterprise (EME) -level improvement.

FP7: TRADEIT: Traditional Food: Entrepreneurship, Innovation and Technology

The development of TRADEIT was informed, in part, by the experience of the CO-IMPROVE project. The TRADEIT project was a multidisciplinary, multi-sectorial collaborative project engaging with traditional food small and medium enterprises (SMEs)

and food researchers. The objective was to support innovation, entrepreneurship and collaboration in order to increase the competitiveness of the SMEs. Four European universities engaged with 30+ firms from three sectors – dairy, bakery and meat - in nine clusters in eight countries. This objective was achieved through focused regional coordination and support activities and events.

Inter-Reg Ireland-Wales Fund: Hydro-BPT: Towards a More Sustainable System of Water Supply in Ireland and Wales: Exploring Opportunities for Hydropower in Break Pressure Tanks:

The objective of the Hydro-BPT project was to reduce energy and carbon associated with water production and distribution. Two European universities, two water authorities, a conservation charity and three SMEs from two countries collaborated to determine the technical/economic feasibility of energy recovery and the associated CO_2 emissions saving, as well as the development of guidelines for implementation of this technology by industry. Four disciplines interacted, drawing together engineering, environmental science, geography and management.

Inter-Reg Ireland-Wales Fund - Distributing our Water Resources: Utilising Integrated, Smart and low-Carbon Energy (Dwr-Uisce)

The Dwr-Uisce project built on the Hydro-BPT research and was informed also, in part, by the experiences of the CO-IMPROVE and TRADEIT projects. The objective of the Dwr-Uisce project was to quantify and demonstrate the scope to improve the energy efficiency of the distribution of water resources in Ireland and Wales using integrated smart and low-carbon technology. Two European universities, two water authorities, a conservation charity and sixty firms from two countries collaborated in exploring, demonstrating and diffusing

energy reduction and carbon removal. Four disciplines interacted, drawing together engineering, environmental science, geography and management. Key outputs include energy recovery system designs and diffusion through demonstration of installations in practice.

Common across the projects was the use of action learning and also how the insights generated by earlier ones informed the design of those carried out later. More significantly, we applied the learning from each project to those following. In the next section we reflect on how we understand the five projects as initiatives within Mode 2 knowledge production.

Reflecting on the five projects as Mode 2 knowledge production

As we reflected on our learning from NALP and CO-IMPROVE and prior to the emergence of TRADE-IT, Hydro-BPT and Dwr Uisce, we received an insight from MacLean, McIntosh and Grant's (2002) view that the tradition and practices of participatory action-oriented research meet the criteria for Mode 2 knowledge production. This insight, of understanding action learning in terms of Mode 2, was equivalent to that of Monsieur Jourdain in Moliere's *The Middle-Class Gentleman*, who learns that he has been speaking in prose for many years without realising it.

Gibbons et al. (1994) introduced Mode 1 and Mode 2 knowledge production approaches in their book, *The New Production of Knowledge* and subsequent writings (Nowotny, Scott and Gibbons, 2001, 2003). The authors describe Mode 1 research as characterized by the explanatory knowledge that arises from the academic agenda, and as generated in a disciplinary context. It is accountable to that discipline. In many respects, Mode 1 captures the traditional meaning of the term 'science'. The role of the researcher is that of an observer and the relationship to the setting is detached and neutral.

In contrast, Gibbons and colleagues present Mode 2 as the 'new' knowledge production and as a 'socially distributed', system-based process. They describe Mode 2

knowledge production as an emerging paradigm that is increasingly pervasive alongside the incumbent Mode 1. There are five main characteristics of Mode 2 knowledge production. First, Mode 2 knowledge is generated in the *context of application*. There is no division between knowledge production and application. Second, Mode 2 knowledge production is *transdisciplinary*, mobilizing a range of theoretical perspectives and practical methodologies to address issues. Third, Mode 2 knowledge production is *reflexive,* through a sensitivity to the process of the research itself and to, for example, the dynamics of transdisciplinarity (Max-Neef, 2005). Fourth, Mode 2 research is *heterogeneous* and works with *organizational diversity.* Who comprises research teams, how and to what extent they construct interventions and inquiry across functional boundaries may shift as a project proceeds. With respect to s*ocial accountability and reflexivity* Mode 2 researchers are accountable to their organizations or communities and to the academic community for generation of actionable knowledge. Finally, a *diverse range of quality controls* is exercised as the Mode 2 researchers work with their organizations or communities to establish learning mechanisms to sustain the change.

There has been a great deal of reflection on the application of the Mode 1 and Mode 2 construct to management and organizational research (Coghlan, Shani and Dahm, 2020; Hodgkinson and Starkey, 2011). MacLean, McIntosh and Grant (2002) in their broad review of Mode 2 argue that the social sciences have an established tradition of Mode 2 research, particularly in research conducted through action research, clinical inquiry, and other participatory inquiry approaches. Bartunek (2011) comments that she found more discussions of Mode 2 than demonstrations of it in practice in academic journals. This article seeks to redress this imbalance.

Returning to the five research projects, the action learning component was always explicit. However, it was as we progressed within and between the projects that we saw that

we were engaged in Mode 2. It was a critical insight, supported by McIntosh et al, which guided the emergence of the research focus for this paper. Table 2 captures the essence of this insight.

Table 2: The five projects as Mode 2 Knowledge Production

Mode 2 Characteristics	**NALP**	**CO-IMPROVE**	**TRADEIT**	**HYDRO-BPT**	**Dwr Uisce**
Knowledge is generated in the context of application	Indigenous manufacturing and service settings	International manufacturing settings	Indigenous artisan food production settings	Water production and distribution settings	Water production and distribution settings
Knowledge production is transdisciplinary	• Operations Management • Organization Development	• Operations Management • Organization Development • Engineering Management	• Food science (dairy, bakery, meat) • Operations Management • Organization Development	• Engineering • Environmental Science • Geography • Operations Management	• Engineering • Environmental Science • Geography • Operations Management
Knowledge production is reflexive	Learning and operations improvement towards World Class Manufacturing	Collaborative improvement in the supply chain	Innovation, entrepreneurship and collaboration	Energy recovery and carbon reduction	Energy recovery, carbon reduction, demonstration and diffusion
Research is heterogeneous and works with organizational diversity	One university / research institution, one membership institution, six firms One country	Four universities / research institutions Nine firms Five countries	Four universities/ research institutions Nine clusters Three sectors 30+ firms Eight countries	Two universities / research institutions Two water authorities (Public enterprise) One conservation charity Three firms Two countries	Two universities / research institutions Two water authorities (Public enterprise) One conservation charity 60 firms Two countries
A diverse range of quality controls is exercised	• Engagement with real-life issues • Collaborative • Reflective • Workable outcomes and actionable knowledge				

In this table, the knowledge producers were tied closely to the applied contexts of each project. They combined theoretical knowledge with applied, practical knowledge to address particular scientific and organizational problems. They were charged by the EU with achieving concrete results by creating actionable knowledge that was aimed at advancing the particular practical agenda of the practitioner participants. In sum, each network was engaged in Mode 2 research. From here the, we began to explore the network setting within which this research was carried out. The next section describes the concept of inter-organizational learning networks.

Reflecting on the five projects as inter-organizational learning networks within which Mode 2 knowledge production is undertaken through network action learning

The European Union (EU) investment in research through Framework Programmes (FP5, FP6 and FP7) has aimed to generate knowledge in the context of application across different sectors. While the particular characteristics of individual Framework Programmes guide their design, implementation and evaluation, we have reflected on our first-hand experiences of five EU-funded research projects in terms of how they were designed and delivered as action learning networks and can be understood in terms of Mode 2 knowledge production. Our reflection elaborates this understanding with a view to guiding those who design and implement projects, those who approve and provide funding, and those who exploit and build upon the resulting research.

Inter-organizational networks

Docherty, Huzzard, de Leede and Totterdill (2003) characterize inter-organizational networks in terms of four types: strategic, learning, transformational and professional networks. In our view, the five funded research projects are categorised appropriately as learning networks as they aimed at increasing knowledge or the capacity to do something. A networks of organizations work through groups of representatives (such as senior managers) who meet to reflect on their experiences in order to explore and to exploit learning opportunities. Network learning involves such exploration and exploitation both within participating firms and between them as they engage in the network (Coghlan and Coughlan, 2015; Coughlan, Coghlan, O'Leary, Rigg and Barrett, 2016; Garde and Mothe, 2011; Holmqvist, 2003; Yström, Ollila, Agogué and Coghlan, 2019).

The five projects constituted inter-organizational learning networks, each with an aim to generate knowledge in the context of application. We illustrate in Table 3 the characteristics of each project as a network action learning initiative. In each project the problem was that specified by the EU in its calls for research. The groups comprised research institutions made up of multidisciplinary researchers and business partners (multi-national enterprises (MNEs), small and medium enterprises (SMEs). Each project had the aim of taking action to address the problem and, so, engaged in a Mode 2 knowledge production mode to apply the work of the project to the strategic and operational challenges faced by the participating organizations. The participants in each project were committed to exploiting emerging insights, including co-producing guidelines, cases, theses, papers and inputs to future research proposals (Coughlan, Coghlan, Dromgoole, Duff, Caffrey, Lynch, Rose, Stack, McGill, and Sheridan, 2002; Coughlan, Coghlan, O'Leary, Rigg, and Barrett, 2016; McNabola and Coughlan, 2014). And significantly the mode of working was through

reflecting on and uncovering meaning through questioning experience – both within the firms and away at site installations, demonstrations, training events, site visits and workshops.

Table 3: The five projects as Network Action Learning

	NALP	**CO-IMPROVE**	**TRADEIT**	**HYDRO-BPT**	**Dwr Uisce**
The problem	How to exploit learning and operations improvement towards World Class Manufacturing in firms	How to improve the supply chain through collaboration among manufacturing firms	How to develop innovation, entrepreneurship and collaboration in artisan food producers	How to recover energy and reduce carbon in water distribution	How to demonstrate and diffuse the application of technologies to recover energy and reduce carbon in water distribution
The Group	• Researchers from Operations Management and Organization Development • Firms in one country (including a public enterprise)	• Researchers from Operations Management and Organization Development, Engineering Management • Firms and their suppliers in three countries	• Researchers from Food Science, Operations Management, Organization Development • Firms in three sectors and eight countries	• Researchers from Engineering, Environmental Science, Geography and Operations Management • Firms including public enterprises and a conservation charity in two countries	• Researchers from Engineering, Environmental Science, Geography and Operations Management • Firms including public enterprises and a conservation charity in two countries
Commitment to action	Operations improvement towards World Class Manufacturing	Collaborative improvement in the supply chain	Innovating and collaborating across sectors, markets and boundaries	Recovering energy and reducing carbon through micro-hydropower applications	Demonstrating the recovery of energy and reduction of carbon through micro-hydropower, heat recovery and system design applications

Commitment to learning	Exploiting the emerging insights, including developing a contingent understanding of collaborative strategic improvement from a Mode 2 perspective through action learning and network action learning Co-producing guidelines, cases, theses, papers and inputs to future research proposals				
Questioning and reflection	Questioning experiences gained at home and away at site installations, demonstrations, training events, site visits and workshops. Reflecting and uncovering meaning through questioning experience and co-developing guidelines, cases, theses, papers and inputs to future research proposals.				
Roles [A- Architect LO - Lead Operators C: Caretakers]	A: Membership institution LO: Membership institution and university C: Theme coordinators	A: Academic partners LO: Academic partners C: Workpackage Leaders, country coordinators, Action Learning coaches	A: Academic Partners LO: Academic Partners C: Workpackage Leaders, Hub Advisors, Action Learning coaches	A: Academic Partners LO: Academic Partners C: Workpackage Leaders, Action Learning coaches	A: Academic Partners LO: Academic Partners C: Workpackage Leaders, Action Learning coaches

Each of the networks in the five funded project exhibited its own dynamics, depending, for example, on whether the relationships between the partner organizations were *contractual or non-contractual* (Coughlan and Coghlan, 2011*).* In the *contractual* setting of CO-IMPROVE, the participating organizations in the network were systemically linked by the contractual structures of a supply or service chain. Accordingly, for organizational members who participated in this network, participation had a compulsory and contractual tone to it with an explicit basis of power inequality. In the *non-contractual* settings of NALP, TRADEIT, HYDRO-BPT and Dwr Uisce, each set of organizations formed networks voluntarily in order explore and address issues and areas of common interest. As loosely-coupled peer systems, the participating organizations were generally equal, with no superior-subordinate relationships among them. We turn now to consider how these networks became learning networks in the first place.

Becoming a learning network

Like all relationships, whether interpersonal, inter-group or inter-organizational/network, collaborating partner organizations need to build connections with one another. Each network began as a strategic network with a primary focus on reducing transaction cost, increasing competitiveness or reducing environmental impact. However, they soon recognised the limitations of a strategic relationship. Faced with a challenge, for which sustainable strategic improvement is a response, the learning process required transitioning to a learning network, capable of reflecting on shared experience in order to explore and to exploit learning opportunities, and, ultimately, to becoming a transformational network with an explicit aim of transforming of participating partners (Coughlan and Coghlan, 2011). Underlying this transition was the behaviour of individuals from the participating partners acting

collaboratively. In the five networks, this behaviour evolved through repeated learning cycles to the point where it became an integral part of the network culture. Here, the individuals needed to build trust and to achieve a safe environment to be able to engage in collaborative learning and for shared organizational and network insights to emerge (Yström, Ollila, Agogué and Coghlan, 2019).

When representatives of partner organizations came together to engage in inter-organizational action learning two forms of dynamics occurred which are expressed in a sporting parlance. One form occurred in the *away* setting, that is, the setting where the inter-organizational networks met (Holmqvist, 2003). The other occurred *at home* in the respective participating members of the network. Problems faced by individual organizations, when brought to the network, prompted analysis and discussion among the participating firms. The ideas generated from these discussions were brought back to each firm for implementation as its part of the response. Stated differently, what was explored away was exploited at home (Holmqvist, 2003).

Coordinating roles

As the networks are loosely-coupled systems that cross institutional, disciplinary boundaries and often national ones, it is necessary that certain coordinating roles be enacted. For instance, Cross, Ernst and Pasmore (2013) describe five boundary-spanning roles: connector, expert, broker, energizer and resister. These roles build on the power of differentiation across the partners while ensuring autonomy and supporting integration in creating innovation. In EU-funded projects there are identifiable and named roles, such a principal investigator and workpackage leader built into their structure. We focus on the broker role in this article because the networks in the projects depended on those who attended to the continuation and flourishing of the network and who brokered communication and engagement within the

network and the final report to the European Commission. Snow, Miles and Coleman (1992) describe the broker role as necessary for a network to be created and to flourish and identify three significant roles for a network: *architect, lead operator* and *caretaker*. The *architects* set up and design the network and its processes. The *lead operators* build on the work of the architects and connect the participating partners. Snow, Miles and Coleman point out that the roles of *architect* and *lead operator* may overlap considerably and may be played by the same parties. The *caretakers* keep the network functioning through maintaining the relationship between the participating parties and ensuring collaborative behaviour.

The roles identified by Snow, Miles and Coleman (1992) are evident in all five projects. As in typical EU funded-projects the lead research institutions took on the role of network *architect* through envisioning the potential in the EU call for proposals, recruiting academic and industry partners and submitting the proposal. They also played the role of *lead operators* in organizing partner meetings and overseeing the implementation of the project and the submission of progress reports and ultimately the final report. As is usual in such funded projects, project activities were subdivided by workpackage. The workpackage leaders acted as *caretakers* as they attended to the implementation of each workpackage.

In the context of these learning networks where action was undertaken through network action learning we identified a further dimension to the *caretaker r*ole, namely that of the *action learning coach*. In each of the five projects the workpackage team leader played a particular caretaking role in both facilitating the engagement in action and learning and also keeping the focus on learning. The teams comprised both academics and practitioners acting as co-researchers. For instance, in TRADEIT, there were six workpackages in total and it was the role of the action learning workpackage team to encourage and facilitate the action learning process. Similarly, in Dwr-Uisce, there were nine workpackages in total and the action learning workpackage team fulfilled this caretaking role.

Action learning coaching as caretaking

The act of coaching as caretaking began from the outset of the projects. In the language of action learning, the focus of the action learning coaches was on the process of addressing complex and difficult-to-solve problems rather than technical puzzles.

In the CO-IMPROVE and TRADE-IT original designs, activities in the action learning workpackage were not scheduled to begin until after nine months. At the outset, however, the workpackage team realised that action learning began and needed to be recognised from the beginning. As a result, the team role was redefined as coaching, scheduled earlier and recognised as a critical integrator of the process and outcomes of the other workpackages.

In TRADE-IT, the action learning coaches proposed the development of case studies to capture the experiences of the SMEs innovating within the context of the project. Having developed the draft cases as an action learning activity, the cases were presented at a project team meeting. The result was transformative for the project as a whole. The other workpackage leaders recognised their particular contributions to the project within the case histories and came to realise their connections to application.

In Dwr-Uisce, the action learning coaches were responsible for the design and development of demonstrator events. The technologies and supporting systems were demonstrated at these events. However, rather than just a focus on the working technologies, the perspective of the action learning workpackage was on the scope of application, the obstacles to be overcome and the learning opportunities to be realised.

Brokers in the context of application

In summary, in a Mode 2 project, such as the five discussed above, brokers are challenged to enable communication and engagement within a network just as the research is undertaken in the context of application. This context changes and is not just a stage of the project (such as ideation, exploration or development) within which individual workpackage leaders or caretakers may develop a specific task in a silo. Rather, Mode 2 research brings with it the need to integrate the workpackages and to challenge each to demonstrate its relevance and contribution to the project through evidence of applicability in practice. The five Mode 2 projects demonstrate the integrative role of the caretakers and illustrate learning in action, both by the caretakers/workpackage teams and by the broader set of stakeholders in the projects. This integrative role is based upon connecting each workpackage to application.

The projects illustrate also the need for the *architects* and *lead operators* to consider this integrative role at the proposal and design stage, allocating time and resources for timely execution. This role is visualised in a dynamic and integrative way which challenges the more hierarchical representation of the project organisation structure. The communication is two-way with both other workpackages and the principal investigator. When this allocation is missed, the architects may have to review and amend the architecture of the project to suit.

Towards a Framework Enabling Mode 2 Knowledge Production in Complex Applied Research Projects

Many complex applied research projects require combinations of cross-border, inter-institutional, cross-sectoral and academic-practitioner collaboration. The Framework Programmes funding such projects provide a stimulus for interaction consistent with a Mode 2 philosophy of knowledge production. The interaction is undertaken in a disciplined way through network action learning. The resulting knowledge is useful to and usable by

researchers and practitioners – the latter of particular relevance given the applied character of the research: substantive insights that Mode 1 research would not produce, such as situational understanding; appreciation by a network of researchers of a way of working; sustainability of the network and a way of working in order to develop the substantive focus and network further. Figure 1 visualises this insight derived from our reflected learning from the five projects

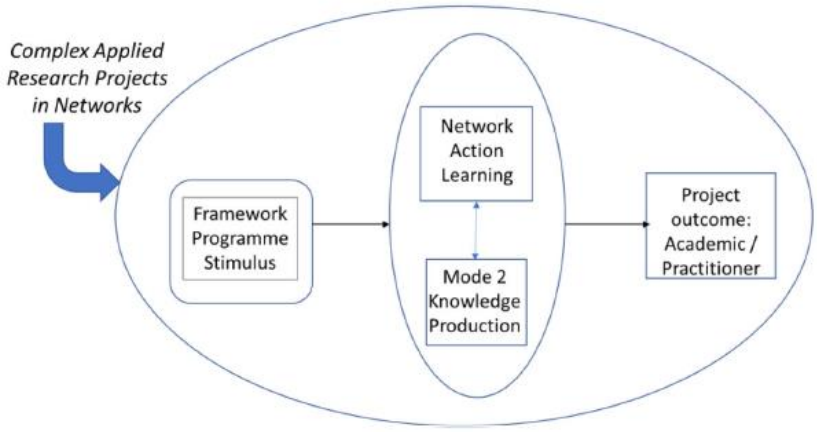

Figure 1. Enabling Mode 2 knowledge production in complex applied research projects in networks [Colour figure can be viewed at wiley-onlinelibrary.com]

Embedded in this framework are three propositions, applicable as a set to the design and implementation of complex applied research projects in networks. The propositions clarify the choices in framing and realising applied research objectives, through adopting a Mode 2 knowledge production philosophy, enacting that philosophy through network action learning, and managing roles to generate actionable knowledge across disciplinary boundaries and in the wider community through action-oriented transdisciplinary research. We introduce each proposition in turn.

Proposition 1

A Mode 2 knowledge production approach enables researchers and practitioners to work together to generate knowledge.

There is an increasing expectation that EU-funded research can achieve impact, not just through contributions to theory, but also on practice and on the grand challenges of our time. Much research will make a contribution to theory only. However, it is the contribution to practice that, often, is troublesome. There may be neither the engagement with practice in the generation of the research nor a translation of the research outcomes into a language understandable and actionable by practitioners. One way to address this challenge is to adopt a knowledge production approach that engages both theory and practice. The Mode 2 knowledge production approach provides a research framework that enables researchers and practitioners to work together as co-researchers. Through Mode 2 they can combine theoretical knowledge with the applied practical experience of the practitioners and produce actionable knowledge that is robust for scholars and useful for practitioners.

Proposition 2

Complex applied research projects can benefit from adopting a network action learning approach, where distinguishing between puzzles and problems enables collaborative questioning of complex issues and collaborative learning in action.

A transdisciplinary research project is a typical response to a complex research question. Three fundamental challenges emerge in such projects: developing and contributing deep discipline knowledge; designing and implementing a project that realises the planned objectives; and, communicating the complex insights simply, both across disciplinary boundaries and to the wider community. The learning approach is based upon the experience of the participating researchers and practitioners engaging with the focal issue in the project which allows for actionable and usable knowledge to emerge. In particular, attending to experiential learning is necessary in order to address the research issue from the perspective of those engaged in and challenged by the issue in practice.

Quality research requires an explicit and underpinning research philosophy. Understanding the learning approach undertaken is central to achieving that quality. The characteristics and assumptions about engagement need to be clear and actionable within the project and recognisable by those who might use or build upon the findings of the project. Action learning satisfies that challenge. Action learning enables researchers and practitioners (as collaborators) to address complex problems through questioning and reflecting in a peer group setting where there is a commitment to taking action and a commitment to learning. The outcomes are both a problem addressed and learning that may be carried forward to address future problems.

Action learning by transdisciplinary networks is facilitated by network action learning. The research partners, assembled in response to a research opportunity, may engage as a learning network. The partners in such a network have the capability to explore the phenomenon and to exploit the emerging research-based insights both *at home* (in the disciplinary or practice home) and *away* (when interacting across boundaries). Deploying an action learning approach as a network brings with it the characteristics and potential benefits of a systematic learning approach. With a focus on the network as a learning system, network action learning enables exploration and exploitation *at home* and *away* by the participating partners so as to achieve the practical and learning outcomes of the funded project.

Proposition 3

Distinct roles in transdisciplinary research projects need to be enacted to enable learning in networks.

Attention to distinct roles and being explicit about them is a critical choice in organizing for research. EU-funded research projects typically define roles such as principal investigator and workpackage leader. The task-based responsibilities of these roles are well defined at the outset of projects. The range of these responsibilities is wider and the organizing challenge greater in a transdisciplinary project context when the multiplicity of disciplinary voices are both vying for attention and seeking integration. The organizing choice is further complicated when the research initiative brings both researchers and practitioners together. Implementing roles requires particular attention what roles are played and is central to enabling the development of a learning approach. Such an approach does not happen naturally in a way that consciously and deliberately develops and maintains commitments to action and to learning. Undertaking a learning approach, through network action learning requires that the collaborating research institutions play the role of *architect* in design the project. Within the structure and process of the project, work package leaders perform the roles of *lead operator* and *caretaker* in enabling the network to function. Within the caretaker role, the *learning coach* is required to keep the focus on learning.

Implications for researchers

We are writing this article for those who design and implement EU-funded projects or other complex applied research projects in networks and those who fund them. While such projects achieve their objectives, the execution of the projects is intuitive and based upon application of previous experience tacitly in an instrumental way and not necessarily explicitly incorporating a learning dimension. So, therefore, we propose taking a network action learning approach with a Mode 2 knowledge production perspective. This model includes connections and evolution of substantive, methodological and philosophical perspectives.

For researchers who are developing a proposal for EU-funded action learning network research, we propose the following prompts to guide their actions:

- Consider the kinds of research question that fit with a network action learning approach. 'How' questions require process answers which are derived from data generation (as well as data gathering).
- Consider the real distinction between a puzzle and a problem. Problems are more appropriate for Mode 2 research and fit with the deployment of a network action learning approach.
- Consider the kinds of partner to be sought. Appropriate partners are those who have a shared commitment to collaborative action, to learning and to research.
- Consider the desired outcome. Sustainable actionable knowledge which is substantive, situational and relational is a desirable outcome.
- Consider the literature base that is relevant. In this context, such literature (or prior research) is relevant for understanding the substantive topic, the process of collaboration and the context.
- Finally, consider the suitability of the funders. Taking a network action learning approach with a Mode 2 knowledge production perspective brings the prospect of emergent insights on the problem that might not have been anticipated at the outset. As such, suitable funders may need to approach Mode 2 research with an openness to emergent (rather than pre-specified) project deliverables and to occasional re-prioritisation of project objectives and budgets.

As a corollary reflection we note that it is commonly noted that when the projects have come to their funded end and the network of researchers and practitioners concludes and

the relationship may disband. The research may have been largely confirmatory and supportive of propositions which were already established. However, transdisciplinary projects which use a Mode 2 knowledge production approach have much greater potential for the work to continue. The initial intellectual curiosity around a complex problem, addressed in the context of application, complemented by the excitement of discovery in practice and learning in action, has the potential to inspire imaginative new questions and fruitful new learning networks. If the research has been undertaken with a network action learning approach, there is both the opportunity and motivation to inquire deeper into the complexity of the problem and to take action more widely for more sustainable impact after the completion of the specific funding.

Conclusions

In this article we have reflected on our experience of engaging in five complex applied EU-funded research projects in networks. Our aim has been to understand and to improve upon the way in which such projects can produce knowledge in the context of application. We have brought two core lenses to this reflection, network action learning and Mode 2 knowledge production. However, this reflection is more than just a rich summary of an emerging argument about the conduct of research that is transdisciplinary, collaborative with practice, learning oriented and sustainable after completion in the service of application. We are making a strong theoretical statement linking network action learning and Mode 2 knowledge production. We conclude that in the collaborative context of contemporary research, knowledge production involves enacting collaboration in networks of researchers and practitioners in the service of application.