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# Scaffolded contributions, active meetings and scaled engagement:
How technology shapes informal learning practices in healthcare SME networks

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None.

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**Highlights**

- Informal learning studied in the real-world context of UK healthcare SME networks
- Tool co-designed with professionals found to shape three informal learning practices
- Of these, one unanticipated practice supports informal learning in active meetings
- Discussion and collaborative document editing functionality remain unused
- Three conjectures associate tool functionality and stages of knowledge creation

**Abstract**
The importance of informal learning in modern, fast paced work environments has long been recognised. While technology support has been suggested for informal learning by individuals and in organisations, it is only more recently, that we have been able to study in more detail how technology can support such learning in real workplaces. This paper examines technology supported informal workplace learning in the relatively unexplored context of cross-organisational networks of small and medium-sized enterprises (SMEs). We developed an informal learning tool, using a participative, co-design approach found useful for engaging such networks. We analyse qualitative data on tool usage, collected over six months from 30 professionals, working in three different cross-organisational healthcare SME networks. We identify three changes in practice: (1) scaffolded contributions, (2) active meetings and (3) scaled engagement. We explain how and why some functionalities in the tool contributed to these changed practices while others were unused. The changed practices are linked to three stages of organisational knowledge creation: making individual knowledge explicit, group knowledge integration and institutionalisation. We propose three associations between tool functionalities and these processes that contribute to our understanding of technology support for informal learning in early stages of knowledge creation in cross-organisational networks.

**Keywords**
Informal learning, knowledge creation, network, SME, technology-enhanced learning, workplace learning

**Abbreviations used in this paper**
SME – Small to medium-sized enterprise
KPI – Key performance indicator
NHS – National Health Service
TEL – Technology enhanced learning

# 1. Introduction

In the modern work environment, organisations and staff are exposed to and are constructing new ideas, technology, services and regulations at ever faster rates. The demand is for agile and reflective organisations and personnel: people who do not just bring skills and knowledge (from formal training) to the workplace, but who are able to learn, share and develop knowledge on the job, within the workplace itself. The importance of such informal learning at work has been recognised by researchers for many years (Eraut, 2004), not only at the individual level, but also as a way in which group and organisational knowledge is created and developed (Maier & Schmidt, 2015; Nonaka, 1994). Technology support for such collaborative learning processes has been proposed (Damiani et al., 2015). But it is only more recently, as technology and social media are used more widely within work environments and there is some evidence that they do improve job performance (Ali-Hassan, Nevo, & Wade, 2015), that we have been able to study in more detail how technology can support such informal learning in *real* workplaces.

Previous research in this area has tended to focus on the use of technology to support informal learning in large organisations (García-Álvarez, 2015; Milovanović, Minović, Štavljanin, Savković, & Starčević, 2012), educational settings (Jones & Dexter, 2014), informal learning acquired outside the organizational context (García-Peñalvo & Conde, 2014) and/or in contexts that are linked to formal learning (Pimmer, Mateescu, & Gröhbiel, 2016). In contrast, there has been little research undertaken into how technology can support informal learning within the most common work environment across Europe - small to medium-sized enterprises (SMEs). In a recent study, Moen, Benum, and Gjærum (2018) have shown that informal learning stimulates innovation performance in the context of SMEs through knowledge sharing. However, as Manuti et al. argue, further research should move beyond theorizing the relation between informal learning and performance and look at workplace learning in practice (Manuti, Pastore, Scardigno, Giancaspro, & Morciano, 2015, p. 13) plus, we might add, at how technology supports such practice.

The focus of our research is on the introduction of technology, we co-designed, to support informal learning in healthcare SMEs and their networks. Specifically, we explore the research question "How does introducing such technology lead to changes in working and learning practices in groups and networks". We relate these changed practices to theories of informal learning and knowledge creation in organisations. We also look at whether and how the different functionalities (design choices) of the introduced technology enable or support the changed practices we found or discuss what may account for their non-adoption. We therefore contribute to the growing understanding of how technology can support informal learning at work by our focus on changed practices and by adding the new and important context of SMEs. The SME context differs from those previously studied since the SMEs are distinct from larger organisations with respect to, for example, organizational structures, resources and capabilities, managerial styles and higher vulnerability to external influences (Man, Lau, & Chan, 2002, p. 128) and therefore need to focus their resources on sustaining competitiveness of their core business activities. Therefore, for both pragmatic and pedagogic reasons the support for learning needs to be offered within the technology that supports work processes, not as separate stand-alone learning technology. SMEs arguably also have more to gain from joining networks and engaging in cross-organisational learning than larger organisations (Xerri & Brunetto, 2011).

Our research formed part of the 4 year-long EU 7th Framework Programme project Learning Layers (Layers, 2017), which explored how technology could scale up informal learning within SME contexts and networks. Our research was undertaken in the healthcare sector in the UK, working with healthcare SMEs and their networks. We adopted an iterative Design Based Research (DBR) approach to guide our interactions between the co-design of tools and their theoretical and empirical grounding (Barab & Squire, 2004; Santos & Cook, 2017; Wang & Hannafin, 2005). DBR, as a learning sciences approach, emphasises the need to address theories of learning in context; iteratively building, testing and refining both tools and theories in the real-world, rather than in laboratory settings. DBR therefore provides us an appropriate approach that helped us to develop technology support for informal learning in this complex real-world context (workplace learning in SMEs). We built an understanding of the context based on both theory and empirical work, then engaged in iterative co-design to design, develop and test the tool. Each iteration led to refinements in our understanding of the context, the design of the next prototype and our reflections on 'knowledge creation' learning theory in the workplace (Cook et al., 2016; Sebastian Dennerlein et al., 2014; Stefan Thalmann et al.,

2013). Additionally a co-design approach was used, and the design teams included professionals working in the healthcare sector (the ultimate end-users), which helped to ensure that a range of roles and perspectives were taken into account during the design iterations.

This paper reports on the final pilots in which the co-designed tool was used and evaluated by 30 professionals in three real-world healthcare SME networks over a six month period. We briefly outline previous research into informal learning at the workplace, organisational knowledge creation and technology support for both; and highlight a gap in this work, which is technology to support informal learning in the SME context. We describe the SME context in which our study took place, the UK's primary healthcare sector, and the main functionalities of the co-designed tool, i.e. collecting, structuring, scaffolding, sharing and synchronous collaboration. We identify three changed practices, (1) scaffolded contributions, (2) active meetings and (3) scaled engagement. We discuss how these changes in working and learning practices relate to the functionalities that were included in the co-designed tool and to the three stages of a model of organisational knowledge creation, i.e. making individual knowledge explicit, integration into group knowledge and institutionalisation of group knowledge. We also identify functionalities that had been co-designed within the tool, but were not used or did not contribute to changes in practice; and we discuss factors that might explain this unexpected non-adoption. We conclude with some reflections and lessons for both research and practice.

# 2. Background

## *2.1 Informal learning at work: a collaborative knowledge creation perspective*

Informal learning at work has been identified as an important learning process (Eraut, 2004) with some researchers even claiming that it accounts for the majority of learning that takes place in workplace contexts (Bancheva & Ivanova, 2015). Unlike formal learning, it is often unplanned, happens serendipitously and may occur without conscious awareness (V. J. Marsick & Watkins, 2001). Informal learning at the workplace has gained considerable attention and scholars have investigated the specifics of such learning in organisations (Garavan, 1997; Y.-J. Lee & Roth, 2007). As Eraut (2010) states, "the workplace context brings new perspectives to research on learning because it encompasses a wide range of more or less structured environments, which are only rarely structured with learning in mind" (Eraut, 2010). In this context, informal learning is defined as learning that is predominantly unstructured, experiential and non-institutional (informal learning on the job). Informal learning is implicit, unintended and opportunistic (Eraut, 2010, p. 247). It is integrated with work and daily routines, often collaborative, with unpredictable learning outcomes (Hager, 1998). Informal learning occurs when individuals face new challenges and problems (V. Marsick & Watkins, 1990; Noe, Tews, & Marand, 2013), is mainly driven by intrinsic motivation (Berg & Chyung, 2008) and takes place in a workplace context, which plays a pivotal role (Cseh, 1999) as informal learning "grows out of everyday encounters while working" (V. J. Marsick & Watkins, 2001). Therefore, contextual factors like culture, structure and processes have a significant impact on the motivations or constraints of the learning activities (V. J. Marsick, 2009).

Beyond individual informal learning, (V. J. Marsick & Watkins, 2001) emphasize the need to learn more about the interface between learning at the individual, group and organisational levels. Groups are seen as learning systems that take collective action through common values, shared vision, goal and strategies (Holmquist, 2005). Learning by collectives beyond groups has been termed organisational learning and is associated with the development of new knowledge (Crossan, Maurer, & White, 2011; Fiol & Lyles, 1985; Huber, 1991). Similarly, (Paavola, Lipponen, & Hakkarainen, 2004) used the concept of knowledge creation and described learning as a social process, in which individuals engage into social interaction in order to understand and solve problems collectively. Knowledge creation is regarded as a dialectical process that involves interactions between implicit and explicit knowledge among individuals, groups, organisations and the environment (Nonaka & Toyama, 2003) and hence intertwines individualist and collectivist perspectives on knowledge creation (von Krogh, 2009). Knowledge creation in organisations is seen as a social process that transforms mainly implicit knowledge emergent in informal learning by the individual to increasingly explicit, mature and institutionalized knowledge on the group and organisational levels (Maier & Schmidt, 2015).

Crossan, Lane, and White (1999) identify processes of knowledge creation that connect the three levels of individual, group and organisation, namely (1) individual level: intuiting and interpreting processes, (2) group level: interpreting and integrating processes and (3) organisational level: integrating and institutionalising processes. Concerning the individual level, Crossan et al. (1999) define intuiting as a subconscious process of pattern recognition from personal experiences, which requires the ability to make novel connections and to discern possibilities. Interpreting picks up on the conscious elements of individual learning and results in cognitive maps developed by explaining, through words and actions, insights and ideas to oneself and others, thus spanning individual and group level. Integrating focuses on the development of a shared understanding among a group of individuals through dialogue and by taking coordinated action both ad-hoc and recurring, with the latter spanning group and organisational level. Last, through institutionalising on the organisational level, learning is embedded in the systems, structures and routines of an organisation. These knowledge creation processes on individual, group and organisational levels conceptualise the interplay between individual and collective knowledge exchange (Kimmerle, Cress, & Held, 2010) and are fundamental for enhancing workplace learning (Veng Seng, Zannes, & Wayne Pace, 2002) as they both form part of and shape the workplace context in which informal learning takes place.

The workplace context of such embedded informal learning typically is not limited to organisational boundaries, but reaches beyond one organisation. Next to the individual, group and organisational levels, learning therefore also takes place in networks. Through network participation, individuals can cross boundaries between fields of expertise (Crossan, Lane, White, & Djurfeldt, 1995) and use the network as an arena for knowledge creation and collective learning (Holmquist, 2005). The main aspects of such network learning include shared goals, participation and awareness of the participants' knowledge and expertise such that the participants are able to transform their ways of thinking and acting (Tynjälä, 2008) - organisational networks therefore offer opportunities to meet for representatives of participating organisations, to exchange ideas, explore and implement new approaches and to develop important relationships and capabilities (Sharma & Kearins, 2011). Hence, inter-organisational networks aim at increasing knowledge or capacity to act (Coghlan & Coughlan,

2015) available for the social processes of knowledge creation that take place in such networks as well as in the organisations that participate in these networks. Technology plays a key role in supporting communication across such cross-organisational networks in the modern workplace, and therefore may also provide a place in which learning support could be provided.

### *2.2 Technology enhanced workplace learning*

Support for informal learning requires technology that is embedded in daily work settings and helps learners to reflect, connects learners with peers, offers them personalised information support and allows both individual learners and organisations to take better advantage of learning opportunities as they arise (Ley et al., 2014; Van der Klink, Drachsler, & Sloep, 2011). Social software could fulfil some of these functions, and has been suggested as an important driver for changes in knowledge management (Von Krogh, 2012) and workplace learning (van Puijenbroek, Poell, Kroon, & Timmerman, 2014). For example, usage of enterprise social software has been found to positively affect job performance, both for routine and innovative jobs (Ali-Hassan et al., 2015). While this relationship between technology usage as *intervention* and improved job performance as *output* can be explained by the creation of social capital by employees (Ali-Hassan et al., 2015), it is still unknown how such technology (*intervention*) helps to change learning and working practices (*processes*) which in turn improve organisational performance (*output*) (H. Lee & Choi, 2003). Despite the many claims made for the potential of social software to improve organisational learning and effectiveness (van Zyl, 2009) there is still little evidence of successful introduction, adoption and use of such software to support learning in real workplace settings.

Furthermore, as so many work processes are now supported by technology, there is great potential for the support for learning to be embedded within the technology and processes themselves, rather than requiring the use of separate social software. Such an approach could both help to situate and contextualise the learning, and could also provide a more efficient way of learning and sharing knowledge. The growing interest in designing and understanding such work process-based Technology Enhanced Learning (TEL) is demonstrated by the emergence of new research communities focused around such integration of workplace learning and its analytics (EC-TEL, 2017; LAK, 2016; Ruiz-Calleja, Prieto, Ley, Rodríguez-Triana, & Dennerlein, 2017).

## 3. Approach and rationale

Our study explores how technology can support informal learning and knowledge creation in an SME context and more specifically in distributed SME networks. This builds on the research already reported, by investigating the effects of TEL support in a new context, one that is a better match for many workplace contexts across Europe. It also furthers existing research by exploring in more detail whether and how the introduction of the technology changes working and learning practices - focusing on the processes rather than the output of technology-based interventions to improve organisational performance. In the following sections we set out our objectives (section 3.1), provide a description of our pilot context (section 3.2) and the co-designed tool (section 3.3), before providing details on the study method and procedures (sections 3.4-3.6).

### *3.1 Objectives*

The objective of the study was to explore whether and how the introduction of a tool to support informal learning in SMEs and their networks leads to changes in working and learning practices. We specifically wanted to take a tool that had been co-designed with healthcare professionals to explore whether it supported learning and knowledge construction practices when introduced into real SME work contexts (see further detail in section 3.2). In line with the characteristics of informal learning being unplanned with unpredictable learning outcomes (Hager, 1998), we also wanted to ensure that our study was able to capture unexpected and emergent changes in practice, not just those that had been anticipated during the tool's co-design. Therefore, our study adopted a qualitative design (as described in section 3.4), which allowed us to collect rich data throughout the pilot period, which was then interpreted and analysed by the interdisciplinary research team.

### *3.2 Pilot context*

The majority of the work reported in section 2 is either theoretical or else reports on empirical studies of informal learning in large organisations or connected to a more formal educational context (e.g. placement or project learning). However, these contexts do not match the working contexts of the majority of European workers. The majority of workers in Europe work in small to medium-sized enterprises (Europa, 2018) which we focus on as pilot context for our investigation. SMEs differ from large organisations (Man et al., 2002) and therefore also informal learning is embedded in different work contexts. For example, SMEs are often resource-restricted (both in terms of staff and financial/material resources) and "*SME organisational strategies tend to be driven largely by concerns for survival and operational needs*" (Bolden & Terry, 2000). This may mean that they allocate resources mostly to core business activities rather than to support development processes (including supporting workplace learning or information technology and management systems). The small size of SMEs also means that they may not have access within the organisation to the range of perspectives and experience that are useful when collaboratively developing knowledge. For example in an SME there may be only one person in a certain job role (Practice Manager, Specialist Nurse). So SMEs may have a greater need than larger organisations for cross-organisational (networked) learning in order to engage with a sufficient number of similar others, get exposure to others' practice and collaboratively develop solutions to problems and create new knowledge.

The specific SME context that we chose to focus on is the UK's primary healthcare sector, working with general practices (local medical centres, your family doctor) and supporting organisations. General practices are at the forefront of primary care; 90% of National Health Service (NHS) contact with patients is through general practices (Government, 2016). Staff working in general practices include managers and administrators as well as clinical staff (doctors and nurses), some of whom also have training responsibilities.

Collaboration and cross-organisational working are essential within the NHS: whilst each general practice is an independent organisation, they are also part of the complex NHS system and as such their work is necessarily cross-organisational as patient care will often involve liaising with secondary care (hospitals), social care and other specialist services. Furthermore,

the UK government is encouraging them to work together more closely to gain economies of scale, avoid duplication of effort and develop/deliver new services. This collaboration is being undertaken through a number of formal and informal cross-organisational networks, many of which overlap in terms of membership and scope (both geographical and purpose). Knowledge sharing across organisational and professional boundaries in the NHS is recognised as being difficult, but it has been argued that it is most likely to succeed when the organisations are themselves similar and subject to the same pressures (Currie & Suhomlinova, 2006). General practice federations are an example of such a network and have been proposed as a new way of working that will support the NHS to "achieve the advantages of scale, such as more diverse skills in the team and greater capacity to manage the relationships and contracts with other providers important for integrated care" (Baird, Charles, Honeyman, Maguire, & Das, 2016, p. 81). . These federations bring together general practices within a small region, with the focus on working together to share workload and the development of new or improved services. The structure and form of these federations is not mandated. Some are forming as legal entities, some under a multi-practice partnership and others working at varying levels of cooperation and collaboration in varying sizes of group. They can involve staff working across organisations; protocols and working practices being shared between organisations, and clinics or specialist services being developed or delivered collaboratively. Federations are relatively new, and most are at the stage of defining their form, purpose and scope, and establishing their groups. Additionally, collaboration is supported by publicly funded bodies and organisations, which work at a national or regional level to support education, learning and innovation across the multiple organisations that make up the NHS. Again the membership and scope of these bodies often overlaps. However this collaboration is not easy due to the pressures within the current healthcare work environment - this includes heavy workloads, resource shortages and increasing demands (in terms of number of patients, complexity of cases and patient expectations) (Baird et al., 2016; Hobbs et al., 2016). Recent reports have included the suggestion that technology could play a role in supporting these collaborations, but point out that this is a currently under-researched area (Baird et al., 2016; Pettigrew, Kumpunen, Mays, Rosen, & Posaner, 2018).

Our study focus is informal learning in SME networks, however such activity is actually enacted by individuals, representing their organisation, within network groups. So in summary our real and complex pilot context has the following characteristics:

- Organisations - **SMEs** (**general practices**), larger **public bodies** (national or regional healthcare public bodies within the NHS)
- Network Groups - working across organisations: **general practice federations** (relatively new and informal networks set up to share workload, knowledge, experiences and problem solving across organisations) and **distributed groups** (within national or regional healthcare public bodies)
- Individuals - **Healthcare professionals**, including managers, trainers and administrators, representing their organisation within these network groups
- Workplace context - **Challenging** in terms of time pressure, lack of slack time, competing demands and multiple lines of reporting

### *3.3 Tool description*

The tool we introduced in the pilots combines two applications (Confer and Living Documents) which were co-designed and developed with healthcare professionals to address the pain points and opportunities for improvement that they had identified in their current working and informal learning at work (Bachl, Grosser, Kunzmann, Schmidt, & Zaki, 2017; Cook et al., 2016; Elferink, 2017; Joynes, Kerr, & Treasure-Jones, 2017; Stefan Thalmann et al., 2013). Therefore, the tool supports the types of knowledge creation and informal learning activity that healthcare professionals had highlighted as being particularly important to them: activities which require a group to explore and come to an agreement on an issue/question and write a joint document setting out their recommendation or plan. Examples include writing or revising a protocol, devising and writing an implementation plan for a new guideline, exploring whether to introduce a new service within the general practice and writing up a recommendation. Project work such as this is typically undertaken by the cross-organisational networks or the advisory/supportive bodies described in the pilot context section (section 3.2). Before the introduction of the tool, the networks mainly used face-to-face meetings and email to manage such work, but they wanted to explore how collaborative online tools (used synchronously and asynchronously) could help them to make better progress on this work, which was often squeezed in their busy schedules. Figure 1 shows the opening screenshot from the tool and the type of collaborative working process that it supports. The tool is not an additional social software application, but is a tool designed to directly support the group's work activity.

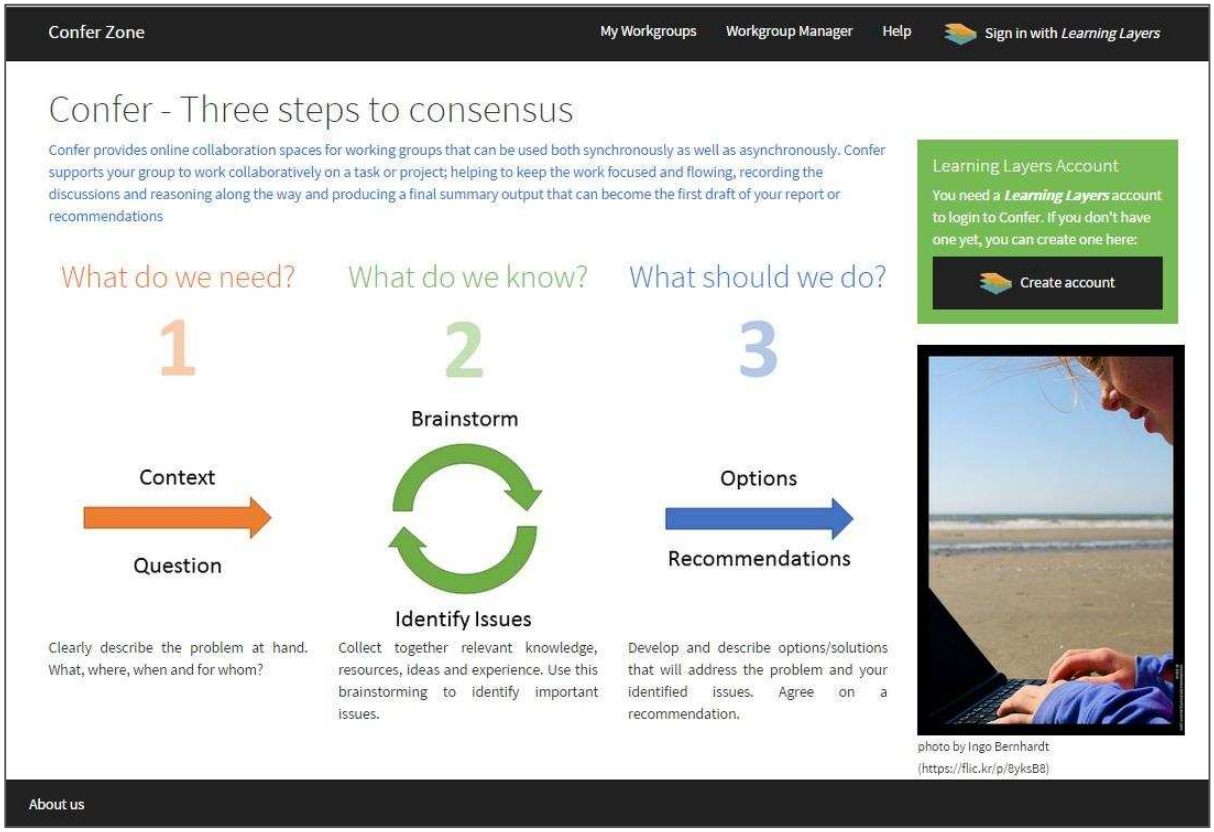

Figure 1: The opening screen of the tool

The tool[1] provides a shared project space for groups, in which they can work following a progressive inquiry process (Cook et al., 2016; Elferink, 2017). This problem-solving approach is built into the interface as 3 steps: (1) What do we need? (2) What do we know? (3) What should we do?

The **3 steps structure** guides and scaffold their exploration of a particular project or shared problem to be researched/answered. Step 1 prompts the group to describe the problem and the context in which it occurs. During step 2 **ideas are created** and **grouped into issues** in a cyclic process. In step 3 the group are prompted to create options/solutions to address these identified issues.

All contributions are **shared by default** within the group - it is not possible to make private, individual contributions. **Discussions** can be started and attached to any contribution made (within any step) in the project space.

**Real-time collaborative contributions** are supported, since multiple group members can add contributions at the same time and they are immediately viewable by all.

Ideas can be emailed into the **dropzone** area by members of the wider network, who do not have login access to the tool itself. The group can **move items from the dropzone into the main problem solving area** to include these ideas in their developing solution.

At any point, the tool can be used to **create and share a summary** of the work in progress with the wider network, who can then be asked to contribute new ideas via the dropzone. Finally, the tool can automatically **create a draft report** from the completed problem solving steps. The report can then be developed further using the **collaborative document editing** functionality provided within the tool.

### *3.4 Sample and procedure*

We conducted our qualitative study between February and August 2016 and involved 30 professionals working in the healthcare sector (Table 1) who used the tool in real work settings. The three pilot groups were proposed by the healthcare professionals who had been undertaking the co-design work with the Learning Layers project (Cook et al., 2016; Sebastian Dennerlein et al., 2014; Joynes et al., 2017; Treasure-Jones & Joynes, 2017) that preceded the study reported here. Each pilot group included at least one person who had been involved in the co-design and who was familiar with the tool. The pilot activities (training, support and data collection) are detailed in Figure 2 and Tables 2 and 3.

| Pilot | Number of Participants | Professional Role |
|---|---|---|
| Pilot A | 19 | Practice managers |
| Pilot B | 6 | Project managers, learning technologists and |

[1] In this description of the tool the key design decisions and functionalities are shown in bold.

| | | |
|---|---|---|
| | | administrators |
| Pilot C | 5 | Trainers, administrators and managers |

**Table 1: Pilot groups**

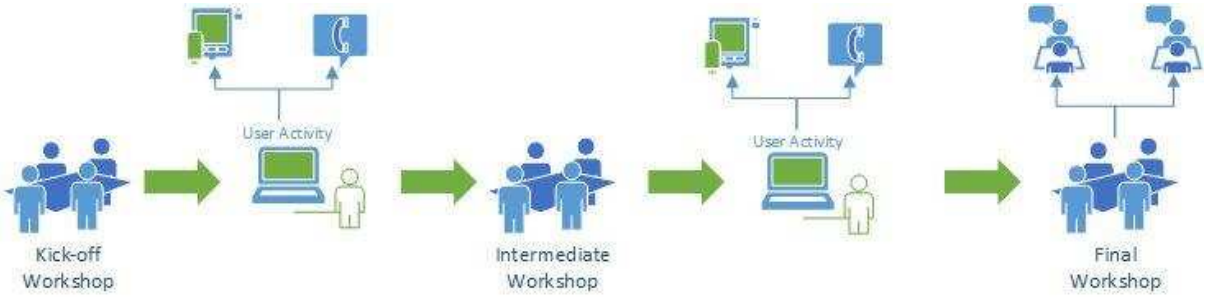


**Figure 2: Pilot study training and data collection activities**

| | |
|---|---|
| Kick-off Workshop (FG1) | • 1-hour focus group on current practice and expectations.<br>• 1-hour training on the tool.<br>• 30-minute discussion on the planned use of the tool during the pilot period (their chosen project, task or report). |
| User Activity | • Documentation of user activity between the workshops (including tool usage logs)<br>• Updates and feedback on the tool and the overall group activity via telephone or e-mail (accompanying conversations)<br>• Observations of user activity during workshops (captured in researchers' field notes) |
| Intermediate Workshop (FG2) | • 1-hour focus group to acquire reflections on the tool, solve issues and support the users on moving their projects forward. |
| User Activity | • Documentation of user activity between the workshops (including tool usage logs)<br>• Updates and feedback on the tool and the overall group activity via telephone or e-mail (accompanying conversations) |
| Final Workshop (FG3) | • 1-hour focus group in which the participants reflect on the benefits and the changes that occurred by integrating the tool within their network as well as the challenges related to the tool, the network and their general working conditions. |
| Interviews (Individual) | • Individual interviews with focus on learning and working practices. |

**Table 2: Pilot study training and data collection activities**

| Pilot | FG1 | FG2 | FG3 | Interviews |
|---|---|---|---|---|
| Pilot A | 15 | 4 | 10 | 3 |
| Pilot B | 6 | 6 | 2 | 3 |
| Pilot C | 5 | 4 | 5 | 2 |

**Table 3: Sample of interviewees across pilots**

### *3.5 Data collection*

We collected data through eight semi-structured individual interviews with self-selected interviewees who represent all professional roles participating in the three pilots (average duration of 23 minutes). Furthermore, we conducted nine focus group interviews of one hour each alongside the kick-off, intermediate and final workshops, which reflected the entire process of tool deployment in our three pilots. We collected a rich set of data - the transcripts of the workshops and interviews, field notes taken by the researchers, records of help seeking and support provided during the pilots, notes from the accompanying conversations and log data of the tool usage. Our data collection activities resulted in more than 16 hours of audio recordings, which were transcribed.

### *3.6 Data analysis*

The collected data were regularly shared with the multi-disciplinary research team, read repeatedly and analysed using an interpretative approach. This approach involved an iterative process of description, analysis and interpretation which has been used successfully in medical workplace learning studies (Kilminster, Zukas, Quinton, & Roberts, 2010) as well as in social science research more generally (Moustakas, 1990; Postlethwaite, 2007; Twining, Heller, Nussbaum, & Tsai, 2017). The team's analysis included identifying themes (including changes in practice, barriers to adoption and suggested changes to the tool or the use cases) and extracting/coding data to these themes. These independent analyses were regularly reviewed and discussed by the research team until consensus was achieved. Thus, we used low-inference descriptors (participants' sentences); reflexivity (through sharing results of text analysis within the research team), thick study descriptions (categorized in themes), standardisation (same protocol for each setting), a triangulation of multiple sources of qualitative and quantitative data plus peer-review examinations and consensus building to affirm the trustworthiness of our results (Patton, 2005).

## 4. Results

Despite relatively low usage of the tool, the reasons for which were explored in a separate paper (Geiger et al., 2017), our analysis of the qualitative data allows us to identify changes in practice that were made across the three pilots. Furthermore, these changes in practice can be linked to the healthcare professionals' use of the tool and to the particular functionalities that had been implemented in the tool, as a result of the co-design process, and are described

in the Tool Description (section 3.3). Below, we describe the three strongest changes in practice, using examples observed in the three pilots (A, B & C) and illustrated by quotes, which we qualify to show whether they come from individual interviewees (e.g. Pilot A_Individual2) or from participants of particular focus groups (Pilot_B FG3 – identifies focus group 3 in pilot B). For each changed practice, we first describe the tool functionality and give an example of its usage, then describe the actual change in practice and finally the effects of that change as perceived by the professionals. In the following discussion section, we then theorize in more detail how these changes relate to three stages of organisational knowledge creation. This includes also examining why some of the co-designed functionalities were not used and its implications on the provision of tool support for the three stages of knowledge creation.

### *4.1 Changed Practice 1 (CP1) - Scaffolded contributions*

*Moving from endless undocumented discussions to structured knowledge contributions (anticipated use)*

| **Tool Functionality** | **Actual Change** | **Perceived Effects** |
|---|---|---|
| Structuring and Scaffolding**:** The tool provides a **3 step structure** for collaborative working on a project or problem. | The groups while using Confer adopted a structure to the way they were dealing with their projects. | The process was formalized and allowed the group to make decisions in a more focused and structured way. |

**Table 4: Functionality and effects of CP1 - Scaffolded contributions**

**Tool Functionality:** The tool supports the group in following a progressive inquiry approach to problem solving. Following the 3 steps structure within the tool should lead to the group providing a context description, brainstorming ideas, identifying issues, proposing options and making recommendations.

As an example of how the groups used this tool functionality, we observed pilot group B using the tool to develop a project plan . Having a research paper as a foundation, the group's goal was to put together a communication and engagement plan for making people aware of their research findings and recommendations. Thus, using the tool they could *"as a team quickly say what are our challenges, who do we need to speak to, how we gonna speak to […]"* (Pilot B_Individual3).

**Actual change:** Prior to the tool adoption the discussion between the members often did not allow the successful completion of their goals: *"We're quite, we like to talk, all of us do, and we do tend to go off on tangents and that does sort of mean sometimes you don't necessarily come to a conclusion on things […]"* (Pilot B_Individual2). The discussions were often unstructured and there was hardly any plan or formal process to follow: *"[…] like I say it tends*

*to be very unstructured our discussions and we don't end up coming to a conclusion."* (Pilot B_FG3).

The tool gave the group a sense of structure and focus that was lacking in the past: *"[…] it gives us a bit of structure to work to. There's not an agenda as such so you have to work through stages and it sort of focuses your work a bit. So I think from that point of view it did help that [...]"* (Pilot B_FG3). The members of the pilot adopted a structure to the way they were dealing with their projects. This structure gave a sense of formality to the group and allowed the members to align their ways of contributing to the project. *"I think it's kind of like what I was saying earlier, I think it just formalized the process […] by using [the tool] it sort of forced us to think about things in a certain pattern, and a certain way of thinking, to come up with solutions, if that makes sense?"* (Pilot B_FG3).

**Effects:** Enabled by the tool and as a consequence of the changed practice, the group adopted a more efficient approach that supported a structured way of working, while at the same time allowed overcoming obstacles that seemed challenging before: *"I do think it's made it easier […] and I think it forced us to have that sort of focused, yeah, that focused discussion."* (Pilot B_FG3). The groups felt that the structuring supported them: "*Using the progressive inquiry process helped us*" (Pilot C_FG3) and could enhance the implementation of essential processes: *"Well I think because of the way that it's structured it's actually very similar to the way that structuring the improvement project and with very little in the way of adaptation it could be aligned to that […]"* (Pilot C_Individual1). They felt that "*it [the exploration of the problem space] was more exhaustive*" (Pilot B_FG2). Additionally they felt that it was an improvement over having less structured discussions within email, allowing them "*to communicate better in a group situation, so they know when they log onto this it's just about what they're dealing with, they don't have to sort through millions of emails"* (Pilot A_FG3)

### *4.2 Changed Practice 2 (CP2) - Active meetings*

*Moving from passive reporting meetings to active tool-facilitated discussions*

*(unexpected use)*

| **Tool Functionality** | **Actual Change** | **Perceived Effects** |
|---|---|---|
| Synchronous collaboration**:** The tool allows **real-time collaborative contributions** and editing in the shared project space. | The tool was used especially to support the discussion and collaborative work during face to face meetings. By showing the content in real time, through a projector, the discussion was guided with the support of the tool during the meeting. | The collaborative work was supported and brainstorming improved as the ideas were added and viewed by the whole group in real time. This supported both more focused discussion and the creation (within the meeting itself) of an agreed record of the results of their discussions. |

**Table 5: Functionality and effects of CP2 - Active meetings**

**Tool Functionality:** The tool supports real-time collaboration, since all group members can view and edit the information in the tool at the same time and the changes made are immediately viewable by everyone. This real-time collaboration functionality was crucial to this changed practice.

The groups used this tool functionality synchronously within meetings to share, discuss and develop their project work. The researchers and the pilot group members had not originally anticipated this use case, but it was observed across all three pilot groups: "*I think it worked really well in a workshop environment and I know that completely defeats the object, that we're supposed to be able to do it remotely in our own time and not have to be face-to-face, but when we're all working together ideas spark and you do type something in and I thought that was really good*" (Pilot A_FG3).

**Actual Change:** Prior to the adoption of the tool, several members focused on their own work during the meetings and they found it often challenging to capture the information shared across the group. Using the tool therefore not only facilitated the meetings, as mentioned in the focus group Pilot A_FG3, but also allowed for a better documentation of the discussions: *"the fact that we were in a meeting together to do it, to use it in that way but it was still good but I think the fact that it was recorded in that way because we would have sat round here with […] in this workshop and said, "Oh, what about this, this, this and this?" And nobody necessarily would have written it all down, with the best will in the world you always miss something, don't you, when you're trying to record meetings."* (PilotA_Individual2).

The groups thought synchronous usage of the collaborative tool functionality during meetings was an important use case:

*"It facilitated the discussion so I know it's for offline discussion but I can see that actually the best use is if when you're having your meeting you have it on there and type some things in whilst you're there and then it feels as though you're adding it on afterwards rather than everybody just go away and do it*." (Pilot C_FG3) This unanticipated "best use" changed the perspective on the tool: *"I think it's like an augmented meeting tool"* (Pilot B_ FG3).

The tool was used both to collect new ideas within the meeting itself, but also to share and discuss ideas that had been added earlier. "*I got [it] up on the screen and went through with them all the things that we'd gone with. The outcome of that was very interesting*". (Pilot C_FG3).

**Effects:** The use of the tool within the meetings meant the group could immediately capture and document the various ideas mentioned during the discussion: *"So, yes it did help with that, it captured that snapshot of that meeting so I think maybe that is some way we could use it a bit more in the future, sort of capture brainstorming*." (Pilot A_Individual2). Furthermore, these active meeting discussions themselves led to changes in the solutions being proposed and the actions taken "*This meeting discussion led not just to changes being made to the training programme plans 'so we've now gone back down to four but a different four, so it has helped with that.'"* (Pilot C_FG3).

### *4.3 Changed Practice 3 (CP3) - Scaled engagement*

*Moving from final approval to earlier, active engagement of a wider network (anticipated use)*

| Functionality | Actual Change | Perceived Effects |
|---|---|---|
| Collecting and Sharing**:** by using the **dropzone** and the **create & share a summary** functionalities. | The group used the tool to share their ideas at a much earlier stage with members of a wider network and then to gather external input. | The group managed to involve members of a wider network earlier to refine the project with their experience. Feedback and further ideas were more easily acquired. |

**Table 6: Functionality and effects of CP3 - Scaled engagement**

**Tool Functionality:** Two functions within the tool support the engagement of a wider network. The "create & share a summary" function creates a structured view of the current work progress, which can be shared with members of a wider network by sending a link. The dropzone area allows members of a wider network to easily contribute new ideas or comments directly into the problem space by simply emailing them into the dropzone.

One of the pilot groups took advantage of this tool functionality to engage a wider working group in its project. In this example the workgroup used the tool to start developing a plan for a new training programme, and they used the create and share a summary function to share their ongoing work with a much wider group. They invited the wider group to send in ideas or comments via the dropzone meaning that they were able to gather input ahead of their face to face meeting with the wider group. They felt that this approach allowed them *"to get input and buy-in on projects from senior or influential people who would not commit to actually being a workgroup member.*" (Pilot C_FG3)

**Actual Change:** Before the tool was introduced, the group relied heavily on email for collaboration when developing new ideas. "*We essentially email like most of these organisations with some people not replying and then chasing them up*" (Pilot C_FG1). This strong reliance on email was partly because the group did not get to meet the members of the wider network face to face very often. "*With our gold trainers network [...] they're all across the region, we hardly ever see each other except on these one occasional meetings*" (Pilot C_FG1). Also (even within the small group) it is difficult to schedule meetings, which also leads to email reliance "*we're all busy people [...] we grab bits of time and even with a small organisation like this, getting [...] together is not really that easy*" (Pilot C_FG1). Additionally, the meeting minutes were not really meaningful to people who were not present at the meeting "*they get the minutes but the minutes don't mean much to them because they weren't at the meeting*" (Pilot C_FG1).

In contrast once the tool was introduced then the group used "the create & share a summary" and dropzone functions to collect the opinion of a wider network of people, prior to face to face

meetings. The group used the tool to share their ideas (and their idea development process) at a much earlier stage with the wider network and then to gather input into these early ideas from the group. "*We uploaded it [share a summary] and got them to look at what we'd uploaded and then they emailed into the dropzone*" (Pilot C_FG3). "*This [sending in ideas] was [done] by the dropzone*" (Pilot C_Individual2). These collected ideas were then discussed at the meetings "*that worked quite well just in the dropzone, we saw it and then we went to the face-to-face meeting with that knowledge and we showed them this at the face-to-face meeting"* (Pilot C_FG3). Hence, the wider network could see the initial ideas and could additionally send in comments and further ideas using the Confer dropzone. "*We let the people look and see where we got up to with our thoughts, so we were sharing that [...] they put in their thoughts so that helped a bit with co-creation*" (Pilot C_Individual2).

Whilst the other two pilots did not actually use these functions to engage with a wider network of people, within the pilot period, they did both discuss how the tool could help them to do this:

*"They don't meet together regularly so [...] this [the tool] will be an opportunity for them to communicate better [...] they don't have to sort through millions of emails"* (Pilot A_FG3).

"*You could populate it with what you've got but then ask people to carry on the discussion and say that they will then have collaboratively produced the report. How nice is that? I'm getting excited again*." (Pilot B_FG2).

**Effects:** The group felt that the members of the wider network were more engaged due to this early exposure to the ideas and that they were able to actually change and affect the plans in the way that the core group had hoped they would. For example, they felt that the fact that people had already had an opportunity to contribute meant that the group was already presenting a joint plan at the meeting: "*they put in suggestions which meant that when we had the meeting I was already presenting what we got in the light of people, what they wanted*." (Pilot C_Individual2)

## 5. Discussion - Three stages of organisational knowledge creation

In the next step of our analysis we discuss how these three changes in practice (in our SME context), and the tool functionalities underpinning them, can be tied to three processes of organisational knowledge creation. We also identify and discuss the functionalities that were not used and how these also relate to the three processes of knowledge creation. This step forms part of our overall design based research approach (Barab & Squire, 2004; Santos & Cook, 2017; Wang & Hannafin, 2005), where we use the data from the pilot to help us to reflect on and connect the use of the design functionalities, the theory underpinning the design and our understanding of the domain (context in which it was used). These associations extend our understanding of organisational knowledge creation by a critique of how technology can help to change practices that span three consecutive processes of organisational knowledge creation identified in previous work in non-SME contexts (Crossan et al., 1999; Maier & Schmidt, 2015; Nonaka, 1994): *making individual knowledge explicit*, the *integration of this into group knowledge* and the *institutionalisation* of the resulting group knowledge. Table 7 gives an overview of how the changed practices we observed and the underlying tool functionality (used and unused) relate to these knowledge creation processes.

| Knowledge creation process: | Making individual knowledge explicit | Integration into group knowledge | Institutionalisation of the resulting group knowledge |
|---|---|---|---|
| Relevant changed practices | CP1: Scaffolded contributions<br>CP2: Active meetings<br>CP3: Scaled engagement | CP1: Scaffolded contributions<br>CP2: Active meetings<br>CP3: Scaled engagement | CP3: Scaled engagement |
| **Functionality** that participants **used** to support this changed practice | • Sharing by default (CP1)<br>• 3 step structure (CP1)<br>• Real-time collaborative contributions (CP2)<br>• Dropzone: easy sending in of contributions (CP3) | • Real-time collaborative contributions (CP2)<br>• Moving items from the dropzone into the main area (CP3)<br>• Grouping of items into issues (CP1) | • Create and share a summary (CP3) |
| Potentially supporting **functionality** that was **not used** by participants | | • Discussion functionality | • Create a first draft report from problem solving steps<br>• Collaborative document editing |

**Table 7: Relating the observed changed practices and underlying functionalities to stages of organizational knowledge creation**

Within our context of healthcare professionals working in SME networks, we did see signs of *individual knowledge being made explicit* within the tool, as the tool had no option to add "private" knowledge and thus mandated the sharing of initial ideas and proposals. Thus, all contributions made within the problem-solving structure were shared with the project group by default. This sharing and structuring of the problem-solving was readily adopted by the healthcare professionals as CP1 (scaffolded contributions). However, this contribution of individual knowledge was not always done by everyone in the group. The groups still tended to stick with their more usual practice of one person leading and adding their ideas first, which others then reviewed. However, there were two situations in which a greater range of individual views were captured and made explicit. The first was within CP2 (active meetings), when individuals within the meeting used the real time collaborative contributions functionality to add their individual ideas into the tool as the discussion progressed. The second was within CP3 (scaled engagement) when individuals (from the wider network) sent in their ideas via the dropzone functionality. Both the co-design participants and the pilot participants had expressed a desire to collaborate more, however, our study appears to show that in the busy workplaces of our participants, actual practice ultimately was more driven by time-efficiency - so there was a tendency to stick with the cooperative work model of the one person leading on the knowledge creation. The two cases in which more individual views were captured were ones where this could either be done within scheduled time together (the active meetings of CP2) or where the manner of sending in ideas/knowledge was very simple (the dropzone functionality in CP3) not requiring the contributor to really interact with the other ideas at this stage or to integrate their own ideas with others. Taking the dropzone route to sending in ideas meant that the idea integration task/responsibility was still left with the "leader". This approach also meant that the addition of individual ideas was less "intrusive" in that the contributor was merely adding ideas and not changing the content or structuring of others' contributions. So in summary we observed that this changed practice of individual knowledge contributions being shared with the group was associated with (a) synchronous usage of the tool in meetings and (b) the option of non-intrusive submission of additional ideas or material.

Our results are mixed in terms of group knowledge integration activities. We had anticipated identifying signs of *group knowledge integration activities* (different views being discussed, ideas being refined, shared understanding being established) within the discussion areas of the tool. However, the discussion functionality was not used and did not appear within any of the changed practices. Instead, as shown by their use of the tool in face to face meetings, the healthcare professionals preferred to use the tool as a way of externalising and sharing their ideas and then having the discussions about these outside the tool itself, predominantly during face to face meetings (CP2). There was only minimal evidence of the use of the tool to support asynchronous discussions. Explanations indicated in our individual interviews and focus groups included the usability of the discussion functionality within the tool, the fear that comments posted within the tool would not be seen if others were not committed to using the tool and/or the busy workloads meaning that most work on the projects ended up being undertaken within the face to face meetings out of necessity: "*if you're doing something we need to have belief that everyone else is going to be doing their bit too so otherwise I'm doing wasted work*" and "*to get some kind of momentum we need to be in a place where there's enough people who've got some time to do something about it*" (Pilot A_FG3). The end result is that the tool itself was not able to fully capture the development of the knowledge, since the discussions often occurred outside the tool.

However, the tool did support those discussions and group knowledge integration activities taking place outside the tool, as the view that the tool provided onto the shared knowledge was used within the meetings to trigger and guide the discussion (CP 2 - active meetings). The tool was also used to capture the ideas/knowledge created during the meeting, it just did not capture the discussion itself. Whether recording of the discussions would be valuable (for wider sharing with colleagues, for audit of decisions made or for evidence of individual learning as part of staff appraisals) is something that might be worth exploring in future work. At the moment, our study suggests that the expected value of using this discussion functionality (within the tool) did not exceed the anticipated effort and so it was not judged to be valuable enough to lead busy healthcare professionals to change their practice (from synchronous face-to-face discussions to asynchronous online discussions).

There were two functionalities within the tool that we did observe being used to support group knowledge integration. The first was the ability to move items from the dropzone to the main area in which all ideas were collected. This was used within CP3 (scaled engagement). The second was the grouping of ideas into issues. This was used within CP1 (scaffolded contributions). However, in both cases it is notable that these were mainly used asynchronously by the 'leader' of the project work, rather than being a functionality that all group members engaged with. Again this points to the retention of the existing co-operative practice of one participant actively leading on the work and the others adopting a more review-like role. In other work we used workshop activities to actively move people into adopting a more fully collaborative approach (S Dennerlein, Treasure-Jones, Lex, & Ley, 2016) and, following some initial reluctance, the participants reported that the collaborative approach was very valuable. Future work could explore whether nudging techniques such as we used within those workshops could also work in real-life work contexts and whether the benefits of a more collaborative approach can be realised outside a workshop context.

Within our study of healthcare professionals in SME networks, we saw little evidence of the tool supporting *institutionalisation* of the knowledge created. Within the 6-month period, none of the pilot groups made use of the tool functionality which allowed them to create a first draft of a report (formed from the content of their problem solving steps) and then to collaboratively edit this document. We are also not aware of any of them writing up such a report outside the tool either. However, in CP3 (scaled engagement) there was some evidence of early activities that could form part of an institutionalisation of the knowledge. Within CP3 the group used the tool functionality which allowed them to create and share a summary of their work in progress with a wider network of people for comment (comments then being emailed to the dropzone). But this informal work-in-progress report was not (within the pilot timeframe) developed into a more formal document that would be used for knowledge dissemination (and institutionalisation) purposes. So it appears that the work they undertook within the tool was not work that they considered needed to be shared more widely in a formal/institutionalised format or that the timescales of the pilot were too short to reach this stage. One possible explanation for this is that the problems solved in our SME networks were so highly contextualised (and possibly time limited), that it was not thought worth the time to write them up for longer-term sharing. Future work could explore in more detail the type of projects that such SME networks undertake and identify when there are benefits to sharing their solutions and learning more widely.

# 6. Contributions, implications and limitations

In this section we summarise our key findings and discuss the contributions, the implications both for research and practice as well as the limitations of our study.

The research question we set out to address was "How does introducing technology lead to changes in working and learning practices in groups and networks?" Specifically we were interested in exploring this within the context of SME networks, an area that has been identified as needing further study, particularly in terms of understanding informal learning practices (Manuti et al., 2015). Our study identifies three observed changes in practice within the SME networks that were connected to the introduction and use of the tool. Taking a design based research approach, this paper adds to the scientific knowledge base a detailed analysis of these changed practices that helps to explain how and why which of the organisational knowledge creation processes were involved in these practices and which functionalities of the tool supported these practices – and which functionalities were not used as anticipated (see Discussion section above). Our analysis confirms previous work (Crossan et al., 1999; Maier & Schmidt, 2015; Nonaka, 1994) and substantiates the importance of these three knowledge creation processes in the context of SME networks, as all three were present in our users' practices with the tool. We contribute three conjectures that associate four tool functionalities with three stages of organisational knowledge creation thus extending the theory of organisational knowledge creation by propositions that help designing technology for informal learning and knowledge creation in SME networks. Below we expand on this and identify implications for designers, researchers and practitioners.

**Designing technology to support organisational knowledge creation**: Based on our analysis, we propose the following ***conjectures*** regarding which tool functionalities (shown underlined) provide effective support for each of the three stages of organisational knowledge creation. In this SME network context:

(1) Making *individual knowledge explicit* was associated with the default option of sharing contributions.
(2) The *integration into group knowledge* was associated with (a) the option of non-intrusive submission of material and (b) the option of synchronous usage of tools in meetings.
(3) *Institutionalisation* of the resulting group knowledge (by means of the provision of feedback by members of a wider network shared with the core group) was associated with the option of sharing a tailored summary of work-in-progress with a wider audience.

A key aspect of a design based research study is to identify which functionalities or affordances are adopted in a given context so that this can be used to guide the future design of TEL tools in similar contexts and their testing in further design based research studies. We therefore propose these conjectures as design recommendations that extend the theory of organisational knowledge creation and substantiate it in the context of informal workplace learning in SME networks. While many studies have focused on whether technology is adopted or not, we follow the call of (Ali-Hassan et al., 2015) and investigate how technology is adopted and used in the context of SMEs. In doing this we also described functionalities that were not adopted. Our healthcare professionals were not only united in their positive attitude and strong support of using the tool for their networks, but also in their assessment of

why they, as a group, abstained from using some of the functionalities. Understanding why these functionalities were not used contributes to theory by explaining how the factors trust, reciprocity and visibility of availability affect workplace learning practices in SME contexts, thus further developing the work of (Manuti et al., 2015). As previously discussed, group knowledge integration processes were not, in this case, supported by the use of the asynchronous discussion functionality, as the anticipated effort was perceived to be greater than the expected value. In particular, our healthcare professionals were concerned about investing their own time in making contributions when there was a risk that others would not have time to read these and contribute themselves. Trust (that others would contribute) and ability to gain momentum (having an active number of participants contributing and building on each other's work) were raised as issues. This was particularly an issue for asynchronous work between meetings, when the other group members' ability to regularly participate were unknown. Potentially this is a greater issue for cross-organisational networks then it may be for internal organisational communication, since it is arguably easier to be aware of others' workloads and availability when working within the same organisation, particularly when using shared calendars. Thus whilst (Xerri & Brunetto, 2011) argue that SMEs have much to gain from cross-organisational working, trust, reciprocity and visibility of availability could be key factors to consider in this context. This argument extends the work of (H. Lee & Choi, 2003) that emphasize the role of trust when assessing the potential impact of technology in knowledge combination, as according to our results trust and reciprocity are also essential for knowledge externalization.

Whilst our participants were aware of the network effects needed to create sufficient benefits for the group as a whole so that they keep using the tool, they differed concerning their individual reasons for non-usage of some of the tool functionality. In a related investigation, we identified three types of networked individuals that differed in the reasons why they did not use tools for informal learning and knowledge creation (Geiger et al., 2017): (1) The convinced connector, waiting for collaborators. (2) The savvy explorer, sceptical about the tools' benefits. (3) The ambivalent follower, overwhelmed by complexity. This finding has also implications on our design recommendations with respect to the provision of tool support for the three stages of knowledge creation in that these three types of participants need different support to overcome their barriers for using the tool. For example, the ambivalent followers might be provided with extra training and coaching sessions to help them master the complexity of the tool. Once the followers start using the tool, the convinced connectors will find a sufficient number of collaborators and eventually provide the added benefits sought after by the savvy explorers.

In the SME network context, we also found that co-operative models of working, in which one person leads and integrates the individual knowledge tended to be predominant. It has previously been suggested that there is a greater requirement to focus resources on core business activities in SMEs (Man et al., 2002). Our work corroborates this as our users argued that the SME network work had to take a lower priority than their core business work, which is one reason why little progress was made in between face to face meetings. Our work however extends (Man et al., 2002) by adding that SMEs adopt practices (such as the co-operative model of working) which reduce the workload involved in engaging in SME network activity by providing a way in which they can work with others without requiring the deeper levels of trust, reciprocity and regular participation that would be involved in fully collaborative working.

This focus on cooperative models of working also highlights a possible implication for future design work. A deeper adoption of our tool by an entire network would also mean a change in the dominant logic from cooperative to collaborative which requires a corresponding shift in the networks' culture and work style that might need more time to unfold than captured in our pilot observations and reflections. Future tools could either introduce nudges and greater support for a more collaborative approach or actively support the prevalent co-operative approach to group knowledge integration.

**Engaging SMEs in TEL research:** Our study can be regarded as proof-of-concept research (Nunamaker Jr, Briggs, Derrick, & Schwabe, 2015) and our results show that it is possible to take TEL prototypes into real-world professional workplaces and use them within SME contexts to learn more about how such learning technology can affect practice. The healthcare context in which the tool was piloted was particularly challenging, given the current financial and workload pressures on healthcare systems, and yet we did get engagement from the busy healthcare professionals, and were able to observe changes in their practice. There was no financial inducement behind the engagement that was likely to be linked to the strong relationships built up during the prior three years of co-design work with healthcare professionals, who recruited their networks to the pilots. Another factor in the continuously high engagement is that the tool addresses real challenges (supporting collaborative working across organisations without overloading network members with unconnected information such as emails) which had been identified during earlier empirical studies (Thalmann, 2013), refined through co-design (Cook et al., 2016) and were recognised and verified by network members. Our experiences suggest that researchers who want to work in this area would benefit from taking a similar participative, co-design approach (S Thalmann et al., 2018; Treasure-Jones & Joynes, 2017) when developing or adapting tools to be used by SMEs.

**Identifying changes in practice:** The changes we observed in practice were identified from the qualitative data (focus group and interview transcripts) - specifically from the stories that the healthcare professionals told us and demonstrated, by showing us the artefacts in the tool, about how they used the tool. The log data supported these stories, but it would not have been possible to identify the actual changes in practice from the log data alone, since some of the key activities prompted by the tool (e.g. discussion in the face to face meetings) happened outside the tool itself. It is possible that surveys may have picked up some of the changes in practice, but this would not have allowed us to explore those changes in depth with the healthcare professionals. With a survey, we also would have risked only identifying or confirming anticipated outcomes and missing the unexpected changes. The qualitative approach we took was time consuming, but rewarded us with a richer understanding of how the tool was used and the impact it had on practice - not just whether the tool was used. We would therefore recommend taking this qualitative approach particularly when exploring changes of informal practices associated with technology usage in contexts such as busy professionals in SMEs, where use of the pilot tool is not mandated and the anticipated use during the pilots may therefore be low.

**Why pilot technology in such challenging real workplace contexts?** Given the difficulties discussed above, it is reasonable to ask why researchers would consider piloting technology in challenging workplace contexts. Possible alternative approaches would be to:

a) study the introduction of commercial, stable technology into a real workplace setting
b) study the use of novel technology (research prototypes such as our tool) in experimental settings (outside normal work, potentially within a workshop)

We argue that there are several issues with restricting studies to these contexts. The risk with option (a) is that by the time this point is reached then the implementation decisions have all been taken and there is little opportunity left to change and adapt the technology/tool to support and fit practice better. At this stage the focus is only on the adoption of the tool. In contrast, option (b) allows for an exploration of the details of how the tool will be used under experimental conditions and there is still an opportunity to alter the tool (or implementation plans) to better fit practice before they are rolled out in the real world. However, conducting the study within an experimental setting means there is a risk that we do not capture how the tool would actually be used in real work settings, to support real activities by professionals. In our study we were able to identify some unanticipated changes that emerged over time (such as the use of the tool within face to face meetings), which would probably not have arisen within the more rigid and short time frame of an experimental setting. Therefore, the study provides us with a better understanding of which functionalities (and the associated support for knowledge creation processes) were most valued by the healthcare professionals in this real SME context. The highest value appears to be placed on the early stages of knowledge creation (making individual knowledge explicit and integrating this into group knowledge) rather than on the institutionalisation of such knowledge. Thus, our associations between tool functionality, changed practices and knowledge creation resonate with empirical results confirming the positive effects of technology support for knowledge activities on individual and collective knowledge creation (Kaschig, Maier, & Sandow, 2016). Conceptually, the associations build on the input (support) - process (activities) - output (knowledge creation) model (Hackman & Morris, 1975; McGrath, 1964) and the enabler (support) - knowledge process (activities) - intermediate output (knowledge creation) model (H. Lee & Choi, 2003). Our findings corroborate that tool support for knowledge activities that connect individual contributions, both from within the group and from a wider network, supports collective knowledge creation in SME networks (Kaschig et al., 2016).

**Implications for healthcare SME networks**: Previous work had identified the difficulties (Currie & Suhomlinova, 2006) and potential benefits of collaboration in healthcare SME networks, and had suggested that technology might offer some support for this way of working (Baird et al., 2016; Pettigrew et al., 2018). In this study the tool had been co-designed to support asynchronous work on projects in such SME networks, since healthcare professionals involved in the earlier co-design sessions had identified this as an area in which they needed support to help their projects move forward in between their meetings. However, despite the tool providing this functionality and support, it was not actually used in this way. Instead, the unanticipated changed practice 2 (active meetings) emerged of using the tool synchronously within face to face meetings in order to work on the project itself within the meeting. It appears that it may not be the lack of tool support that is preventing work taking place in between meetings. Instead it may be the heavy workloads and the low priority given to this collaborative work that is having that consequence. Therefore, we propose that leaders and members of informal networks such as those involved in our pilots consider whether this is also the case for their work. If it is, then we recommend that such networks remodel their face to face meetings in order to make more effective use of this time that is dedicated to their joint work.

This would involve accepting that the main progress on the projects will actually take place during their face to face meetings and therefore using the meetings to undertake that work rather than using the meetings to report and explain why work has not progressed since the last meeting. This could involve using collaboration supporting technology within the meetings themselves (as our pilot groups did in changed practice 2). Face to face meetings would then focus more on active, participatory knowledge creation, ideally with the created knowledge/ideas shared and recorded for all to see during the meeting itself. Our work therefore builds on the general proposals by (Baird et al., 2016) and (Pettigrew et al., 2018) that technology could be used to support collaboration in primary care healthcare networks, by identifying a specific, and unanticipated use case, that emerged in this context. For developers we highlight the opportunity to design and develop tools that can provide better support for this specific use case.

**Limitations:** One critique of our approach could be that we did not identify in advance Key Performance Indicators (KPIs), which could then be measured and used to evaluate whether the tool had the anticipated impacts. However, since this was an initial study of informal learning - emergent, opportunistic, unplanned learning - then we felt that such an approach would be restrictive. We envisage such KPI type evaluations taking place in later stage investigations, building on the learning from these first more exploratory studies in real workplaces.

The relatively small pilot size does not allow us to draw any strong generalisations from our work; our findings are only indicative, yet substantiated in three different settings of healthcare SME networks. A larger-scale study in a similar context could be undertaken to check whether our findings can be replicated. Our anticipation is that in such a larger-scale study, there would be more variety in the use of the tool. One of the comments raised by our participants was a fear that not enough people would use the tool to make it worth while putting in their own contributions. With a bigger pilot size it might be more likely that a critical mass of contributions would be obtained, thus addressing this fear and encouraging greater use. Greater use would then increase the chances that more of the functionalities would be explored and adopted, as the work progresses further within the tool itself. This may then also expose new limitations (connected to scaling) and/or new unexpected uses of the tool.

Another limitation to our work is the context in which we undertook it. The SME networks within the NHS are under very high pressures and also are unusual in that, whilst they are SMEs, they also are part of a highly regulated nationalised healthcare system. As such these SMEs may not have the same level of freedom and control over their own workloads and work focus as SMEs in other sectors. We would therefore recommend that future work explores whether our findings are also applicable in other SME contexts. In particular, it may be worth exploring whether other SME networks also have a greater need for support in the earlier knowledge creation stages and less need for institutionalisation of that knowledge. It may also be worth exploring whether asynchronous collaborative work in other SME network contexts is also slow/blocked due to heavy workloads and low prioritisation, or whether networked collaborative work is given higher priority and therefore is more feasible in these contexts.

The timeframe of the pilot (6 months) could also be viewed as a limitation, as it potentially did not give the participants enough time to fully integrate the tool into their activities and/or it

limited the type of projects that they chose to work on. In particular, this could be an explanation for the low amount of institutionalisation activity observed. A longer timeframe may also lead to participants having time to develop greater trust in and understanding of the tool and their ways of using it to work collaboratively. So over a longer time period we may see more use by the whole group of the group knowledge integration functionalities, rather than these functionalities being mainly used by the 'leader'. To test this, future pilots could take place over a longer time-frame and include projects with a goal of institutionalising knowledge.

# 7. Conclusion

This study of technology supported informal learning at the workplace took place in the relatively unexplored context of cross-organisational SME networks. Specifically we worked with healthcare SMEs, their cross-organisational networks and the individual healthcare professionals who represented their organisations within these networks. Our piloting of research prototypes in real world professional workplaces (rather than experimental settings), combined with a qualitative data collection evaluation approach enabled us to identify unexpected as well as anticipated changes in practice. Following the introduction of a tool to support informal learning in groups, we observed three (positively perceived) changed practices: (1) scaffolded contributions, (2) active meetings and (3) scaled engagement. Analysis of the changes enabled us to examine how and why functionalities in our co-designed tool supported these changed practices while other functionalities were unused. In this paper we discuss these changes in practice in relation to three stages of organisational knowledge creation (making individual knowledge explicit, integration into group knowledge and institutionalisation of group knowledge), helping us to understand more clearly which knowledge creation processes were most important (or most easily adopted) within this SME context. Next to this rich account of how technology helped to change professionals' working and learning practices, we contribute three conjectures on associations between tool functionalities and stages of organisational knowledge creation to the theory of organisational knowledge creation that are also intended to aid the design of technology for informal learning and knowledge creation in SME networks. We argue that in our context the emphasis was on the earlier stages of knowledge creation, rather than the formal institutionalisation stage. We propose that further work could explore whether this is a common characteristic of informal learning and knowledge creation in SME networks.

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