‘The System Says...’: Exploring the Nature of Organizational Learning When Interdependencies are Encoded in Software

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Abstract

Organizational learning research has explained how groups learn to meet new goals by engaging in processes such as action-reflection cycles, through which members collectively determine how to change their interdependent work. Yet research has not yet explored the nature of organizational learning when groups’ interdependencies are encoded in software systems. These digitally-encoded interdependencies challenge learning processes because they introduce action-reflection cycles that are difficult to observe and understand; one group takes action in the system but the impacts unfold asynchronously in distributed locations as other groups later engage with the system. In this paper, we explore how these distributed networks of digitally-encoded interdependencies can be reflexively changed. We draw on a 12-month ethnography of health care consultants attempting to design a new patient check-in process. We found that the action-reflection cycles necessarily involved IT-in-the-loop, but the problems that arose were still not easily understood by IT. Instead, the learning process involved the consultants developing a new frame of reference that enabled them to meticulously trace a complex network of interdependencies that was not visible to others. These findings explain how change agents can guide reflexive change even as local groups are unaware of the extent of their digitally-encoded interdependencies.

INTRODUCTION

Organizations are characterized by constant change; they adapt in response to changes in policy (e.g., Dobbin & Sutton, 1998; Dobbin, Sutton, Meyer, & Scott, 1993), changes in market and workforce conditions (e.g., Cappelli, 1999; Klein, Ziegert, Knight, & Xiao, 2006), changes in societal expectations and pressures (e.g., DiBenigno, 2018; Lounsbury, 2001; McDonnell & King, 2013), and changes in technologies and technical approaches (e.g., Bailey & Barley, 2011; Kellogg, Valentine, & Christin, 2020; Valentine, Retelny, To, Rahmati, Doshi, & Bernstein, 2017). Yet, as complex social systems, organizations tend to respond to these changes in slow, variegated, pro forma, and, sometimes, misguided ways. As well, attempts to change often give rise to unintended consequences—even when the proposed changes are well-resourced and broadly deemed important and worthwhile (e.g., Dobbin, Schrage, & Kalev, 2010; Edmondson, 2002b; Kellogg, 2011; Wiedner, Barrett, & Oborn, 2017). Deliberate or planned organizational change is difficult and complex because proposed changes tend to threaten the status quo of power relations, jurisdictional truces, existing mental models, or well-established interdependencies between roles and groups (e.g., Brown & Eisenhardt, 1997; Contu & Willmott, 2003; Henderson & Clark, 1990; Vallas, 2003). Given the imperative for organizations to change to meet new objectives, as well as the well-established difficulty inherent in this process, many researchers have sought to document the specific processes whereby organizations successfully learn to accomplish new objectives.

One primary theory that lays out the processes of organizational change adopts a "situated learning" perspective (e.g., Brown & Duguid, 1991; Duguid, 2012; Edmondson, 2002a; Suchman, Blomberg, Orr, & Trigg, 1999). This perspective starts from the assumption that all work activities are an embodied, improvised "knowing in practice", wherein what people

"know" about how to do their work is evidenced in their ongoing work practices (Orlikowski, 2002). This practice-based perspective on organizational "knowing" emphasizes that people know how to act in certain ways in their given situations, including as they interact with interdependent co-workers (Edmondson, 2002b) and with relevant technologies (Suchman et al., 1999). As an implication, organizational change necessarily involves those local groups figuring out new ways of "knowing in practice" or, put differently, learning new ways of acting and interacting in their local situated contexts. Thus, the situated learning literature focuses on how local groups engage in collective learning processes of "action, reflection, action" to figure out new practices and new ways of coordinating their work together (Edmondson, 2002b). In local groups, various roles engage together in these iterative processes of acting and reflecting to understand and alter their role interdependencies—or, the routines, activities, or tools through which they integrate and coordinate their specialized efforts within the group (Edmondson & Bohmer, 2001; Senge, 1996). And, because local groups are also interdependent with other groups, in some cases entire networks of local groups are tasked with figuring out how to change their interdependencies through more complex learning processes (e.g., Henderson & Clark 1990; Valentine, 2018).

One of the most consistent findings in the situated learning perspective is that organizational learning processes fail when people fail to understand, anticipate, and adequately address complex interdependencies between roles within local groups or between networks of groups (Henderson, 2002; Edmondson & Bohmer, 2001; Tucker & Edmondson, 2003; Valentine, 2018). The process of reconfiguring interdependencies is thus central to the study of organizational learning and change, and many studies have explored how groups understand and alter their interdependencies through their ongoing interactions. The processes documented in

these prior studies are likely to generalize when interdependencies relate to roles within a team, or between groups within a network. While they can be contentious, role interdependencies tend to be discernible and can be rewired with the engagement and commitment of all participants (e.g., Edmondson, Bohmer, & Pisano, 2001). Additionally, between-group interdependencies may also be rewired by relying on managers to respond to unforeseen contingencies resulting from change (e.g., Valentine, 2018). Yet existing theory does not help us understand how learning unfolds when interdependencies are not easily discernible, such as when they are encoded in software systems. These digitally-encoded interdependencies challenge learning processes because they introduce action-reflection cycles that are difficult to observe and understand; one group takes action in the system but the impacts unfold asynchronously in distributed locations as other groups later engage with the system. Digital technologies in general are "characterized by brittle interconnections and complex interdependencies" that are encoded in the technology over time (Orlikowski & Iacono, 2000: 360). Further, the complexities of these interconnections often only become observable and salient when the technology changes in some way such as when it is used for novel purposes. In this paper, we draw together these perspectives to suggest that organizational learning research can be extended to also account for the processes involved in understanding and changing the complex interdependencies encoded in an organization's pervasive digital technologies. Bailey, Leonardi, & Chong (2010) argue that even though role interdependencies have been the focus of social learning research (e.g., Van der Vegt, Van de Vliert, & Oosterhof, 2003; see also Shaw, Duffy, & Stark, 2000), technology interdependencies may be as important for understanding how organizational learning unfolds.

We aim to combine and extend situated learning theory with research on digitally-encoded interdependencies to offer an account of organizational learning that generalizes to

complex digitally-threaded organizations. To develop this account, we first propose an undertheorized reason why organizations struggle to learn even when they are pursuing well-supported goals: members do not know how to expect, anticipate, discover, or change the interdependencies that are coded and sometimes forgotten in information systems. We refer to these as *digitally-encoded interdependencies*. We expect that digitally-encoded interdependencies will be a key part of any social learning process in organizations today, and in the future.

We developed these ideas in the context of a year-long ethnographic field study of consultants leading a change process at an academic cancer center. Their well-resourced and broadly supported change initiative focused on improving patients' experience by implementing a new "universal check-in" procedure. Before the change initiative, patients needed to go through the same check-in process at the front desk of each department in the large cancer center, including, for example, at the lab, the clinic, and the radiology center, even if their appointments were on the same day and only minutes apart. For cancer patients whose treatments involved multiple, multi-department visits per week, the baseline check-in process was onerous and taxing. We observed the consultants' process attempting to streamline this check-in procedure so that patients were able to check-in one time per day and every department could "recognize" and make use of any departments' check-in. Our analysis found behaviors consistent with prior accounts of organizational learning processes including researching and applying best practices (Tucker, Nembhard, & Edmonson, 2007), engaging in local group action and reflection (Edmondson et al., 2001), and drawing on managers to coordinate synchronized multi-group learning (Valentine, 2018).

However, we also found that this collective learning process was dramatically influenced by digitally-encoded interdependencies in ways not explained by prior literature. The consultants discovered those interdependencies because they determined that several different groups were engaging in redundant interactions with patients. When the consultants asked the groups about those interactions, the groups could not account for why they were engaging patients with those specific interactions except to say that they had to follow the workflow in the electronic medical record (EMR) system. But, when the consultants then asked different IT groups why the EMR system was directing those interactions, those groups could not easily explain why that particular workflow in the system was configured the way it was, who had initially asked for it to be configured that way, or who had the authority to change it. This learning process involved an extended reflection and discovery phase to figure out the many expected and unexpected groups who had together—over time and from various locations across the cancer center—contributed to the existing multi-group check-in workflow so that it could be understood and changed. A key problem in this process was that no one group working on their local, specialized activities could fully see or understand the interconnected network of process owners, system administrators, and patient-facing users all coordinating through the EMR system, or how that network was impacting patient interactions.

Our analysis showed that a critical capability that addressed this problem involved the consultants developing a new frame of reference that enabled them to meticulously trace, understand, and ultimately change the digitally-encoded interdependencies of an emergent network of groups. Gioia (1986: 56) defines “frame of reference” as a “repertoire of tacit knowledge that is used to impose structure upon and impart meaning to otherwise ambiguous social and situational information to facilitate understanding”. The consultants’ original frame of

reference was “what does a patient day look like?” and so was different from that of any other group at the cancer center, and allowed them to observe and reflect from a new perspective. The consultants could newly see and ask about redundant activities, which local groups struggled to account for from their local perspective—they only knew that they were doing what the IT system said to do. The consultants then embarked on an extended reflection phase that also involved discovering which other groups were implicated in changing this one workflow. The major efforts in this extended reflection phase thus included both 1) asking users and system administrators to reflexively consider specific activities or specific system configurations in ways they had not done before, and also 2) figuring out what groups had originally asked for the specific activities or system configurations now in question.

Overall, this learning process was a meticulous investigation wherein the consultants traced connections among users, the IT system and its system administrators, and process owners who had asked for specific system configurations. Our process theory suggests that a key capability in this learning process will be the frame of reference used to reflect on user and system action, and to focus on specific connections. We expect that frames of reference that allow change agents to focus on and reflexively change complex digitally-encoded interdependencies will be an important organizational learning capability going forward, especially given how complex and intertwined social practice and digital technologies are (Orlikowski & Scott, 2008).

SITUATED LEARNING AND CHANGING INTERDEPENDCIES

Edmondson (1999: 350) argued that organizational learning is a “managerial imperative” because of the importance of organizations being able to adapt operations to accomplish new

objectives. Numerous studies over the past several decades have analyzed how members of organizations collectively learn to adapt their work to meet new goals (e.g., Edmondson, 1999; Edmondson & Moingeon, 1996; Nembhard & Edmondson, 2006; Nembhard & Tucker, 2006; Tucker, Edmondson, & Spear, 2002; Tucker, Nembhard, & Edmondson, 2007). This body of research has exhaustively demonstrated that organizational learning is fundamentally a process of managing and changing the interdependencies in how people divide and coordinate their efforts. *Interdependence* is challenging to define, theoretically, as well as empirically (Pennings, 1974). Here we follow Thompson (1967: 54-65) in defining interdependence in terms of workflow or the flow of work and tasks between people. This concept was developed to explore coordination efforts across different ways of dividing and integrating labor—when people specialize, the completion of one person's work depends on how other people have done their relative work. Our study builds on this classic understanding of interdependence by exploring what happens when the interdependent relationships produced by specialization and integration are mediated by an organizational information system. In particular, we aim to explore how digitally-encoded interdependencies shape organizational learning processes.

Local learning processes and changing role interdependencies

One of the main tenets of situated learning theories of organizational change is learning is necessarily a local group activity (Brown & Duguid, 1991; Edmondson, 1999). Organizational learning is a local activity because it is linked to the context wherein work and learning unfold (Brown & Duguid, 2001; Lave, 1988; Orlikowski, 1996; Wenger, 1998). And it is a social group activity because it involves the interactions and mutual understandings that develop among members of a group (Brown & Duguid, 1991, 2001; Edmondson et al., 2001; Edmondson, 2002a). Studies in this area have analyzed how groups interact to develop and learn new ways of

working. These studies consistently emphasize that these learning processes involve members figuring out how to adapt the interdependencies between members of the group, or their *role* interdependencies.

The most common depiction of the local learning process centers around two primary learning activities: action and reflection. Action refers to activities that operationalize new or improving practices, for example managers training members on new checklists or surgical teams practicing together with a new technology (Edmondson et al., 2001; Nembhard & Tucker, 2011; Tucker et al., 2007). Reflection includes activities that develop and refine plans, such as discussing trial runs and adjusting plans, conducting need finding efforts, or researching other groups' effective practices (Brooks, 1994; Edmondson et al., 2001; Edmondson, 2002b; Gibson & Vermeulen, 2003; Sarin & McDermott, 2003; Schippers, Den Hartog, Koopman, & Wienk, 2003). Edmonson (2002b) emphasized the 'iterative' nature of the action-reflection process; learnings that emerge during the reflection process are integrated and inform subsequent action.

Prior research has emphasized the primacy of role interdependencies throughout this action-reflection cycle. In order for successful learning to occur, role interdependencies need to be understood by interdependent groups and then rewired through the action-reflection process, a process that entails considerable trial and error in real-time (Edmondson, 2002a). For example, Edmondson and colleagues (2001) showed that the implementation of a new technology required nurses and doctors to specifically change their interdependencies. In particular, surgeons needed to assume more interdependent roles and learn in a more mutualistic way with nurses and other team members, depending on them for real-time updates, ideas, and observations.

Multi-group learning processes and changing interdependencies

A second key idea emerging from the situated learning perspective on organizational change relates to the idea that all of these local situated learning activities need to be synchronized or coordinated in service of overall organizational change (Henderson & Clark 1999; Valentine, 2018). Such synchronized multi-group learning is complicated by several factors. First, myopia plagues group learning—distinct groups tend to understand the intricacies and details of their own practices, but gloss over the complexities underlying other groups' practices, which complicates coordination (Dougherty, 1992; Trope & Liberman, 2010). Dougherty (1992), for example, found that different groups involved in new product development paid attention to either technological change or customer shifts, and, in turn, drew different conclusions about the perceived correct course of action. Second, in developing their specialized expertise, each group becomes invested in their own specific practices and their specialized domain, which they may try to protect when engaging in acts of collaboration or co-production (Bechky, 2003; Carlile, 2002). Each of these challenges makes it difficult for different groups to understand and anticipate how their interdependencies need to change in order to learn collectively (Henderson, 2002). Often, groups recognize local interdependencies in terms of their own workflows but do not understand interdependencies with other individuals or groups (Dearborn & Simon, 1958; Dougherty, 1992; Heath & Staudenmayer, 2000; Valentine, 2018).

Prior research has identified two main ways that multi-group learning can be coordinated—through boundary objects and by mobilizing networks of managers. Studies have shown how boundary objects and managers (by virtue of their network position and roles) can help complex networks of groups manage their changing interdependencies. First, boundary objects provide the means for individuals "to learn about their differences and dependencies

across a given boundary" and, in turn, transform "current knowledge (knowledge that is localized, embedded, and invested in practice) so that new knowledge can be created" (Carlile, 2002: 452-3). Since boundary objects "inhabit" several intersecting social worlds (Star & Griesemer, 1989) and, thus, illuminate interdependencies, they can be key precursors for identifying, renegotiating, and reconfiguring role interdependencies and, in turn, facilitating collaboration and learning (Barrett & Oborn, 2010; Carlile, 2002; Pawlowski & Robey, 2004). Boundary objects help overcome the challenges arising from the reality that individuals differ in their ability to perceive interdependencies (Heath & Staudenmayer, 2000). In addition to boundary objects, managers occupying hierarchical positions may also be helpful for rewiring interdependencies to facilitate multi-group learning. Valentine (2018) analyzed the complex and unexpected spillover consequences for adjacent groups when an interdependent group changed its practices, and showed how networks of managers were mobilized to manage those unintended spillover consequences. These theories of local and synchronized group learning have importantly conceptualized the processes whereby local groups and networks of groups come to understand and change their complex interdependent ways of working.

Situated learning involving digitally-encoded interdependencies

The processes documented in prior research related to situated learning are likely to generalize when interdependencies relate to roles within a team, or between groups within a network. Yet research on situated learning does not yet explain the nature of organizational learning when interdependencies are not easily discernible, such as when they are encoded in digital technology. We define *digitally-encoded interdependencies* as multi-group workflow interdependencies that involve people-to-technology interactions not typically apparent in boundary objects such as standard work documents or plans. As well, unlike workflow

interdependencies, they are typically poorly understood by managers and even members of local groups who do not easily understand the work of their adjacent or interdependent groups.

Digital technologies are "characterized by brittle interconnections and complex interdependencies" (Orlikowski & Iacono, 2000: 360). Over time, technologies encode important information, including interdependencies, that become masked when technology becomes appropriated into different local milieus. These interconnections and complex interdependencies only become salient when the technology needs to change in some way, such as when it is used for novel purposes (Orlikowski & Iacono, 2000). Impediments to organizational learning are bound to arise when interdependencies are encoded into so firmly a technology that they are not easily discernible. Bailey et al. (2010: ii) showed how technology interdependencies can fundamentally impact work, arguing that amid organizations' increased reliance on technology, "understanding technology interdependence may be as important as understanding task interdependence for theories of organizing."

To explore the nature of organizational learning processes that involve these distinct types of interdependencies, we analyzed a large-scale learning process at a large cancer center. Over the course of our 12-month ethnographic research, we observed behaviors consistent with previous accounts that learning involved discovering best practices (Tucker et al., 2007), local group action and reflection (Edmondson, 2002b), and also involved managers coordinating synchronized multi-group learning (Valentine, 2018). However, we also observed that digitally-encoded interdependencies dramatically shaped how the learning process unfolded in ways not explained by prior literature. The process of discovering these interdependencies was challenging and, due to the inherent complexity of all of these interdependencies, required consultants to

develop a new capability of changing frames of reference to foreground and understand different interdependencies.

METHOD

Research Setting

We conducted this study at an academic cancer center in the United States (referred to in this paper as "Academic Cancer Center" or ACC). The cancer care delivery system in the U.S. is an opportune setting for studying organizational learning because it is a system seen to be "in crisis" because of the growing complexity of care and how that care is organized (Bylander, 2013; Levit, Balogh, Nass, & Ganz, 2013). The organizational complexity of most cancer centers ends up placing considerable burdens on cancer patients and their families as they seek care (Levit, Balogh, Nass, & Ganz, 2013; Weaver & Jacobsen, 2018). These coordination burdens impact patients in many ways during their months or years of care, including their efforts to schedule and coordinate appointments with a team of specialists such as medical oncologists, surgeons, and radiologists who all provide specialized components of their care (Fleissig, Jenkins, Catt, & Fallowfield, 2006; Junor, Hole, & Gillis, 1994). Many cancer centers are attempting redesigns or change efforts to try to help mitigate the negative impacts of hyper-specialization and related organizational complexity (e.g., Adesoye, Greenberg, & Neuman, 2016; Gardner, Bedzra, & Elnahal, 2012; Valentine, 2018).

We studied one such change effort at ACC, a nationally ranked cancer center. Ten years before our fieldwork began, ACC had redesigned its organizational structure by dividing patient care into twelve clinics defined by cancer type. These clinics operated in the same large building as a large infusion center where chemotherapy was administered, a radiology suite, a radiation

therapy center, an outpatient surgery center, and many ancillary services such as financial or nutrition counseling. When our observations began, ACC had recently launched a large-scale, donor-funded initiative, aimed at "transforming the patient experience". As part of its pursuit to transform the patient experience, ACC hired internal consultants to oversee the various change initiatives. The consultants were full-time employees of the ACC hospital system. They were assigned to ACC specifically to lead change initiatives and they collaborated with all of the groups and departments implicated in a proposed change. This paper focuses on one specific change initiative, which the consultants and ACC staff referred to as "universal check-in". This change initiative was similar to others in terms of the experience and education of the consulting team, the extensive resources dedicated to support the proposed changes, and the broad support from clinical and administrative leaders for the proposed change. We selected this initiative for analysis for this particular research question because it was successful and thus offered a useful case for theory development about how the consultants had overcome the problems of unseen and unexpected digitally-encoded interdependencies (Edmondson & McManus, 2007; Eisenhardt & Graebner, 2007).

Data Collection

The data for this study were collected through longitudinal, ethnographic observation. The data collection period relevant to this study lasted about a year. Our point of access for this data collection was the consultant team leading the universal check-in process. One of the authors spent between 10 and 30 hours a week shadowing this team, observing all of their planning meetings and shadowing their meetings with the many clinical and operational groups with whom they interfaced during this change initiative. Members of the consultant team each participated in weekly reflection interviews. They also introduced us to other clinical and

operational staff who became involved in the change initiative over time, which allowed us to triangulate our observations and also develop deeper understanding of the processes we observed (Jick, 1979; Spradley, 1979). Using the consultant team as our point of access was generative for this inductive research question because we were able to follow the consultants as they interacted with multiple operational groups and in many different settings. They would spend time analyzing and understanding various groups' activities, and, because of our work shadowing them as they did so, we would similarly gain access to those various local groups to understand their work. The consultant team had its own structured data collection to analyze the impact of their new check-in process on patient waiting times. Because of our work with them, we also had access to how those outcome data were designed, interpreted, used, and reported.

Analytic Approach

Over this year of observation, we produced hundreds of pages of field notes, transcripts, and archival materials. We analyzed these data in several ways. We first determined the general timeline of events, and importantly tracked the different groups who became involved in the change initiative over time. We knew from this analysis that the universal check-in change initiative had involved many unexpected events that required extensive follow-up discovery and investigation. With the goal of understanding the nature of the events, and the nature of the discovery and learning processes, we then conducted the more fine-grained analysis typical of inductive qualitative research. We used NVivo and spreadsheets to code and organize our data. Our first-order open coding was intended to comprehensively analyze all of the relevant events and processes, and we saw many events and processes that were not easily connected to the organizational learning and change literature (Glaser & Strauss, 2017; Strauss & Corbin, 1998). As we analyzed the many frictions and events that arose, we began to focus on the idea of

interdependencies. We analyzed particular interdependencies that became relevant during the study, including task, role, between-group, and technology-related interdependencies. Through this analysis, we saw that many of the key interdependencies were mediated through the EMR system that was the main information operating system used to coordinate most of the work at ACC. We further saw during our observations that no group at ACC—including the relevant IT groups—easily observed or understood these interdependencies because they were mediated through the EMR system, meaning actions that involved the system produced asynchronous and distributed impacts. Building on these ideas, our final round of coding compared the action-reflection activities common to organizational learning literature with the action-reflection activities we observed when the consultants had to discover and understand digitally-encoded interdependences as part of the change process. It was through this final analysis that we realized that the consultants had developed a new frame of reference that enabled them to see and investigate interdependencies between various groups that the groups themselves did not see or understand.

FINDINGS

This formal organizational change began with an open-ended goal to improve patients' experiences receiving care at the cancer center. The ACC leaders and staff had come to recognize that the complexity of their operations was creating stress and adverse experiences for patients in various ways. Our study focused on one of the proposed change initiatives aimed to redesign patients' "check-in" to any of the ACC departments for their clinical appointments. This initiative was considered a success: it accomplished observable changes to the check-in workflow, and produced improvements on metrics the ACC leaders and consultants cared about.

Figure 1 shows one of the consultants' slides that was presented at an ACC-wide meeting at the end of the study period: ACC had accomplished an almost 60% reduction in the time that patients spent checking-in for their appointments. For cancer patients who spent many days each week at ACC over months or sometimes years, the check-in process streamlining was a welcome relief.

---Insert Figure 1 Here---

At its onset, this change initiative was well-supported and well-resourced. Figure 2a shows the consultants' slide outlining the check-in process at the beginning of the learning initiative, while Figure 2b shows their slide proposing the envisioned process change. However, even with broad organizational support and a seemingly simple redesign, this change process became much more complicated than anticipated at the start, largely because of unexpected interdependencies that had been encoded in the EMR. One of the consultants reflected at the end that it had not been "an appropriately timed project" because of all of the unexpected complexity that emerged. Different clinical groups or compliance groups had asked IT to make changes in the EMR system and those changes had influenced the activities of other clinical groups in ways that neither the requesters nor various IT groups fully observed or understood. Both the intended and unintended impacts of system changes were difficult to observe and fully understand because they were asynchronous and distributed. The impacts were *asynchronous* because they emerged over time as users interpreted system changes in the context of their ongoing work. The impacts were *distributed* because every group at ACC used the EMR system in their local clinics, and interpreted changes based on their local group context, routines, and activities. Thus, no single group in the interconnected network of groups that produced a patient check-in

experience had the perspective to understand the full network of interrelated user and system activities or how they shaped patients' experiences.

---Insert Figures 2a and 2b Here---

Eventually, the consultants came to see how this interconnected network of user and system activities impacted patients' experiences in problematic ways. But that eventual insight, as well as the eventual changes, were much more complex than anyone anticipated. Over the year we observed, the consultants engaged in many learning behaviors including researching and applying best practices (Tucker et al., 2007), engaging in local group action-reflection cycles (Edmondson, 2002; Edmondson et al., 2001), and drawing on managers to coordinate synchronized multi-group learning (Valentine, 2018). However, we also observed that much of their time and effort involved discovering and changing various interdependencies that were encoded in the EMR system. Our analysis revealed that a key capability in this learning process was the consultants developing a new frame of reference that they used to analyze and reflect on user and system action. This new frame of reference allowed them to focus on and understand a specific set of user and system actions that no one other group observed or understood in the same way. The new frame of reference that consultants developed also allowed them to meticulously trace, understand, and ultimately change the digitally-encoded interdependencies of an emergent network of groups. Gioia (1986: 56) defines "frame of reference" as a "repertoire of tacit knowledge that is used to impose structure upon and impart meaning to otherwise ambiguous social and situational information to facilitate understanding". The consultants' frame of reference was different from that of any other group at the cancer center and enabled them to observe and reflect from a new perspective.

Thus, in the *action-reflection* framework of organizational learning, our findings demonstrate that the consultants embarked on an extended *reflection* phase that ended up including an emergent and unexpected network of groups. The major efforts in this extended reflection phase included both 1) asking users and system administrators to reflexively consider specific activities or specific system configurations in ways they had not done before, and also 2) figuring out which groups had originally asked for the specific activities or system configurations now in question. The first effort was led by the questions "why are you doing that?" directed at users or "why is the system making the users do that?" directed at IT. Often neither the users nor the IT groups could directly answer the questions that consultants asked them related to one specific activity or bit of code. These were questions that were being asked for the first time and ones that no one had previously paid attention to before. The second related process then involved figuring out "who asked for that?" or "who owns that process?" and then asking the newly identified process owner group, "why did you ask the system to be configured like that and can it be changed?"

Phase 1: Reflection and a new frame of reference

As is common in organizational settings, much of the learning and formal quality improvement efforts at ACC were "local and variegated" (Edmondson, 2002b), meaning they were focused on local group operations. When ACC began its formal "transformation" efforts, many of the change initiatives were indeed focused on improving group operations, for example streamlining clinic operations so that more patients could access clinic appointments. As one of the consultants explained in an interview, "The purpose of the operational excellence consulting department is to partner with operational areas to help improve business metrics, engage staff in

problem-solving—really to improve patient value however that improvement is defined by that unit." She further explained, "Sometimes we will work on concrete projects, so one of my projects before this one was redesigning our core lab because we are growing our outpatient volumes and recurrent lab equipment. All of that couldn't handle any of that increased volume at a speed that would provide patient results quickly."

However, some of the other consultants' change initiatives were structured around more open-ended goals or values, such as "improving the patient experience". The universal check-in initiative evolved from one such open-ended project. It and related initiatives grew out of an intensive "need finding" exercise that the consultants initiated at the start of the study period. The need finding work involved shadowing patients through various experiences that were not necessarily confined to one clinical location. They saw a common pattern across all of these shadowing experiences. As one consultant explained: "The clinic is not talking to the surgery center, the surgery center is not talking to radiology, radiology is not talking to the clinic and the patients get lost." One consultant shadowed a patient who ended up "getting lost" by the system, and this story was told many times. The consultant shadowed the patient through her entire day that began at 6:00 am and involved a complex yet common surgical procedure that entailed the patient going to the clinic, radiology, and the surgery center. Another consultant later described this experience,

> The patient came in, they're told to be here at 6 o'clock in the morning and they don't go into surgery until 1 or 2 o'clock in the afternoon. They've been fasting since midnight, they haven't had anything to eat or drink. There's a schedule change in the surgery center and they don't call radiology to tell them that. So, radiology is still expecting the patient, but then the patient doesn't show so they lose that appointment and all that waiting is lost.

The consultant concluded, "I still think about the one patient that Mia followed, by the end of the day she was just in tears." The consultants spent many hours shadowing patients

through various experiences as part of this need finding phase. They saw time and again that the patients were going through something that felt to them like a single experience with the cancer center, but that the cancer center systems considered separate appointments. In the example above, the patient considered herself to be getting a certain surgery at ACC, but the ACC systems were structured as though she was having three different appointments, which were not necessarily linked in the EMR system or even connected in the daily routines of the involved groups. When their observations were bracketed by "the patient day" or "the patient visit", the consultants saw the check-in process from a very different perspective than did the ACC staff who only interacted with the patients during one of their several clinical stops. The ACC staff were focused on making each of those separate interactions as caring and efficient for patients as possible, but the consultants began to see very clearly that improved coordination of patients' separate appointments and integration within ACC's systems and activities would offer a huge value to patients. At the start, the patients were needing to do the work of integrating their appointments themselves, often by waiting uncertain amounts of time and by repeating information many times to many different people. One of the consultants said, "Right now we are putting our complexity on them." The consultants had gained new perspective by shadowing patients through their experiences. One of the consultants summed up this period of time:

> We've opened a can of worms. I think that there's been a lot of things that have been shown because we're looking at patient experience and by doing that, we're looking at current state processes and everything and going, "what is going on?"

In reflecting on these learnings, the consultants were inclined to attribute the problem to poor "process" rather than ill-intentioned people. Reflecting on her experiences shadowing a patient through a complex, poorly coordinated visit, one consultant said,

> It was pretty terrible. But it's not even surprising anymore. Disconnected processes everywhere. Even if every [staff member] tries to do the best they can, they're all

> professional, all very good, but it's just there's no communication… It's a broken process… Staff feel like they're struggling every day and not doing the right thing. If they knew, they would've done it ..."

Working with this new perspective, the consultants wanted to scope a small pilot project to learn how to address this overall issue. They chose a small but impactful example, which was a common pattern of care where patients had to interact with the lab, an oncology clinic, and the infusion center where they received chemotherapy treatment in one day. At the start, patients had to go through the same check-in process at the front desk of each of these departments, even if their appointments were on the same day and only minutes apart. As the consultants shadowed patients during the need finding period, they discovered that patients needed to undergo a lengthy check-in process at each location; ACC did not 'remember' patients as they moved throughout different areas of the cancer center. For example, a patient might register at ACC's lab for blood work and then engage in an almost analogous process at a clinic down the hall several minutes later. These multiple check-ins were burdensome for the patients. As one consultant said,

> I mean it feels a little disconnected. It doesn't feel like it's all together. At a minimum, you shouldn't have to go through the whole registration thing again. But you have to start all over again, with your birthday, and your story...could there not be a simpler way, is your birthday and your weight and all that going to change when you walk up the stairs to the other appointment?

By focusing on the unit of work (the patient's overall encounter in a given day) and using this as a frame of reference, the consultants were able to newly recognize between-group interdependencies that would need to be accounted for in order to streamline the patient experience. These between-group interdependencies had not been apparent to anyone before when they were working with a more localized frame that bracketed local specialized operations. One IT group member, in a follow-up interview after the check-in initiative had been completed,

explained the challenges of what he called a "siloed kind of workflow that you have the dedicated teams and they really are just focused on their one kind of myopic problem". He added,

> You've got…teams that are working parallel tracks, but not so well cross-talking things with each other, because they're not thinking about the impact that it has to other workflows, right? They're thinking about just their one piece.

Through their newly emerging frame of reference, the consultants came to realize that several groups collectively produced what they called the "patient day", defined as the patients' overall experience. Put differently, the consultants identified an outcome interdependence between the groups, defined as the extent to which groups' goals or outcomes are related (Van der Vegt, Emans, & Van de Vliert, 2001). All groups were interdependent in producing the patient encounter for the day, even though the groups themselves did not see or center this frame of reference. After recognizing this outcome interdependence, the consultants shifted from employing a frame of reference oriented around local practices to framing the problem of the registration process in terms of the outcome interdependence, or the patient encounter for the day. One consultant explained,

> We are having to be the connector for all these pieces and trying to get them to the top [i.e., organizational leaders]. I think that's the question…it is figuring out how to connect everything, so everybody is on the same page and aligned around the same pieces. It is a lot of that, which is not easy to figure out.

In employing this new frame of reference, the consultants changed how they observed and 'bracketed' the current check-in process. Table 1 outlines this first reflection process that centered around the key question: "What do patients experience in a full visit?"

Understanding baseline workflow. Using this new frame of reference, the consultants began to observe and understand three specific service-line registrar groups— clinic registrars, lab registrars, and infusion registrars—that were responsible for specific parts of the patient

registration process—namely, checking patients into ACC's clinic, lab, and infusion departments, respectively. Each registrar group performed standardized registration work, though their workflows were slightly different for checking patients into different clinical areas. These groups were each responsible for inputting patient information into ACC's EMR system and, in turn, checking patients in, meaning changing their status in the EMR to alert clinical staff that the patient had arrived and registered in that area.

In addition to the service-line registrar groups, the consultants also interfaced with the managers of three service-line clinical staff groups—clinic staff, lab staff, and infusion staff, who were responsible for administering care to patients at each location. The clinical department workflows depended on the registrar groups' workflows. At the start of the check-in initiative, these six service-line groups were each operating as distinct communities of practice. Each executed their work, reflected, acted, and improved on their local activities of registering and administering care to ACC patients.

Finally, the consultants also engaged a specific IT group as another community of practice that would play an important role in the new patient check-in process. As one of the consultants reflected, "Patient registration has IT components to it. We've been learning as we go what changes need to be made from an IT perspective standpoint." The IT group was responsible for analyzing, developing, configuring, testing, and implementing the EMR system. Typical activities that the IT groups were involved in included building applications tailored to meet specific ACC department needs, creating activity reports for specific groups at ACC, and testing new software updates. This work was primarily routine and did not typically involve redesigning workflows. The IT group approached their work with a frame of reference of "writing software based on workflow requirements".

---Insert Table 1 Here---

Phase 2: Extended reflection, digitally-encoded interdependencies, and changed system

Having understood the work of the relevant groups, the consultants began to work with the local managers to figure out the new workflow. As is visualized in Figure 2b, they designed a "universal check-in" proof of concept plan. Any registrar at the lab, clinic, or infusion departments could check-in a patient and that check-in would be remembered and recognized by all other groups. One consultant explained,

> The process will include a step to inform all departments that the patient is at [ACC] and has checked-in for the first service in their itinerary for the day with particular focus on notifying relevant groups. Registrars will need to have access to all check-in documents for the selected services.

Initially, the consultants thought that the redundancies could be eliminated by asking managers to negotiate and redefine workers' role interdependencies--changing their flows of responsibilities (e.g., Valentine, 2018). As part of their efforts to eliminate the redundancies in the check-in processes, as well as redefine role interdependencies, they engaged managers of the three local service-line groups (clinic, lab, and radiology) to eliminate redundancies.

However, in newly recognizing these between-group role interdependencies, the consultants discovered another major redundancy in the check-in process. The clinic, lab, and infusion registrars all asked patients to complete the same Medicare survey, which was mandatory per federal policy. No one had mentioned this redundancy to the consultants prior to this during planning or other sessions. When the consultants asked managers for the rationale behind the survey redundancy, the managers were surprised to learn that all of the groups asked the questions at each check-in. They were at a loss for why multiple groups all needed to

complete the survey. None of the registrar or clinic managers or staff knew why every group included this survey at check-in.

In order to understand the nature of this redundancy, the consultants observed each group's practices in terms of how they interacted with the EMR system to understand how the EMR system was structuring local group practices. In doing so, they realized that the group members were following the workflow displayed on the EMR system, which mandated that they perform certain actions. The groups' workflows had been rigidly structured by the EMR system. Since the local groups relied on frames of references that bracketed their local practices, they had not recognized the redundancy, as reflected in the following interaction:

> Consultant: "Why are you asking [patients] that Medicare survey?
> Lab registrar: "I don't know, that's just what the system makes me do."

The consultants did not have the expertise or authority to judge whether the survey could be eliminated or asked once per day, since they did not know why the system was configured this way. They realized that they needed to understand why the EMR system structured workflows in the way it did to eliminate the redundancy. In an effort to understand this, the consultants met with the IT group responsible for the specific check-in module that was being changed. They asked the IT group why the Medicare survey was administered multiple times to the same patient by different groups. Similar to the service-line managers, the IT group did not know why the EMR system had been configured to structure workflows in the way that it did. We observed five separate meetings, over the span of five weeks, that involved consultants meeting with the IT group to determine who "owned" the process that triggered the survey code in the EMR process. Figuring out who owned the code would enable the consultants to determine if the survey could be asked only once.

The consultants' confusion and frustration are illustrated in meeting notes involving one of the check-in consultants and the IT group that was responsible for coding the changed process into the IT systems:

> Big group meeting with consultants and several IT people. It's getting heated.
>
> One of the IT techs complains that they still haven't been able to find the detailed policy on the Medicare survey. He doesn't know how to recode the new check-in process until he knows what to do with that survey, and with the data being generated from that survey.
>
> The problem seems to be that the current program deletes the data immediately after the survey is asked, rather than saving it. That means the clinic registrars, lab registrars, and infusion registrars have to ask the survey questions every time, otherwise the system presumes that they don't have the information that Medicare, by policy, requires for each patient.
>
> Someone on the phone suggests that the system may be automatically saving the data, but no one knows that for sure, or whether that is even allowed. [Consultant] gets upset that no one knows what they're doing with the data from the survey. It has been five weeks of no one knowing. He's yelling: "We have been asking every patient this every time they check-in and no one knows what we are doing with that data?" He demands that someone clarify this issue. No one can and the meeting ends.

At the fifth meeting involving the consultants and IT group trying to figure out who owned the code, an IT manager of a different group suggested that the Compliance group owned the Medicare survey. The Compliance group was responsible for ensuring that the center complied with federal Medicare policy, including collecting and storing certain data. The consultants then met with the Compliance group, and learned that they indeed owned the Medicare survey and only they had the expertise and authority to decide its appropriate use. One consultant explained the authority the Compliance group:

> The subprocesses for the registration piece were another piece we had to work through, which is kind of figuring out how we're going to complete the regulatory compliance items at each point of contact. We didn't know… what is the *actual* rule for the compliance? Sometimes we build rules and processes out to kind of really protect ourselves but they are not strictly necessary. We didn't know.

The consultants had thus discovered new interdependencies—the registrars' workflow depended on the IT group's work in coding the EMR system, as well as the Compliance group's work in asking that the survey be encoded in the EMR. These interdependencies had been encoded in the EMR system, but no one group fully observed or understood how these interdependencies were influencing the activities of the three different front-line registrar groups. Compliance and IT had taken action in the EMR system that had asynchronous and distributed impacts that neither group observed or fully understood. Later, each registrar group followed the workflows of the EMR system, not knowing that their work was redundant with other groups whose activities were asynchronous and distributed from their local system use. The registrars and managers had not observed Compliance and IT's plans to configure the survey into the system workflows, so did not understand the intention or goal well enough to reflect on its implementation. It was only after the consultants used a frame of reference that enabled them to bracket and reflect on an entire patient encounter that these complex interdependencies came to light. Table 2 shows how consultants' new frame of reference compared to other groups' frames of reference.

---Insert Table 2 Here---

Even with this clarification of interdependencies, figuring out the new process took time. After one of the meetings with IT, a consultant reflected,

> The dynamic of this meeting is very familiar to me, having represented the business side as well when working with IT in my previous job. All the attention seems focused on showing how well the IT part of the project is progressing. But during these discussions about compliance, IT just complains that they still don't have the detailed policy on the data issue. I had to ask if they know the definition of "identical treatment" which seems to be at the heart of this policy issue and they don't.

The consultants then convened a meeting with a group of managers to renegotiate the new workflow, including the registrar manager, clinic manager, Compliance manager, and IT group. The Compliance group was implicated as the owner of the survey and was responsible for researching the policy. They eventually determined that, per Medicare policy, the data collected by the survey could be stored for 30 days. This meant that patients only needed to complete the survey once per month at any one of their check-ins at ACC. During the negotiation, the Compliance group was able to formally approve a new workflow based on a clarified understanding of the redundancy and the data request. Compliance now understood that the EMR system had been programmed to administer the survey at each check-in and not store the data. This meant that patients checking in many times a day and many times a week were asked the survey questions each time they checked in. Since the Compliance group had focused on their careful interpretation of the policy and in carefully reviewing IT's encoding of the policy, they were assured that each check-in was compliant. They had not been aware that the system was configured to ask at each check-in or that patients were checking in many times a day and week.

In sum, by adopting a frame of reference that foregrounded the objective of the learning initiative—streamline the patient encounter for the day—the consultants discovered three unanticipated digitally-encoded interdependencies that needed to be reconfigured in order to streamline the registration process. First, they determined that the Compliance group's work in ensuring Medicare compliance depended on the IT group's work in changing the software code, as well as service-line registrar groups in interfacing with the EMR system. Second, the IT group's work depended on the Compliance group's approval to change the software code, as well as the service-line registrar groups' workflow requirements. Third, the service-line registrar

groups' work depended on the IT group coding their workflows in the EMR system, as well as the Compliance group's approval to change the code.

Once the consultants had recognized the digitally-encoded interdependencies that needed to be reconfigured in the EMR system, they needed to understand how workflows should be rewired to account for the code-level changes. These changes would, ultimately, enable the IT group to successfully recode the EMR system software to eliminate redundancies in the registration process.

Phase 3: Extended reflection, digitally-encoded interdependencies, changed user activities

Having convened the relevant group of managers and renegotiated the expectations for the new system workflow and new user workflow, the consultants began planning for the roll-out of the new universal check-in process. They spent about a month trying to figure out the most effective way that registrar staff could be alerted that a patient had arrived at subsequent locations after their first check-in. Their goal was to design a system where the staff would be somehow automatically alerted without the patient needing to interact with the registrar staff. The registrar staff would then need to "arrive" the patient in the EMR system, which just involved the registrar changing the patient status in the EMR system. Without the registrars "arriving" patients in the EMR system, the clinic staff in the back rooms would not be alerted to greet patients at the waiting room and start their workflow to administer care. The consultants considered several options, and ultimately decided to design a workflow using ID cards. When patients arrived at the physical location of the next appointment, they would drop their ID cards in a plastic box at each successive location. Each registrar would be responsible for monitoring the box and "arriving" patients in the EMR system after placing their ID cards in the box.

Getting agreement for this workflow took time, and the consultants were concerned that the redesign was spanning months longer than planned.

At this point, the consultants began to work with the registrar managers to train local registrar teams on the new planned workflows. And, to this point in the process, the consultants had worked extensively with only one IT team to reconfigure the EMR system to enable the new universal check-in. In training each local team on these new workflows, the managers and consultants focused only on cross-training the registrars on the universal check-in workflow. They alerted other groups at ACC to alert them of the changes:

> We also have other clinics within [ACC] so I've started reaching out to some of the managers in those areas just to let them know how we're doing, not to say that they're going to be part of it but just to let them know here's what we're doing, here's why, and if you realize or recognize any issues or problems that are affecting your clinic, let me know immediately so that way we can address and make sure there are no problems moving forward.

The consultants finally set a launch date for the new check-in process. At this point, the learning initiative had spanned eight months longer than anticipated. Yet, days before the launch date, the consultants discovered another unanticipated digitally-encoded interdependency. The problem was that a check-in to the clinic included one small feature in the EMR that when triggered by a patient check-in automatically alerted clinic staff of the patients' arrival and automatically printed a pre-visit summary with all of the information needed for that day's visit. One specific IT team had built the pre-visit summary workflow to help the clinic managers streamline clinic operations and make each clinic visit shorter. No one anticipated or realized that the new EMR check-in process needed to be specifically changed and configured to still trigger the pre-visit summary in the clinic. Instead, the check-in process would happen at the lab and then nothing would happen at the clinic, because the new process inadvertently missed triggering this new EMR clinic-specific workflow. Two separate IT teams had developed the

new clinic pre-visit summary workflow and the new check-in process and no one really understood how they related to each other in the EMR, or in the flow of patients between the lab and the clinic. One of the IT staff explained that this kind of unanticipated relationship is not uncommon in complex change projects that involve IT systems:

> And so you've got those two IT teams that are working parallel tracks, but not cross-talking with each other. Because they're not thinking through all the impact that theirs has to other workflows, right. They're thinking about their one piece with their business owners.
>
> Even when you do integrated testing. It's not perfect. I mean, there's still something that is going to come out. Then you'll be like, "Oh, wait, this broke this over here and that was unanticipated."

None of the managers or the IT team or the consultants had anticipated the importance of this new digitally-encoded interdependency. It was only through trying to change the existing interconnected networks that the consultants disrupted and thereby realized the importance of the pre-visit summary for the overall check-in workflow—including triggering certain other workflows within the clinic. The pre-visit summary was dependent on the code for the registration process such that a change to the registration process threw an error that prevented the administration of the pre-visit summary. There were digitally-encoded interdependencies in the EMR system that were in tension with the between-group interdependencies and newly reconfigured workflows enacted outside the EMR system. Discovering this digitally-encoded interdependency resulted in another major delay in the check-in initiative. One consultant expressed her frustration:

> There are so many different departments in IT and they each own a little piece of the puzzle. There was no sharing of information about things that were going on, so that was a gap. One of the IT teams [who was responsible for pre-visit summary] didn't even know we were doing this...It was by happenstance that they figured it out.

But one of the seasoned IT staff explained that this was not an IT error, but the simple reality of organizational change when most processes in the organization met in the same EMR system. He said:

> There's always going to be something that's going to be unforeseen. You know, maybe not if it's something very simple, but if you're dealing with any complexity, especially when you're thinking across multi-disciplinary clinics and care, you're going to run into unforeseen situations. Because it is so complex... If you mapped out like every touchpoint… everything that happened in IT from a patient standpoint, it is extremely complex even for a simple just patient clinic visit.

He then explained all of the different EMR modules that are involved in one simple, straightforward clinic visit, from "scheduling that original visit, all the way through checkout, and everything else… billing and coding and everything else that goes on." His point was that given the complexity of the EMR system itself, the complexity of the IT organizational group, and the complexity of the business user groups and activities, there was no way to understand or anticipate all of the relationships between all of the modules and groups. Only by changing something and tracing the consequences could the interdependencies and relationships be seen and addressed.

After discovering this interdependency, the consultants worked with the two IT groups to change the pre-visit summary to be automatically triggered even if the patient checked-in first at the lab front desk. This change involved negotiating with the clinic managers, registrar managers, and two IT managers about possible new workflows and asking "does this change work for all of us?". The consultants led the reconfiguration of these digitally-encoded interdependencies without alerting the local groups of any changes even while their workflow interdependencies were being changed within the EMR system. Once they had uncovered all the between-group and digitally-encoded interdependencies involved in the check-in process, the consultants trained all of the local registrar groups on the standardized universal check-in

process. As before, the consultants abstracted away the nature of between-group and digitally-ended interdependencies and trained each group only on their new local workflows and "knowing in practice". These new universal check-in practices became standard work that every registrar was trained on.

After the training was complete, patients were able to check-in for their visit anywhere, and only once, at ACC. The learning initiative was seen as a success. Both patient and staff sentiment were strong. As one patient said, "I like it, very convenient, like a one-stop-shop". As one lab registrar reflected, "I think it's great! It really makes sense for the patients, and helps us with our lines."

The consultants recognized that their new frame of reference oriented around the patient experience enabled them to discover between-group and digitally-encoded interdependencies that were integral to the ultimate success of the learning initiative:

> [Changes] like universal registration and other things where we're doing something quite differently… So that's something that we really had to own. We drove more. It's been piloted here and is very successful, and will be rolled out [throughout ACC system].

In a PowerPoint presentation describing the process, the consultants recognized the analytical power of this new frame of reference, stating that the new frame "forced us to ask 'why?' and dig deeper. They acknowledged that the check-in initiative involved a "simple solution on the surface" but that "truly complex problem solving and coordination" was required "to address technical changes and requirements behind the scenes". Only by adopting a frame of reference that allowed them to uncover between-group and digitally-encoded interdependencies were the consultants able to consolidate and reconfigure workflows.

DISCUSSION

We studied a learning initiative at a state-of-the-art cancer center that was intended to span a few weeks. Despite considerable organizational support and resources aimed at this learning initiative, we observed a very challenging extended reflection phase that involved discovering unanticipated interdependencies, which ultimately led to the initiative taking 12 months to complete versus three weeks, as initially projected. While many of the learning and formal quality improvement efforts at ACC were focused on local group operations and, thus, "local and variegated" (Edmondson, 2002b), the patient check-in process that we studied involved an EMR software system that was encoded with interdependencies that spanned multiple local groups. These digitally-encoded interdependencies meant that as one group interacted with the system, the impacts unfolded asynchronously in distributed locations as other groups later engaged with the system. While no one group at ACC easily observed or understood these interdependencies—because each group relied on localized frames that bracketed local specialized operations—the consultants we observed were able to newly recognize between-group interdependencies that would need to be accounted for in order to streamline the check-in process. To accomplish this, the consultants needed to develop a frame of reference that focused on the unit of work (the patient's overall encounter in a given day) rather than local activities. Ultimately, the consultants were able to guide reflexive change even as local groups were not aware of the extent of their digitally-encoded interdependencies.

The Process of Multi-Group Learning

Our study makes important contributions to research on multi-group organizational learning. It demonstrates two primary ways in which multi-group organizational learning in the context of software systems may diverge from prior theories and conceptualizations of learning. First, whereas prior research has emphasized learning as an iterative process of action and

reflection (Edmondson, 2002b), our study shows that this "action, reflection, action" cycling does not fully explain multi-group learning involving complex software systems. Instead, in our study, successful learning involved an extended reflection phase that entailed change agents adopting a new frame of reference. This extended reflection phase enabled consultants to effectively reflect on user and system action, focus on specific connections, and recognize that several groups collectively produced the patients' overall experience. Only after this extended reflection phase could the consultants take action by eliminating redundancies and training local groups on new workflows.

Second, in contrast to prior that has emphasized that multi-group learning is contingent on groups identifying and negotiating interdependencies (e.g., Henderson, 2002; Edmondson & Bohmer, 2001; Tucker & Edmondson, 2003; Valentine, 2018), our study demonstrates that when change agents are able to anticipate, identify, and manage interdependencies through a frame of reference that foregrounds the unit of work, they can reconfigure new interdependencies in digital technologies, train local groups on new "knowing in practice" to enable collective learning, while abstracting the details of their interdependencies from local groups (Orlikowski, 2002). Ultimately, the learning process we observed was successful and new practices were embedded in local groups to become standard work even though local groups did not understand the interdependences that were encoded in the software systems that they interacted with each day. Given the criticality of this capability of developing a frame of reference that foregrounds the unit of work rather than local activities, we hope future research will investigate antecedents that may enable change agents to develop this new frame of reference that enables effective discovery of interdependencies.

The Concept of Digitally-Encoded Interdependencies

Our study also advances our understanding of how software systems impact the learning process. Most studies of learning in the context of technology pertain to how members reinterpret and renegotiate their roles in light of new technologies, rather than changes to already existing ones (e.g., Edmondson et al., 2001). In studying a learning initiative pertaining to an existing technology, we illuminate the importance of interdependencies that are digitally-encoded in existing technologies and the challenges associated with discovering them. Our study makes important contributions to research on situated learning, which has not yet explained the nature of organizational learning when interdependencies are not easily discernible. In particular, we show that developing a new capability and frame of reference that facilitates discovering and understanding where digitally-encoded interdependencies exist may help streamline the multi-group learning process. We expect that developing frames of reference that allow change agents to focus on, and reflexively change, complex digitally-encoded interdependencies will be an important organizational learning capability going forward, especially given how complex and intertwined social practice and digital technologies are (Orlikowski & Scott, 2008).

Yet most organizations will not have extensive resources comparable to those at ACC or the support of a team of consultants to assist them in their important learning initiatives. Our study suggests that there may be value in mapping out these digitally-encoded interdependencies ex-ante and documenting emergent interdependencies over time to help shortcut the discovery process as learning unfolds. We hope future research will examine how local groups may be able to collectively discover and understand digitally encoded interdependencies without reliance on change agents. For example, in addition to good code documentation (e.g., Spinellis, 2010), organizations may consider also documenting where and when “knowing in practice” has been encoded in digital technologies.

Our study also contributes to research on technology interdependencies. Despite the importance of technology in organizations and the increasing prevalence of interdependent technologies in organizations, scholars have largely overlooked the importance of technology interdependencies (Bailey et al., 2010). Bailey et al. (2010) made an important contribution by showing how technology interdependencies—defined as technologies' interaction with and dependence on one another in the course of carrying out work—impact organizational processes. We contribute to this research by showing that technologies are not only interdependent on one another, but also on workflow and outcome interdependencies. In contrast to Bailey and colleagues (2010) who emphasized the importance of identifying where "gaps" exist between different technology components, our study suggests a potentially more important and challenging question: where has "knowing in practice" been digitally-encoded in technology? Future research should investigate how digitally-encoded interdependencies change depending on the nature of technologies. For example, it may be more difficult to discover digitally-encoded interdependencies in algorithmic technologies, which may be opaque and difficult to decipher (Dietvorst, Simmons, & Massey, 2015; Kellogg et al., 2020; Weld & Bansal, 2018).

Finally, our study offers practical implications for managers and other change agents. It demonstrates the value of framing learning initiatives around the objective of those initiatives. When learning is inextricably tied to digital technologies, it is very likely that the learning process will involve unavoidable complexity. By switching from a frame of reference that foregrounds local practices to one that foregrounds the unit of work, important interdependencies can be discovered. Whereas it may be infeasible to map out all relevant between-group and digitally-encoded interdependencies ex-ante, developing this capability can not only help illuminate interdependencies, but also help abstract away the complexities of fine-grained

interdependencies for those not leading the change process, and, in turn, increase the likelihood of the success of learning initiative and, perhaps, lead to more resilient organizations (e.g., Vogus & Sutcliffe, 2002).

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TABLE 1. Timeline of learning activities

Phase	Month	Focal groups	Learning process	Specific reflection, negotiation, or action
1	**1**	Consultants	Reflection	What do patients experience in a full visit?
2	**2**	Consultants	Reflection	Why does this patient day involve redundancies?
	2	Registrars	Reflection	Why are we, as users, doing this activity?
	2	IT	Reflection	Why does the system tell those users to do that activity?
	3	Compliance	Reflection	The system is structuring activity because of misapplied regulation
	3	Registrars, IT, Compliance	Negotiation	Clarify regulation and new system workflow; Does this change work for all of us?
	4	IT	Action	Change system
	5	Registrars	Action	Attempt to train on changed system
3	**5**	Registrars	Reflection	Why is the system not letting us do this activity?
	6	IT	Reflection	What are they trying to do?
	6	Front desk	Reflection	This change involves another IT process
	7	Front desk, IT-1, 2 Registrars	Negotiation	Does this change work for all of us?
	8	IT-1, IT-2	Action	Change system
	9	Front desk, registrars	Action	Train on changed system

TABLE 2. Consultants' new frame of reference compared to other groups' frame of reference

Group	Frame of reference
Consultants	Original: "What is a patient's day like?" Developed: Multi-local network of groups involved in universal check-in
Registrars	Local operations
Clinic staff	Local operations
IT	Configuration and maintenance of EMR codebase
Compliance	Regulation and legal adherence of any organizational decision or policy

FIGURE 1. Improvements in per-patient and staff registration times

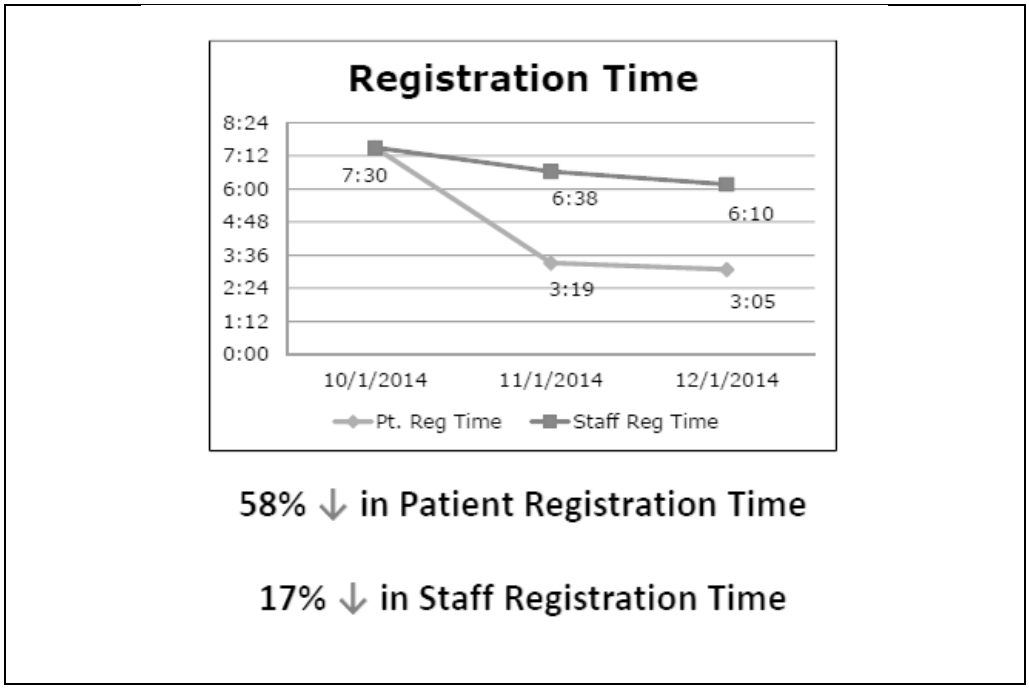

FIGURE 2a. The patient experience at the beginning of the check-in learning initiative

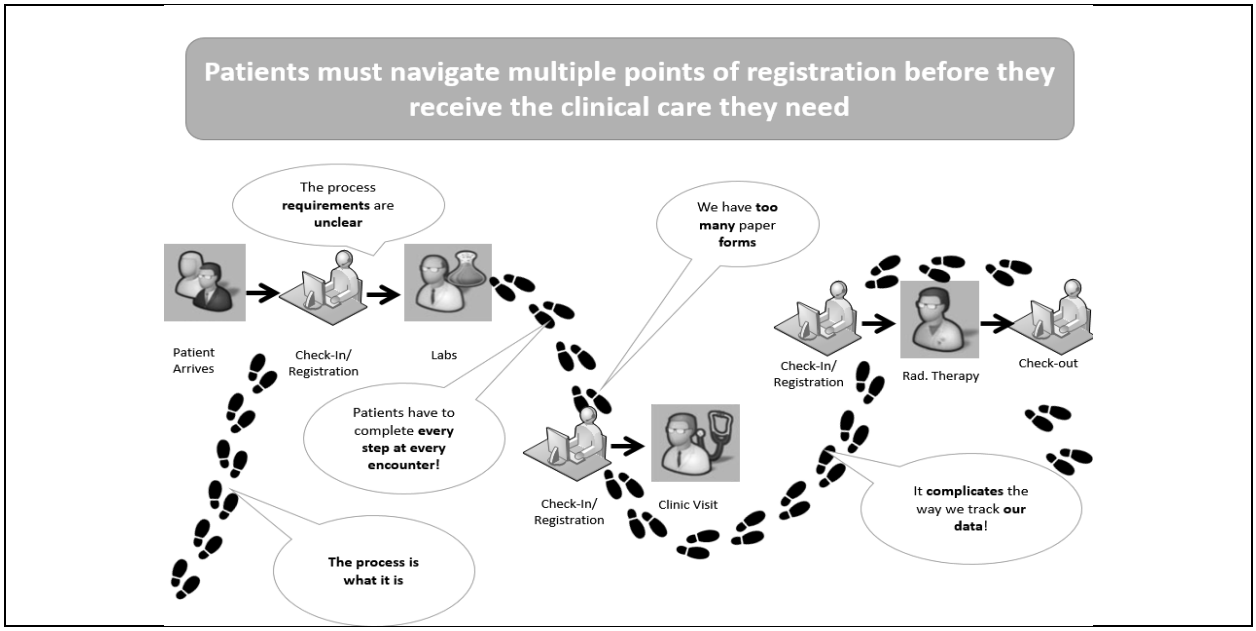

FIGURE 2b. Consultants' proof of concept of desired end state of check-in initiative