

Running Head: Team Learning, Emergence, and Transformation

Team Learning, Emergence, and Transformation: An Instrumental Case Study

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Abstract

Despite extensive team studies research over the past 40 years, team learning remains an emerging field of study where there is significant conceptual discord. Three conceptualizations have dominated the literature where team learning is represented as: acquisition; participative activity, or an open system. Team learning models have also emerged integrating these three conceptualizations and included elements such as feedback, mediational factors and emergent states, though they have generally maintained the linearity of traditional input – process – output models.

Teams have also recently been conceptualized as complex learning systems, yet there is a paucity of research at the team level of analysis particularly within dynamic work teams. In conjunction, exploration into a complementary area, collective transformative learning within authentic work teams, is also limited. Through an instrumental case study, the researcher investigated in what ways is collective informal learning is enacted within this authentic work team. Additionally, the potential for unfacilitated collective transformative learning was also studied.

Using a social constructivist lens, this case study leveraged multiple methods including document analysis, observation, focus groups and interviews to capture a rich picture of team informal learning at the collective level of analysis. The study found that team informal learning was embedded in work activities and enacted in various ways through team interactions and activities. Moreover, the findings supported that the team had experienced collective transformative learning. The study concluded that conceptualizing teams as complex learning systems supports team informal learning and emergence as well as the potential for collective transformative outcomes in and through work. Overall, this study enhances our understanding of collective informal learning in authentic work teams and collective transformative learning.

Key words: Informal learning, team learning, emergence, transformational learning, transformative learning, workplace learning, information technology security, social constructivism.

Dedication

This thesis is dedicated to my wife. She has been my anchor through the tumultuous seas of my academic experience as we sailed together through my bachelor's, Master's and most recently my PhD. I would not have been able to do this without her love and support.

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Chapter One - Introduction

We are all familiar with teams. Many of us have had the opportunity to be a member of a team whether it was through sports, our schooling, or in the workplace. While the contexts in which the teams work and the situations they encounter significantly vary, all teams aim to achieve a particular objective such as win a competition, complete a project, or achieve a component of work.

In the workplace, “performance and delivery of work typically requires, and is generated from the collective efforts of several individuals working together” (Johnsson & Boud, 2010, p. 359). Nowhere is this more evident than in workplace teams. Workplace teams have become common place as organizational success hinges upon the ability of teams to collaborate effectively and work efficiently to solve complex problems (DeChurch & Mesmer-Magnus, 2010). There are many conceptualizations and definitions of teams. As Katzenbach and Smith (1993) note, “while most of us are familiar with teams and team work, we are imprecise in thinking about them” (p. 61). This includes how teams learn.

Collective learning is an emerging field of study within the larger disciplines of workplace learning and adult learning and education. As with any emerging field of study, there is room for theoretical exploration, different perspectives, and research. My interest in this field is drawn primarily from my experience in various teams and my efforts to design and develop learning programs to support diverse team types. Within this work, I have noted various phenomena at the team level of analysis that I also recalled from my own experiences as a member and leader in dynamic work teams and crews. However, in my studies I have not seen significant discussion of collective informal learning within teams and when I have encountered them, the literature has not matched the whole of my experience. As a learning and development specialist with an interest in workplace learning, collective learning, and the potential for collective transformation, I believe team informal learning warranted further research.

This chapter introduces the problem statement and provides definitions that help frame the study within the larger domain of informal workplace learning. It also describes the purpose of the study, discusses its significance and, then closes with an overview of the thesis.

Problem Statement

Within the work context, there are different types of teams such as: work teams, crews, service teams, project teams, research teams, development teams, management teams, and task

forces (Cohen & Bailey, 1997; Sessa, London, Pingor, Gullu, & Patel, 2011). As Mathieu, Maynard, Rapp, and Gilson (2008) point out, different types of teams face different demands, and as a result, function quite differently. Teams often work in a social reality where processes of interaction and negotiation are not part of the rule-bound and concrete world of the functional structure established by the organization (Murray & Blackman, 2006). Teams are comprised of individuals who inherently bring different knowledge, understanding and perspectives to the team. To adequately solve problems, teams “face the challenge of integrating these different perspectives and developing a shared understanding of the problem at hand” (Van den Bossche, Gijsselaers, Segers, & Kirschner, 2006, p. 491).

The study of teams is not new. The past four decades have seen significant interest in team studies resulting in hundreds of scholarly articles encompassing primary studies, meta-analysis and literature reviews (Mathieu et al., 2008). These include social constructivist perspectives on teams (Murray & Blackman, 2006), but go beyond. The early work on teams and team development, looked at teams as specific work groups that were bounded entities that lie within and are organized or sanctioned by the organization (Brown & Duguid, 1991, p. 49). Most conceptualized team development as linear and expanded on traditional input-process-output (I-P-O) models (McGrath, 1984; Hackman, 1987; Tuckman & Jensen, 1977). These models provided insight to the organizational work team as a social entity with unique attributes at various stages of development.

Since these early models of team development and performance, there has been a surge of research and literature. More recent concepts and models have integrated mediational factors (Marks, Mathieu, & Zaccaro, 2001), cyclical feedback and emergent states (Ilgen, Hollenbeck, Johnson, & Jundt, 2005). There has also been support for viewing teams as complex adaptive systems (Arrow, McGrath, & Berdahl, 2000; Mathieu et al., 2008). These have all contributed to a richer understanding of teams, team development and underpin the discussion of team informal learning.

In a complex systems view of teams, individual team members are seen at the micro level of experience within their group or team interacting in various settings to which they are exposed. The team is at the meso-level of experience, interacting with and responding to the exo-level system of the organization and the macro-level system which is society. This places the team at intersection of the micro and higher level systems, interacting with both individual and

organizational entities where there are multiple emergent phenomena which can provide a “rich slice of organizational life” (Kozlowski, Chao, Grand, Braun, & Kuljanin, 2013, p. 591).

Viewing teams as complex adaptive systems, is a far less linear and mechanistic conceptualization which can provide a different perspective and important insights into how teams interoperate and interrelate within an organizational context. This also has the potential to significantly adjust our conception of team learning. However, other than the scholars noted above, there seems to have been limited literature and research that supports this view of teams. Rather, most of the literature assumes teams as a collection of individuals within an organization where learning processes and outcomes are focused on instrumental goals. Teams, therefore, are often considered a group of individual learners. Consequently, organizations and workplaces tend to adopt individual metaphors of learning for teams (Ellis, Hollenbeck, Ilgen, Porter, West, & Moon, 2003; Fenwick, 2008).

Given the extent of research and literature on team development and the new perspectives introduced, I had an expectation that there would be considerable research on team learning. However, team learning as a phenomenon remains under researched and under-theorized (Chatalalsingh & Regehr, 2006; Edmondson, 1999; Garavan & McCarthy, 2008; Hager, 2011, Kozlowski & Chao, 2012). The limited literature on team learning is rife with conceptualizations and models that borrow strongly from individual learning metaphors which see collective learning as a process of acquisition, sharing and participation. More specifically, these conceptualizations situate a team as a group of individuals who are either ‘containers of knowledge’ that contribute to the aggregate collective knowledge or, as part of a social group, who construct and co-create knowledge within the social interactions and learn together and then contribute to the collective knowledge. In these conceptualizations, regardless of how they come to know, the summative learning of the team is dependent upon what the individual team members learn and then share within the group. This can be seen in much of the workplace learning literature pertaining to collective and organizational learning.

As a form of collective learning, there should be greater distinctions between individual learning, learning amongst individuals and team learning (Garavan & Carbery, 2012). Team learning should also be distinguished from other forms of collective learning as group learning or organizational learning as it is different in nature, scale and context. Accordingly, this distinction provides significant impetus to better understand how collective informal learning activities

might be understood and enacted at the team level as directly experienced in the workplace (Chatalalsingh & Regehr, 2006; Kozlowski et al., 2013).

Well-known and prolific team researchers Kozlowski and Chao (2012) note that the origins, processes and outcomes of team learning remain conceptually unclear and there is considerable diversity in the ways that researchers have represented and measured team knowledge and the processes by which it is acquired, emerges and manifests within the team. Beyond the previously discussed individual learning metaphors of team learning, there is an opportunity to explore the conceptualization of the team as a complex learning system where knowledge emerges in and from the interactions and activities of the collective. This can best be appreciated at the collective level of analysis and, by its nature, includes team informal learning. Indeed, there seems to be very few research-based accounts of team informal learning within that tie in the more recent appreciation of the complexity of interactions that constitute it.

This research focuses on a specific type of team, *work teams*. Work teams are a permanent part of contiguous work flows within an organization. They perform a specific segment of work on an ongoing basis that contributes to organizational outcomes. But they are more than that. Kozlowski and Bell (2003) provide a comprehensive description of work teams as a system within a system which appreciates the social and organizational contexts in which they work. Work teams are:

collectives who exist to perform organizationally relevant tasks, share one or more common goals, interact socially, exhibit task interdependencies, maintain and manage boundaries, and are embedded in an organizational context that sets boundaries, constrains the team, and influences exchanges with other units in the broader entity. (p. 334)

The permanent integration into organizational work flows makes them distinct from other types of teams such as research teams, project teams, task forces, tiger teams, development teams or management teams. This research provides the opportunity to better understand informal learning in work teams. More specifically, there has been limited research or scholarly literature on collective informal learning of authentic work teams. 'Authentic' reflects that that the team is employed in their natural work setting and they are engaged in actual day-to-day work activities; there is no facilitated, simulated, laboratory or constructed environment that is often a condition of team research.

In investigating team informal learning in the workplace, there is a complementary opportunity. The notion of teams as complex adaptive systems raises additional questions regarding collective learning. Referencing Prigogine and Stengers (1984) seminal work *Order Out of Chaos*, Karpiak (2000) suggests that living systems, including human beings and related social systems, are open systems in constant interaction with their environment. This line of thinking is well aligned with social constructivist understanding of learning as emerging from social interactions, but goes beyond it. As articulated by McMurtry (2008) complex systems embody possibilities exceeding the sum of their components and possibilities emerge at the level of the system as a whole. Similarly, a team can be seen as a complex system and as such this suggests potential for these ongoing interactions to result in teams emerging, renewing or even evolving and transcending themselves. Borrowing from Karpiak's (2000) understanding of individual learning, this thesis posits that a team also emerges as an entity that is "always becoming", always a "work in progress", destined to change and grow (p. 33).

If one accepts that collective learning can result in emergence and growth which can result in substantive change to the team, then this opens the possibilities for transformation. Indeed, there has already been theoretical consideration that as a result of the learning process, teams may undergo transformation (Decuyper et al., 2010; Gersick, 1991; Illeris, 2013; Paavola, Lipponen, & Hakkarainen, 2004; Sessa, London, Pingor, Gullu, & Patel, 2011; Silberstang & London, 2009). However, while there have been numerous theorists that have espoused this potential, there appears to have been no research that has investigated team transformation from this perspective and particularly not within authentic work teams.

This connects the previous discussion of collective transformative learning to the potential for teams to transform as a result of their learning at work. Transformative learning theory has become one of the most influential theories in adult education (Choy, 2009; Merriam & Bierema, 2014). Research and other scholarly work continues to grow exponentially (Taylor & Cranton, 2013) and various conceptualizations of transformational learning continue to evolve toward a more holistic theory of adult learning (Illeris, 2004; Mezirow, 1996; Taylor, 1998). However, there have been numerous critiques and repeated calls for expanding the theoretical discourse and research in transformative learning. In particular, there has been limited research on collective transformative learning and transformative learning at work. This research can

therefore expand on our understanding of potential processes and outcomes of transformative learning within a work context and its applicability to groups, such as an authentic work team.

The case. The case team studied is the Shared Services Canada (SSC) Information Technology Security Incident Recovery Team (IT SIRT). At the time of the study, the IT SIRT is a 10-person work team engaged in various forms of workplace learning including formal, non-formal and informal learning. However, this research is focused on the team informal learning and how it may contribute to team transformation.

The IT SIRT provides an excellent case to explore team informal learning as it is a nascent team within the Government of Canada (GC). The team works at the edges of their discipline, forming and re-forming past knowledge and generating new knowledge to respond to complex, high risk threats to GC operations. While there is formal and non-formal training in which they participate, their work is highly contingent and dynamic; much of the learning happens through their work and involves almost continuous interactions within and across team boundaries to connect to other teams, groups, and organizations. As well, there is potential for collective transformation of this work team as it continues to form, develop and evolve with its work.

Of note, the team manager is not considered to be a participant in this research nor a team member. He is a representative of senior management and he is not normally engaged in the day-to-day work in which the team members are regularly employed. While managerially responsible for team outcomes, he is rarely a personal contributor to the team outcomes and not engaged in the same interactions. He therefore would have different experiences and perspectives from the remainder of the team members.

Purpose of Study

The purpose of this instrumental case study is to research collective informal learning in an authentic work team and to identify the potential for collective transformative learning. For this case, authentic work team refers to the IT SIRT that is working in its natural work environment are engaged in actual day-to-day work activities.

Research questions. The main research question is “in what ways is collective learning enacted within this authentic work team?” Sub-questions to be answered within the scope of the research are: how can this collective learning be understood and articulated; what are the triggers/drivers for this type of learning; and how can Mezirow’s theory of individual

transformative learning contribute to our understanding of how learning may occur in this authentic work team?

Significance of the Study

As a line of inquiry in educational research, the proposed study occurs at the intersection of three sub-disciplinary study areas shown in Figure 1: workplace learning, collective learning, and transformative learning.

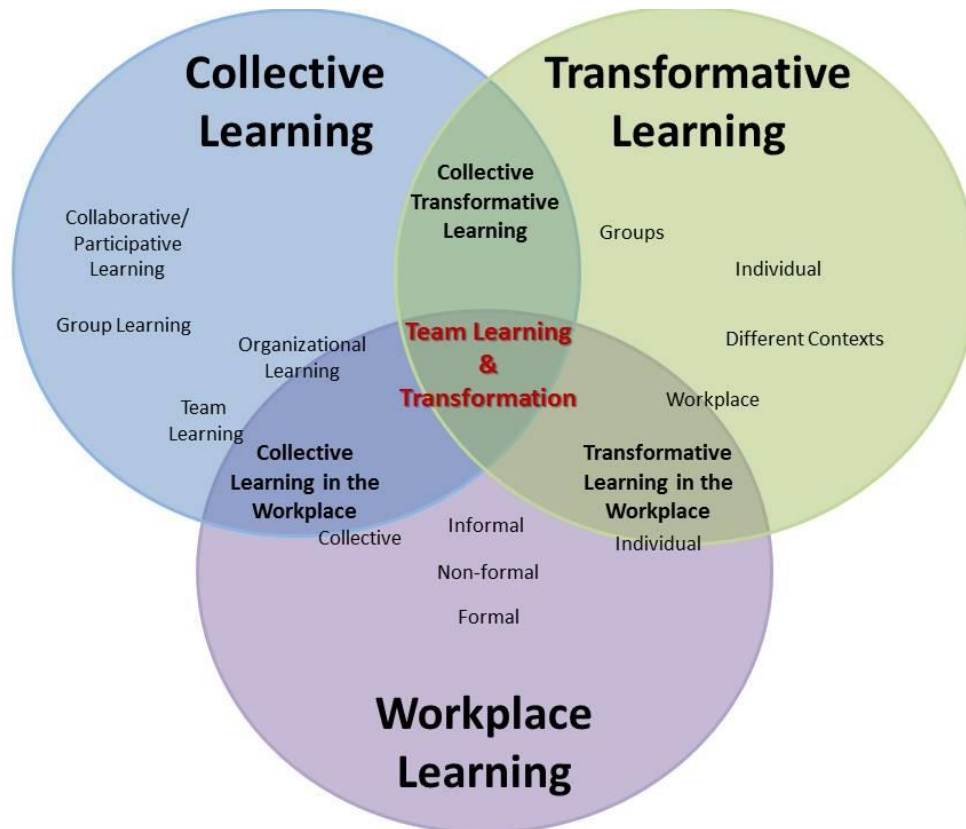


Figure 1. The research context at the convergence of three fields of study.

As an educational researcher, I believe that the struggle to better understand teams as complex learning systems is overshadowed by the predominant conceptualizations that echo individual learning metaphors. Research can help to elaborate and expand on our understanding of team informal learning in authentic work settings. There is the complementary opportunity to conduct research on collective transformative learning in a workplace setting. Consequently, in exploring collective informal learning and transformation in authentic work teams, this research can contribute to the three sub-disciplines shown in Figure 1. To date, research in all three has been limited in scope.

As a facet of workplace learning, the focus of a majority of research has been in individual learning processes and learning structures. Most adult learning and training occurs at the workplace (Canadian Council on Learning, 2009). Therefore, studies that support more inclusive concepts of how adults learn have the potential to help to better support learning. As well, by studying collective informal learning and transformation within an authentic work context, this research links the previous two theoretical legacies within the emergent field of study of workplace learning. This research has the potential to progress collective learning theory by enhancing our understanding of how team informal learning is enacted in and through work. It also has the potential to enrich our understanding of transformative learning by helping establish its applicability to groups within work-related contexts.

Definitions

Learning and work are broad areas of study. Prior to the literature review, the following key definitions provide scope and context for the research. The definitions include: learning, formal, non-formal and informal learning, team traits, triggers and drivers.

Learning. Learning is a complex, multifaceted process that has been variously defined by many scholars often intended for a particular context. For example, a noted workplace learning scholar, Illeris (2008) defines learning as “a complex, recursive activity wherein there are two distinct processes: an external interaction process between the learner and his or her social, cultural and material environment, and an internal psychological process of elaboration and acquisition in which new impulses are connected with the results of prior learning” (p. 5). Particular to his study of work, he further points out that learning always includes three dimensions: the content dimension – what is to be learned; the incentive dimension – why it is being learned; and the social dimension – the interaction. Notably, Illeris includes the social dimension of learning. However, the predominance of the internal cognitive processes related to acquisition remain. To extend this definition to the team would continue to hold the team as a collection of individuals rather than a learning system.

To better frame the discussion within this study, it is necessary to emphasize social learning. Piaget (1928/1977) acknowledges that “social life transforms the individual’s very nature (p. 239). Vygotsky (1978) appreciates that all learning has a history external to the learner. He saw construction of knowledge as a social process and that learning experiences expand knowledge beyond that of the individual alone. Within the social constructivist view,

meaning is created through our engagement with the world and through our social exchanges (Ernest, 1994). Hein (1991) suggests that learning involves language, is a social activity, and is contextual. Learning is a social process shaped by external forces and arising from those interconnections (McMahon, 1997). Within the social constructivist perspective, learners do not simply 'acquire' knowledge, rather knowledge and the associated meaning are constructed and elaborated upon by learners within a social context which includes past and current experiences. This learning and experiencing are situated within a context and are coincident, simultaneously occurring within the social context.

Formal, non-formal and informal learning. Within educational research it is necessary to identify disciplinary boundaries and categories that provide important context so that the 'learning space' is clear. Educational research often refers to formal, non-formal and informal education which is defined in terms of the structures for education systems. In the past decade, this typology has been expanded to include the wider discipline of learning: formal, non-formal and informal learning. Since the focus of this study is on informal learning in the work team, it is appropriate to distinguish between formal, non-formal and informal learning, particularly as formal and non-formal learning are also evident. The following are largely drawn from definitions provided by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) (2012) and includes nuances introduced by the Organization for Economic Development and Cooperation (OECD) (2016) and the Canadian Council on Learning (CCL) (2009).

Formal learning. Formal learning is structured according to educational arrangements such as curricula, qualifications and teaching-learning requirements. Consequently, it takes place primarily in education and training institutions, is recognised by relevant national authorities and leads to diplomas and qualifications. Normally the province of mainstream educational institutions, there is now an appreciation that certain educational environments organized around work can also support formal learning. The CCL (2009) describes formal learning as "any clearly identified learning activity that takes place in an organized, structured setting and leads to a recognized credential" (p. 26). This definition broadens the landscape of possibilities as it applies to workplace learning. Three examples of formal learning institutions that are not part of mainstream education, but are now widely accepted are: corporate universities, police colleges and military training and education establishments. A critical, persistent characteristic, however,

is that the learner has limited control over the objectives and the means in which the learning occurs (Mocker & Spear, 1982).

Non-formal learning. Non-formal learning is learning within structured settings that is in addition to or alternative to formal learning. It often structured according to educational and training arrangements, but is typically more flexible (UNESCO, 2012). The CCL (2009) describes non-formal learning as taking “place alongside the mainstream systems of education and training and does not typically lead to formalized certificates” (p.26). The CCL associates non-formal learning primarily with continuing education or further education. A majority of structured workplace learning is non-formal and includes: union-related training, orientations, job-related courses and legislated training such as occupational health and safety awareness. Non-formal learning may be recognized through certificates, but does not typically result in a more globally recognized credential.

Within the workplace, non-formal learning still has structure which is normally defined by an organization or other formal body. It is intended to meet explicit requirements, whether participation is optional or mandatory. In addition to classroom-based activities, other non-formal learning activities may include structured on-job-training, formal coaching, peer-learning activities, or e-learning. In non-formal learning, the learner may or may not have a role in defining the learning objectives, but tends to lack control over the means (Mocker & Spear, 1982).

Informal learning. Given my research emphasis on informal learning, this topic warrants more detailed discussion. There are multiple definitions of informal learning and this clouds what is written and understood about it (Garrick, 1998, p. 130). The following provides a small sample of the posited definitions. UNESCO (2012) defines informal learning as learning that occurs in daily life, in the family, in the workplace, in communities and through interests and activities of individuals. Marsick & Volpe (1999) describe informal learning as “predominantly unstructured, experiential, and non-institutional...part of daily work life and driven by people’s choices, preferences, and intentions” (p. 4). Hager (1998) describes informal learning as an unplanned and implicit process with unpredictable results. The CCL (2009) states that informal learning is also known as experiential learning. They define informal learning as divided into unintentional and intentional learning. Unintentional, or unplanned, learning occurs during everyday activities and in many forms of basic socialization. In such cases, the learner controls

the means, but not the objectives (Mocker & Spear, 1982) as they are not defined within the experiential learning context. Intentional informal learning is distinguished by the learner's own conscious recognition of a significant form of knowledge, understanding or skill acquired through his or her own initiatives (CCL, 2009, p. 26). This can also be referred to as self-directed learning where the learners tend to control both the objectives and the means of learning (Mocker & Spear, 1982).

The various definitions discussed above and further conceptualizations (Livingstone, 2001), categorizations (Marsick & Watkins, 2001) and typologies (Eraut, 2004) have helped to establish boundaries to support research of informal learning within workplace contexts. However, as Fordham (1993) notes none of these are hard and fast categories particularly as there can be overlap with all three; informal learning is ongoing regardless of the structures and spaces in which learners find themselves. This is particularly the case when viewed from a social constructivist perspective.

Since the focus of this study is on informal learning within a work team, Eraut's (2004) typology of informal learning helps to distinguish between types of informal learning that can be extended to collective learning activities as shown in Table 1. The three types are implicit, reactive and deliberative learning. He defines implicit learning as learning where there is no conscious attempt to learn and there is no explicit awareness of what was learned. He suggests that most learning from experience has some implicit aspects as to other forms of learning. He describes reactive learning as intentional, opportunistic and 'near-spontaneous'; it occurs in the middle of activity offering little to no time for reflection. Finally, he describes deliberate learning as situations where there is a definite learning goal and time set aside for the learning and engagement in activities such as planning and problem-solving (p. 250).

Time of focus	Implicit Learning	Reactive Learning	Deliberative learning
Past episode(s)	Implicit linkage of past memories with current experience	Brief near-spontaneous reflection on past episodes, events, incidents, experiences	Discussion and review of past actions, communications, events, experiences
Current experience	A selection from experience enters episodic memory	Noting facts, ideas, opinions, impressions; asking questions; observing effects of actions	Engagement in decision making, problem solving, planned informal learning
Future behaviour	Unconscious expectations	Recognition of possible future learning opportunities	Planning learning opportunities; rehearsing for future events

Table 1. Eraut's (2004) typology of informal learning

Team traits. A trait is a relatively enduring characteristic that is represented by “consistent patterns of behavior that are relatively immune to situational contingencies” (Zaccaro, Kemp, & Bader, 2004, p. 103). These are often stated in terms of psycho-social behaviours. In contrast to individual traits, team traits equate to those characteristics or attributes that are understood to arise within the collective, but may not necessarily be evident at the individual level. Common examples include cohesiveness, autonomy, psychological safety, group efficacy, mutual trust, shared beliefs and common affect (Cohen & Bailey, 1997; Decuyper et al., 2010; Edmondson, 1999). Team traits may also be discussed as team attributes or characteristics such as ‘diverse’, ‘goal oriented’, ‘innovative’ or ‘tenacious’, even if these qualities are not seen in individual members.

Variouly defined and often used interchangeably, traits, attributes and characteristics of the team are also considered as mediational factors which can influence team learning (Marks, Mathieu, & Zaccaro, 2001). As the focus of this study is on how the team learns and not the pre-conditions for learning, the discussion of the team traits and attributes will be limited to that

which becomes evident during the research such as when they are identified as a trigger or driver for learning.

Triggers and drivers. Most agree that learning is prompted by particular individuals, events, situations, leaders or conditions (Fenwick, 2008). Triggers and drivers are terms that may be recognized from individual learning literature, particular grade school education circles. However, there have not been any scholarly definitions found that discuss triggers and drivers for team learning or workplace learning. Accordingly, definitions are warranted. For this case, triggers stimulate team learning in the moment and often relate to problems, issues, or changes that influence team activity. In contrast, drivers are bound within the context in which the team works. As opposed to arising from the work, they background the work and ‘drive’ the team to learn. Within the workplace, drivers are often related to mandate, anticipated tasks or activities, as well as team traits or attributes.

Thesis Overview

This thesis will continue with Chapter Two that provides a literature review and critical analysis of relevant research and predominant theoretical perspectives in workplace learning, collective learning and transformative learning. This will be followed by Chapter Three which will discuss the methods employed and the data analysis and interpretation through a social constructivist lens. In Chapter Four I will provide my synthesis of the findings. In Chapter Five, I will discuss the findings relative to the research questions. This will include my expanded understanding of team informal learning and collective transformative learning. Chapter Six includes a summary of my research, the scholarly contributions, implications, suggestions for further research and my personal reflections on the project.

Chapter Two - Literature Review

Organizational Structure of the Literature Review

In this literature review, the reader will be guided through three interrelated areas of research that converge and are of import in this thesis: workplace learning, collective learning, and transformative learning. The ‘workplace’ serves as a distinct context and this chapter accordingly opens with a brief review of relevant concepts and issues in the study of workplace learning. The subsequent sections focus on two areas of specific interest to this research: collective learning, and transformative learning. Each will be discussed through a social constructivist lens, progressing from general concepts to detailed team-specific relevance. Each section will also include a critical analysis and summary highlighting theoretical and practical gaps. By the end of this chapter, the hope is that the reader will be apprised of my principle understanding of these three areas of study and how they intersect. As well, the reader should be able to appreciate the concerns and issues that arise from the current body of literature that this research attempts to address.

Workplace Learning

As an emerging discipline, workplace learning has been identified as “the largest adult education endeavour” (Watkins, 1995, p. 3). Workplaces are recognized as significant developmental sites for adult learning (Fenwick, 2006, p. 187). As Billet (2004) suggests, learning and participation in work are inseparable. Moreover, there is increasing emphasis on workplace learning as organizations recognize the power of learning in responding to dynamic economic and competitive pressures (Boud & Garrick, 1999; Spencer, Bratton, Mills, Pynch, & Sawchuk, 2003).

Eraut (2004) argues that “[a]part from being under-researched, 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” (p. 24). Consequently, there is growing awareness of the frequency and importance of informal learning in the working lives of adults and increasing research interest in workplaces as learning environments (Livingstone, 2001; Marsick & Watkins, 2001; Wihak & Hall, 2011). Theoretical and research interest revolves around questions of why, what and how people learn at work and the ways in which this differs from the learning that takes place in other learning settings (Fuller & Unwin, 2011, p. 50). There are also disparate and often conflicting purposes for promoting

learning in the workplace (Fenwick, 2010, p. 80). As Eraut & Hirsch (2007) state, “individuals are in a dynamic relationship with their work setting, being both influenced by it and being part of it themselves and through their relationship with others” (p. 3).

For this research, the focus is on collective informal learning within an authentic work team. Consequently, formal learning structures will be given limited attention. An understanding of workplace learning and, in particular, informal learning that occurs in and through work provides the foundation for the following discussions of collective, team and transformative learning. To further elaborate, I will define workplace learning and express how workplace learning is conceptualized for the purposes of this study.

The “workplace” is a compound term that is often associated with only traditional work. “Work” is constituted primarily through an individual and a social lens and can unfold differently for each individual and collectives such as teams. Work can be paid or unpaid, or both. “Place” is where the work may occur. The workplace is not a stable, unitary, identifiable location; it is shaped by one’s work experience and may vary throughout the course of work (Fenwick, 2006, p. 187). The term ‘workplace’ is therefore highly contextual, socially constructed and locally defined. Examples of workplaces include: an office, a store, an assembly line, an institution, a home, a farm, a vessel or a truck. Within this study, the workplace is understood to be a specific purposeful, social space in which learning occurs. In this case, the workplace is largely situated in a government office environment. Additionally, the team’s workplace includes cyberspace, which is defined as “the electronic world created by interconnected networks of information technology and the information on those networks” (Government of Canada, 2010).

Jacobs and Park (2009) define workplace learning as “the process used by individuals when engaged in training programs, education and development courses, or some type of experiential learning activity for the purpose of acquiring the competence necessary to meet current and future work requirements” (p. 134). They stress that this is a process in which individuals or groups engage in learning and not the organizational constructs in which the learning occurs. This is an important distinction; workplace learning is primarily about what learners do (Watkins, 1995, p. 3) and not the formal structures that support it. Jacobs and Park (2009) also note that their definition assumes the need to balance the needs of organizations with

the needs of individuals. This recognizes individuals who may undertake the learning to advance their own work-related interests and goals.

For clarity, workplace learning is fundamentally differentiated from other forms of learning in that the learning is intended to be defined by the work. Individuals or groups may learn at work, but this may not have any relationship to the work space or work requirements. Within Jacobs and Park's (2009) definition, there is provision for learning that is not defined by the organization, but the learning nonetheless remains work-related. For example, if I am at work and I am doing online research on a work-related subject but for which I was not tasked, I am still engaged in workplace learning. On the other hand, if I am at work and during lunch I am doing online research on a personal issue, the learning that occurs is not workplace learning even though it occurs at work. Jacob and Park's (2009) view of workplace learning emphasizes conscious individual engagement in learning activities resulting in instrumental outcomes. However, this definition does not capture the extent of learning that is spontaneously occurring through work, nor does it recognize the learning that occurs amongst individuals or collectives.

The Canadian Council on Learning (CCL) (2009) states that workplace learning is simply "learning that takes place through the workplace" (p. 25). This includes learning that occurs both on and off the work site. The CCL acknowledges that workplace learning may include formal, non-formal and informal learning. As this study focuses on informal learning, it is important to note that it forms a significant part of the learning that occurs in and through work (Eraut, 2004; Livingstone, 2001; Wihak & Hall, 2011). In some workplaces, informal learning may constitute all learning that occurs particularly if there is the expectation that new hires already have the skills and knowledge needed to do the work.

From the social constructivist perspective, research in workplace learning is primarily interested in learning issues from the 'bottom-up' and is focused on learning systems, processes, practices, and outputs with the intent to gain subjective perspectives at the individual or collective level (Fenwick, 2010). Typical constructivist inquiries explore the lived experience of those within the workplace settings and expand on the knowledge of perceptions, motivations and beliefs around workplaces and learning that would not necessarily be captured through objective evidence.

Four constructivist learning forms predominate and continue to emphasize individual learning processes within workplaces as social contexts for learning: self-directed learning

(Candy, 1989; Follman, Hall, & Omotade, 2012; Garrison, 1997; Merriam, 2001; Tennant & Pogson, 1995); experiential learning (Andresen, Boud, & Cohen, 2000; Marsick & Watkins, 2001; Michelson, 1996); reflective practice (Argyris and Schon, 1996; Boud, 2001; Fenwick, 2000; Schon, 1983) and social learning (Brown, Collins and Duguid, 1989; Collins, Brown, & Holum, 1991; Lave & Wenger, 1991). That said, even within these conceptualizations of social learning, they predominantly represent individual learning; the idea that learning occurs beyond individuals and becomes visible within collectives at the collective level of analysis continues to be underrepresented in workplace learning literature. This will be further discussed in the next section, collective learning.

Collective Learning

Within the social constructivist frame, individual learning is understood to be a social process that results in changes to individual cognition and behaviour. Collective learning is also understood to be a social process that becomes visible through changes in the collective. Accordingly, the discussion of collective learning is rooted in sociological and group analysis concepts that include collective cognition, collective consciousness, and social unconscious. From these roots, the discussion will progress to collective learning in organizational settings as a multi-level phenomenon that includes societal, organizational, group and team learning.

A definition of collective learning that is particularly suited to workplace settings is as “a social process of cumulative knowledge, based on a set of shared rules and procedures which allow individuals to coordinate their actions in search for problem solutions” (Capello, 1998, p. 2). However, this definition remains individual-centric and focused on problem solving. Within work settings, knowledge creation and learning apply to more than problem solving; learning occurs through collective activities and interactions that include conversation, collaboration, innovation, discovery, reflection, and other activities. From the social constructivist perspective, perhaps a preliminary definition of collective learning is contingently formed patterns of understandings and interactions within practical and situated activities where learning is discovered and generated together with others (Johnsson & Boud, 2010). This is a better suited definition that provides for a range of collective learning activities within workplace settings. This definition will be revisited and expanded in this section.

Collective learning is inextricably tied to collective knowledge processes and the outcomes that would otherwise go unrealized if the collective did not exist. Collective learning is

premised on the existence of collective cognition. Collective cognition involves the processes related to social knowing. Also understood to be socially shared cognition, and occasionally referred to, perhaps inappropriately, as a 'group mind', the basis for collective cognition continues to be debated (Cranton, 2006; Thompson & Fine, 1999; Wegner, 1987). Indeed, as stated by Hopper (as cited in Weinberg, 2006, p.314) "the metaphor that social systems are like people and have minds in the same way that people have minds, is an extremely useful heuristic device that directs our attention and curiosity towards those parts and aspects of social systems of which people are unconscious." From this construct, collective or social cognition is represented in myriad ways. Thompson and Fine's (1999) review of socially shared cognition, affect and behaviour notes over a dozen terms from a range of scholarly authors expressing this concept including: socially shared cognition; sociocognition; situated cognition; shared reality; naturalistic social cognition; group cognition; contextualized cognition; social cognition; shared mental models; team mental models; distributed cognition; the social science of cognition; and collective identity (p. 280). While there have been numerous refinements, these various understandings of collective cognition tend to complicate discussions on collective learning as there is often conceptual overlap and similar terms with different meaning. Indeed, nothing seems to have changed over the past decade; collective cognition and collective learning remain variously defined, ambiguous and not yet fully understood (Capello, 1998; Garavan & Carberry, 2012).

Important for this thesis is the appreciation that collective cognition is not limited to individual thought about social objects that is then aggregated at the collective level. According to Thompson and Fine (1999), collective cognition is a product of social interchange constructed, shared, and distributed among groups of individuals and across group. Somewhat differently, Hutchins (1995) discusses his concept of distributed cognition noting that, depending on their organization, groups must have cognitive properties that are not predictable from the properties of the individuals in the group. He asserts that the focus on defining cognition inside the individual overlooks the fact that "human cognition is always situated in a complex sociocultural world and cannot be unaffected by it" (p. xiii). The study of distributed cognition seeks to understand the organization of cognition systems that recognizes that cognition goes beyond the skin and skull of an individual (Hutchins, 2000). Collective cognition in this sense extends the traditional understanding of cognition beyond the individual, or aggregation of

individual views, to encompass complex interactions and relations between people and their social objects.

This concept of collective cognition brings to light a critical element in the study of collective learning – how changes to collective cognition are represented both as processes and outcomes. While being about social interactions, collective learning is also about how those interactions are brought together, result in collective cognitive changes and become useable within the collective (Camagni, 1991 as cited in Garavan & Carberry, 2012). The inclusion of outcomes is not explicit in the previously discussed Johnsson & Boud (2010) definition. Expanding on the discussed definition, collective learning can be understood as social interactions that refine meaning or create new knowledge or meaning that resonates within the group and is revealed in changes to the collective structure, activities and artefacts. For example, through dialogue, different perspectives may be revealed on an issue and a new collective understanding can emerge that was not previously within the mind of any of the individuals. This new understanding may result in different actions or changes to the collective that otherwise would not have occurred in absence of the dialogue. So, in particular for collective learning research, it is not only important to understand how the collective learns, but how that learning is revealed or becomes manifest within the collective.

As noted by Döös & Wilhelmson (2011), increased research on learning that occurs at levels above the individual (i.e. collective level), such as team, organisation, inter-organisation and network level, has led to a situation where the concept of learning is defined in a number of different ways (Fenwick, 2008). Of particular interest within this study is that collective learning is represented as group interaction processes (learning) and group action processes (outcomes) (Marks et al., 2001; Ilgen et al., 2005; Sessa et al., 2011; Van Der Vegt & Bunderson, 2005; van Offenbeek, 2001;). Ilgen et al. (2005) and Sessa et al. (2011) suggest a focus on behaviours and outcomes that flow from collective learning that can be used to help distinguish learning processes. Indeed, collective learning outcomes are often the visible results of the learning processes and provide insight to what learning has occurred at the collective level of analysis. Caution is needed, however, in defining collective learning by the outcomes alone as such definitions may not delineate how learning occurred and they do not appreciate the context in which teams are placed where the macro structures influence and shape team processes and activities (Kozlowski et al., 2013, p. 600).

For the purposes of this study, both processes and outcomes are important. It is therefore necessary to expand on Johnsson and Boud's (2010) definition: collective learning is contingently formed patterns of understandings and interactions within practical and situated activities where learning is discovered and generated together. This learning results in changes to the collective cognition which becomes evident in the collective or through collective action. This definition opens possibilities to provide more evidence-based research that can hope to detect collective learning within workplace settings. The relevance for workplaces is coming to understand how collective learning processes and outcomes are implicated in work.

Collective learning defined by level of analysis. There are various ways in which teams can be situated within the larger collective contexts. In this case, the focus of study is on an authentic work team within a government organization. Figure 2 is an adaptation of Bronfenbrenner's (1979) developmental ecological systems theory on childhood learning and development that has been repurposed to show the nested relationships of collectives across four levels of analysis within organizational settings: societal, organizational, groups, and teams. The societal level of analysis is included as organizations are situated within a societal context and, in today's global marketplace, often extend across diverse societal contexts. Discussion of the societal context also supports discussion of sociological and group analysis concepts which are useful when studying lower-order collectives nested within the society. The following will discuss each level of analysis in greater detail. The purpose is two-fold, to help situate collective learning as defined in different workplace research contexts and to help distinguish team learning from other forms of collective workplace learning.

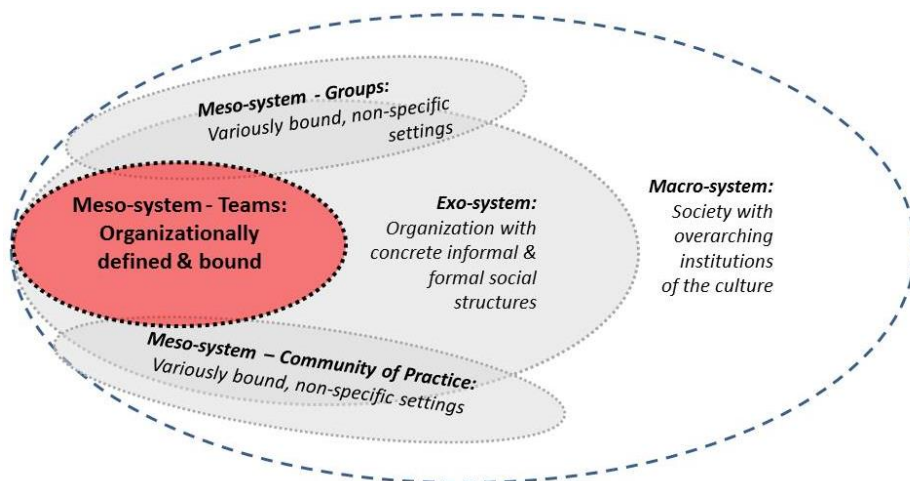


Figure 2. Collective learning at five levels of analysis

Societal learning. The first level of analysis is society as a macro-system and includes societal learning. This is the larger contextual setting in which a workplace is situated and highly influences the underlying systems. This is relevant as it refers to consistencies in form and content of lower-order systems that exist or could exist that include culture and any belief systems or ideology underlying such consistencies (Bronfenbrenner, 1979, p. 26). Organizations and the teams are embedded within this macro-system as part of the larger societal context and they adopt these consistencies. To explore this level of collective learning, I will primarily draw from sociological and group analysis concepts.

Societal learning is not a new concept and there are several sociological concepts that help to frame the learning that penetrates all levels. Mead (1934) identifies that as soon as two or more individuals interact, meaning becomes socially constituted in terms of meaning through social processes. Similarly, Durkheim's 'collective consciousness' represents the "totality of beliefs and sentiments common to average citizens of the same society" that "forms a determinate system which has its own life" (Durkheim, 1893/1964, p. 38). He recognizes that the collective emerges from the social interaction of individuals and that it sustains even as members of the collective change. More recently, Berger and Luckman's (1966) treatise on social construction of knowledge in everyday life solidified the conceptualization of socially created and shared knowledge and meaning. Blumer (as cited in May, 2011, p. 166) asserts that "...any kind of social change, since it involves change in human action, is necessarily mediated by interpretation on the part of the people caught up in the change – the change appears in the form of new structures in which people have to construct new forms of action" (p. 153). Bourdieu (1994) recognized the relevance of history and place in learning within his concept of *habitus*. Understanding that every individual and collective has a history, *habitus* is the active presence of past experiences represented as system of dispositions that perpetuates itself into the future by reactivation of similarly structured practices. The *habitus* therefore tends to generate collective behaviours and practices which are within the local cultural limits. Finally, Hopper (2001) refers to the social unconscious. He describes this as: mind

the existence and constraints of social, cultural and communicational arrangements of which people are unaware; unaware, in so far as these arrangements are not perceived (not known), and if perceived not acknowledged (denied), and if acknowledged, not

taken as problematic (“given”), and if taken as problematic, not considered with an optimal degree of detachment and objectivity (p.126)

As noted by (Weinberg, 2006), this concept of a ‘social unconscious’ drives group behaviour.

There are many other references to collective cognition, collective consciousness, and learning at the societal level of analysis including exploration of the benefits of collective intelligence (Surowiecki, 2005) and intentional societal learning for collective action (Armitage, Marschke, & Plummer, 2008; Ostrom, 1990). Suffice to say that society provides the larger macro context in which teams learn and perform; it provides the overarching belief systems and cultural artefacts such as symbols, language, objects that are used by a team. Indeed, within society, even the word ‘team’ carries with it certain socio-cultural expectations and a common meaning and boundary that pre-exist the formation of any specific team.

Organizational learning. Though there are other potential levels of analysis that include geo-political boundaries, regions, societal groups, and communities, this study pertains to a specific workplace. Accordingly, the workplace organization is the exo-system level of analysis. There are myriad ways that learning is represented within organizations. As noted by Kozlowski, Chao, & Jensen (2010), learning occurs at different levels of analysis: individual, group, organizational and inter-organizational; each includes formal and informal processes. All may be relevant elements of learning within organizational settings, but as they are formalized or structured learning they fall outside the scope of this study. As well, collective learning can be an integral component of organizational learning. However, organizational learning needs to be distinguished as one form of collective learning, particularly as the learning occurs in a different context, with different processes and activities, and with different influences.

As a distinct form of collective learning, organizational learning can be defined “as a change in the organization’s knowledge that occurs as a function of experience” (Argote, 2011, p. 440). Pokharel and Hult (2010) see organization learning is a “continuous process of value/knowledge integration” (p. 251) where the knowledge is integrated into the existing organizational knowledge and, through diffusion, adoption, cooptation and institutionalization processes becomes embedded into routines and practices (Levitt & March, 1988; Pokharel and Hult, 2010). Shrivastava’s (1983) typology is similar, highlighting: phases of adaptation; developing knowledge of action-outcome relationships; assumption sharing; and institutionalized experience.

In organizational learning the knowledge does not necessarily need to apply to the organization as a whole. Argote (2011) suggests that organizational learning is assumed to have occurred if any of its units or collectives acquires knowledge that it recognizes as potentially useful to the organization. The main sub-processes through which organizational learning is stated to occur are acquiring, creating, retaining and transferring knowledge, often through organizationally established mechanisms (Argote, 2011; Pokharel & Hult, 2010). Huber (1991) supports this conceptualization indicating that an organization learns something even if not every one of its components learns it. This can equally apply to the team.

As distinguished from team learning, organizational learning is occurring at the exo-level of experience and occurs within and across an organization. A team may participate in organizational learning. As well, the team can be influenced by and exhibit organizational learning processes and outcomes. However, as a discrete social entity within an organization with a shared task and boundaries (Kozlowski & Bell, 2003), the team learning processes and outcomes may vary significantly from those that predominate or are desired within the organization. Team learning also differs from organizational learning in context and scale.

Within the discussion of organizational learning is a complementary area of study, distributed leadership. Distributed leadership is based on Hutchin's (1995) theory of distributed cognition discussed earlier. Spillane (2005) indicates the concept of distributed leadership suggests that leadership is not necessarily a product of the leader's skill and knowledge, but rather is defined by the interactions between people and their situations. He states "it is not the actions of individuals, but the interactions among them, that are critical in leadership practice" (p.145). He concludes:

From a distributed perspective, leadership is a system of practice comprised of a collection of interacting components: leaders, followers, and situation. These interacting components must be understood together because the system is more than the sum of the component parts or practices. (p.150)

This conception is applicable to semi-autonomous work teams such as the IT SIRT as it would not be possible for the team to work and respond effectively if all decisions had to be made by an authoritative decision-maker. Rather, teams like the IT SIRT, are likely to engage in distributed leadership which is considered an emergent social process (Spillane, 2005).

Group learning. A group is generically defined as a number of people that are located, gathered, or classed together (Oxford University Press, 2016). A group is one type of collective considered to be at the meso-level of analysis. Each group may be characterized by a wide variety of means such as race, religion, physical attributes, work type, location, or socio-economic status. Typically, however, there are characteristics, attitudes or narratives that link individuals with groups. Bion (1961) states that "...no individual, however isolated in time and space, should be regarded as outside a group or lacking in active manifestations of group psychology" (p. 168). In this sense, we are all members of various groups. As well, we may belong to more than one group at a time.

Groups are formed for many different reasons and may have different purposes (Arrow, McGrath, & Berdahl, 2000, p. 4). In the workplace, groups are variously bound within larger organizational, inter-organizational and societal contexts. A group can be defined as a loosely coupled system of mutually interacting, interdependent members, projects and technology with a shared collective identity. Referring back to Bion's (1961) statement, a group may be based on a single attribute, trait or characteristic though the individuals of the group may not share a common goal or purpose. Consequently, a group as it is broadly defined is not considered a team, though a team is a type of group.

Group learning is another form of collective learning that takes place within an organization that should be distinguished from team learning. Research on group learning provides many of the underpinning concepts of organizational learning as groups are often the level at which actual learning occurs in organizations (Argote, 2012, p. 20). Group learning is also variously defined. The previously articulated definition of collective learning also applies to groups and can be simply understood as a process through which groups share and create knowledge through the experience of working or experiencing together. Group learning can mirror the complex processes of organizational learning where the learning manifests through changes in group knowledge, behaviour and/or performance (McGrath & Argote, 2001, p. 616). As well, depending on the group's purpose and level of interaction, any learning may be completely incidental and may not be of any substantive organizational value such as non-work related learning in social groups.

Given the workplace emphasis, a type of group which should be distinguished from the team is the community of practice. The community of practice is also nested at the meso-level of

analysis. Wenger (2011) defines a community of practice as a group of people who share a concern or passion for something they do and learn how to do it better as they regularly interact. Learning is central to its purpose. He cautions that this definition allows for, but does not assume intentionality. He also points out that there are three characteristics that are crucial: a shared domain of interest; a community that engages in joint activities and discussions, help each other and share information; and a shared practice which includes a repertoire of resources: experiences, stories, tools, ways of addressing recurring problems (p.1).

Communities of practice come in various forms and structures. As Wenger (2011) notes, communities of practice often have a core group with many peripheral members (p.3). Moreover, Wenger (1999) suggests that the existence of a community of practice may not be evident to its members because “a community of practice need not be reified as such in the discourse of its participants” (p.125). In many cases, the group is quite informal and loosely structured based on these informal interconnections. This is another distinguishing feature from the team. Often situated within management literature as an ideal concept for knowledge sharing and development of expertise within communities, this is not necessarily the case. As Wenger, McDermott and Snyder (2002) note, the “very qualities that make a community an ideal structure for learning –shared perspectives on a domain, trust, a communal identity, longstanding relationships, an established practice – are the same qualities that can hold it hostage to its history and its achievements” (p.141). Additionally, as informal learning structures, communities of practice may exhibit power, trust or other pre-dispositions that may influence and limit participation (Roberts, 2006).

Unlike teams, communities of practice tend not to be stable or static entities for any period of time; they evolve as new members join and others leave (Roberts, 2006, p. 625). Communities of practice and work teams are different learning structures. A team may foster a community of practice or a community of practice may include all of the members on a team; but they remain distinct.

Team learning. The final level analysis is the focus of this research - the team, which is also viewed at the meso-level of analysis. Unlike the different collectives described above, teams are specific work groups that are bounded entities that lie within and are organized or sanctioned by the organization (Brown & Duguid, 1991, p. 49). Teams are social entities which exist to

perform organizationally relevant tasks and share one or more common goals (Kozlowski & Bell, 2003).

As alluded to in my introduction, teams have been the subject of study for several decades, though the research primarily focused on team development and conceptual expansions on traditional input-process-output (I-P-O) models (Goodman, 1988; Hackman, 1987/1990; McGrath, 1984; Tuckman, 1965; Tuckman & Jensen, 1977). Moving beyond the linear I-P-O models, other scholars expanded on the earlier understanding and introduced concepts including punctuated equilibrium (Gersick, 1988), emergent states (Marks, Mathieu, & Zaccaro, 2001), and mediating factors and cyclical feedback that appreciate the “broader range of variables that are important ... for explaining variability in team performance and viability” (Ilgen et al., 2005, p. 521). More recently, team development has been described as an ongoing and emergent process (Decuyper, Dochy, & Van den Bossche, 2010; Ilgen et al., 2005).

These models provide insight to the organizational work team as a social entity that go through various stages of development and have unique attributes. While the more contemporary models of team development and performance include an understanding of team dynamics and appreciate the social context in which teams work, the predominant view of team learning seems remained tied to individual, cognitive concepts of learning often using similar information processing concepts of acquisition and retrieval (Fenwick, 2008; McMurtry, 2008).

Team learning is a form of collective learning. While a variety of definitions have been proposed for team learning, this research focuses on team informal learning at the collective level of analysis. Consequently, the earlier expansion of Johnsson and Boud’s (2010) definition of collective learning has been adapted to this context: *Team informal learning is contingently formed patterns of understandings and interactions within practical and situated activities where learning is discovered and generated together. This learning results in changes to the collective cognition evident in team activities, artefacts and other outcomes.* In practical terms, team informal learning is considered to have occurred if there are changes to the team’s collective cognition that cannot be explained as the result of formal and non-formal learning events.

This research views teams as unique collectives with specific traits, attributes or characteristics that warrant special attention within discussion of collective learning. Moreover, it is understood that these traits, attributes or characteristics may have a significant influence on

learning and can be considered mediational factors to learning and team performance (Ilgen et al., 2005; Dechurch & Mesmer-Magnus, 2010).

Team learning is an emerging field of study and the literature is “broad and it is also messy and fraught with conceptual confusion” (Bell, Kozlowski, & Blawath, 2012, p. 1). Recent team learning research emphasizes learning patterns (Baert & Govaerts, 2012), models (Decuyper et al., 2010; Kasl, Marsick, & Dechant, 1997); processes and outcomes (Sessa, et al., 2011; van Offenbeek, 2001); or contextual or situational variables and the social interactions, influences and conditions in which the learning occurs (Clarke, 2010; Edmondson, 1999; Ellis, et al., 2003; Silberstang & London, 2009).

The legacy of team effectiveness and performance research helps to explain how groups develop and achieve their organizational and instrumental outcomes which are often described in terms of the ideal (Sessa & London, 2006; van Woerkom & Croon, 2009). However, echoing Dechant, Marsick and Kasl (1993) this does little to shed light on the strategies which teams use to mutually construct new knowledge or on the conditions which facilitate such a process (p. 3). Moreover, the team is a distinct social entity at the meso-level of experience, so it may not always learn what an organization wishes it to learn, nor are the outcomes always those expected by the organization (Kozlowski & Bell, 2003).

In the contemporary literature, team learning is primarily conceptualized in four ways (Bell, Kozlowski & Blawath, 2012; Decuyper et al., 2010; Garavan & Carberry, 2012; London & Sessa, 2006):

- as an aggregate of individual learning as individuals generate, acquire and share unique knowledge and information;
- as participative activity when a collective engages in exploratory or reflective behaviour such as asking questions, seeking feedback, discussing options or errors;
- as an open system; and
- as a complex learning system.

The first three conceptualizations dominate the team learning literature and each appreciates a distinct view of collective learning that is discussed in greater detail below. From the outset, however, we should appreciate that none of these conceptualizations is holistic nor are they necessarily independent of each other; while distinct, they may occur separately or

concurrently (Sessa et al, 2011). As will be seen, the fourth – teams as complex learning system – has not yet been firmly established in the research and literature.

Team learning as aggregation of individual knowledge. This is the predominant view in most organizational settings where learning is seen as primarily cognitive, acquired, normative, and explicitly or implicitly causative (Johnsson & Boud, 2010, p. 360). This is closely aligned with the acquisition metaphor commonly associated with individual learning and discusses collective learning as a process and outcome. In this metaphor, knowledge is seen as the property of the individual mind (Paavola, Lipponen, & Hakkarainen, 2004) and as something to be acquired when, once learned, it can be applied, shared or transferred to others (Sfard, 1998). These characteristics from the individual learning metaphor transfer to team learning where learning is viewed as the transfer of knowledge amongst team members generating a static collective outcome where the team acquires, shares, stores, combines, retrieves and applies that knowledge (Edmondson, 1999; Ellis et al., 2003; van Woerkam & Croon, 2009; Zellmer-Bruhn & Gibson, 2006). The depth and breadth of the sharing speaks to the quality of the learning that occurs (Wilson, Goodman, & Cronin, 2007).

A popular concept folded into this view of team learning is transactive memory. Drawing on his research on team performance, Wegner (1987) asserts that memory systems in a team not only involve communication between members, but also include processes of encoding, storage and retrieval. He identifies two parts to transactive memory: one is the aggregate of member knowledge and the other is member awareness of who knows what within the team. As Wegner (1987) states, transactive memory is activated when “one person has access to information in another’s memory by virtue of knowing that the other person is a location for an item with a certain label” (p. 189). Transactive memory can be understood as distributed knowledge and memory that has been socially indexed which can be accessed by team members.

Another popularized concept that fits within this particular view is the shared mental model. Sessa and London (2006) state that a team’s shared mental model is “the convergence of knowledge structures possessed by team members about the team’s task and how group members operate together” (p. 134). Mohammed and Dumville (2001) describe a mental model as “an organized understanding of relevant knowledge that is shared by team members” (p.89). As it pertains to what is shared, Cannon-Bowers and Salas (2001) identified four broad categories of what is shared: task-specific knowledge, task-related knowledge, knowledge of teammates and

attitudes/beliefs (p.22). The shared mental model is based on the team's collective, shared understanding of the context and the situations they encounter.

While these shared knowledge structures support common understanding across the team, they can also be called into question. For example, when shared mental models remain static in a context of change, continue unchallenged, distort understanding or lack contextual appreciation, they can have unintended results. In citing Janis' (1972) concept of 'group think' Weick (1979), points out "[h]aving become true believers of a specific schema, group members direct their attention towards an environment and sample it in a way that the true belief becomes self-validating and the group becomes even more fervent in its attachment to the schema" (p. 52).

The aggregative view of collective learning situates knowledge as static and located within the minds of individuals; it is activated when individual team members share their knowledge. Transactive memory and shared mental models provide examples of ways in which the aggregative view of team learning can be understood. In this view, teams are viewed as more or less static entities that are intended to deliver on predictable outcomes that rely on the repository of individual knowledge which can be shared. While the structures such as transactive memory or shared mental models may help the team deal with new or ill-defined situations or tasks, there is no appreciation for the generation of new collective knowledge or appreciation of contextual influences on the team.

Finally, while shared knowledge and meaning may be antecedent to team changes, such knowledge and meaning does not in itself stimulate collective transformative change within the team as the team as an entity does not exist beyond what the individual members know. In this view, while individual team members may undergo transformative learning, the team itself has no capacity for collective transformation unless all of the individual members have themselves transformed and then individually act and share in such a way as to transform the team.

Team learning as participative activity. Following social constructivist notions of learning, this view of team learning acknowledges that "social knowledge creation is a shared rather than an individual experience" (Prawat & Floden, 1994, p. 37). In this conceptualization, knowledge does not exist in a world of its own or in individual minds, but is an aspect of participation in actions and cultural practices (Lave & Wenger, 1991; Paavola et al., 2004; Sfard, 1998). Within this social exchange, both knowledge and learning are 'situated' within the given context (Brown, Collins, & Duguid, 1989) and shared meaning is shaped and evolves through explicit

and tacit intersubjective negotiations within the group (Ernst, 1999; Prawat & Floden, 1994; Rogoff, 1990).

Following the participation metaphor of individual learning, team learning as participation supports learning as an aspect of participation in actions, discourse and cultural practices (Lave & Wenger, 1991; Paavola et al., 2004; Sfard, 1998). Though acknowledging the criticality of social interactions in support of learning, this view remains premised on the individual who shares and contributes to the larger collective which, in turn, contributes to the learning of the individual. The connections are dialogic and outcomes are born from a mutual/collective understanding and consensus. Team learning as participation also dominates the team learning literature and is particularly noted in intentional collaborative and cooperative team contexts.

A concept related to participative activity is team reasoning. Bacharach (1999) suggests that acting as a member of a team involves not only being guided by the group's objective, but choosing as a team through team reasoning. Expanding on this concept, Musaeus (2012) argues that "team reason presumes a cultural organization that influences how and what teams think about in the form of either paradigmatic knowledge or narrative knowledge" (p. 507). As distinguished from the instrumental knowledge associated with team tasks, "team reason provides a way for teams to critically examine the knowledge and social practices that they create and they are created by" (p. 514). In this way, team reasoning is a collective phenomenon that requires dialogic and negotiative processes that are not normally associated with aggregative collective learning. Beyond team instrumental outcomes, participative learning can support Senge's (2006) "shift of mind" thereby enhancing a group's "collective capacity to create its future" (p.14).

In this conceptualization of collective learning, the focus is on collective knowledge development processes that are embedded in activities such as interaction, discourse, conflict, and practice (Decuyper et al., 2010; Lave & Wenger, 1991; Paavola et al., 2004). There is increased value placed on context and socially normative knowledge sharing and learning. While the focus is on processes, this is not to say that collective learning as participative activity cannot include explicit, planned outcomes. Rather the outcomes of participative activity and productive capacities are defined within the social interactions of the team as opposed to any 'top-down' mandate. Consequently, the outcomes and products may or may not be congruent with organizational expectations. As well, if we assume that the collective learning in which the team

participates includes the joint construction of meaning through sharing and dialogue, Hayes and Allison (1998) note, that this “process is rarely problem free” (p.856). Differing concepts and ideologies can distort meaning.

Team learning as a participative activity extends collective learning beyond shared individual knowledge to include interconnecting dialogue and co-creation within and at the boundaries of the team that allow for team reasoning and meaning making in addressing new or ill-defined problems. The learning focus, however, is on the process; outcomes do not normally extend beyond the team and may not be supportive of organizational goals. As it potentially fosters reflection, there is a greater propensity for teams to have a dialogue about themselves and collective meaning. Consequently, participative learning may support transformative learning, but in itself does not assure that it will occur unless it is implicit or explicit in the team’s interactions.

Team learning as an open system. The third conceptualization of team learning situates teams as open systems. This system’s view expands on traditional I-P-O models of learning. It provides for a more comprehensive, somewhat less linear view of collective learning, but retains conceptual elements of inputs, various mediated activities and processes and outputs. Team learning represented as an open system includes the conceptualizations above as well as cyclical feedback, external influences and mediational factors all of which support better understanding of the work and learning context in which teams are typically immersed. Further, the embedded feedback and potential development of new perspectives support the potential for significant qualitative change and team transformation. Two models have been identified that reflect this conceptualization of the team as an open system: Dechant, Marsick and Kasl’s (1993) open system model of team learning; and Decuyper et al.’s (2010) integrative systemic model of team learning. Each will be discussed below.

Dechant et al. (1993) present an open systems model of team learning shown in Figure 3 that reflects the I-P-O tradition. This model includes inputs and outcomes at the individual, group and organizational level. At the heart of their model are interactive team learning processes that revolve around collective thinking and action (p.7). ‘Thinking’ is the cognitive side of the learning made visible through the collective framing and reframing of the definition and meaning of a situation. ‘Action’ occurs in the form of experimentation and boundary crossing where the team communicates amongst themselves and others. Dechant et al (1993) indicate that thinking

and action often occur concurrently and teams frame and reframe while crossing boundaries and experimenting. The team integrates perspectives by synthesizing and reconciling any views through dialectical discourse rather than compromise or majority rule. The model retains the linearity of traditional I-P-O models and the emphasis is on task and process dimensions that contribute to generative learning processes that contribute to team outputs.

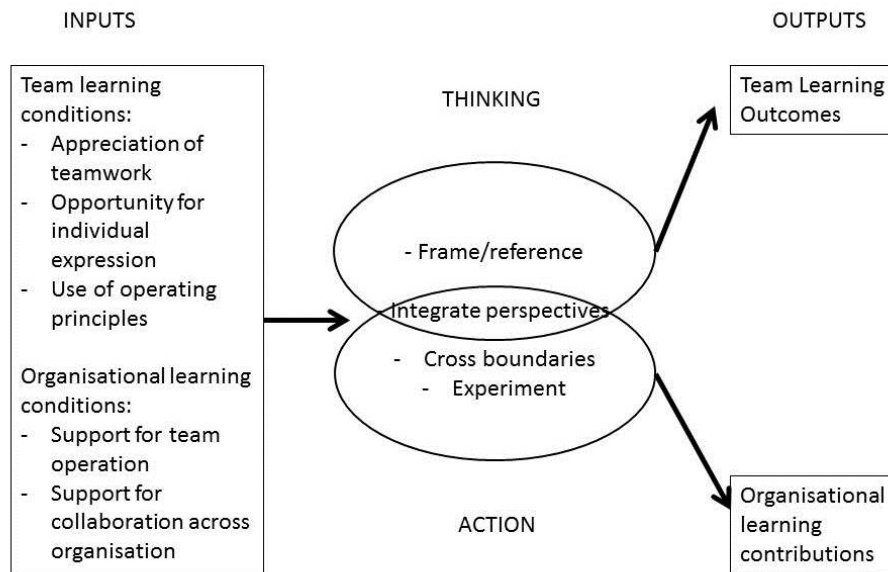


Figure 3. Open system model of team learning (Dechant et al., 1993)

In a follow on paper, Kasl, Marsick and Dechant (1997) expanded on their model including more detailed findings of their research on team-learning conditions and the learning processes in which the team engaged through three stages of learning: fragmented, pooled and synergistic. This latter model and discussion of stages still follows the I-P-O flow. Adaptive and generative learning processes remain associated with instrumental/organizational outcomes. The model incorporates team and organizational learning conditions, though there is limited discussion of the importance of context and how that shapes either the team or the learning processes. Kasl et al. (1997) admit that the model focuses on rational, cognitive learning processes; it does not account for emergent learning and affective interactions that influence a group's capacity to execute these processes. As well, while they acknowledge that "thinking occurs in action" (p.7), there is no discussion of integration of feedback as a result of outputs and outcomes achieved. The focus remains on team outcomes primarily in support of organizational goals. While there is discussion of framing and reframing, it relates to organizational issues and

task-based problems. There is no discussion of such reframing could support team transformation.

The second model that presents the team as an open learning system is Decuyper et al.'s (2010) integrative systemic model of team learning shown in Figure 4. Key components of this model over Dechant et al.'s (1993) are the integration of cyclical feedback and the concept of emergent states. The explicit introduction of a feedback cycle into the process supports team evaluation and reflection. Tied into this cycle is the discussion of emerging states. Marks et al. (2001), state that the emerging states capture the psycho-social dimensions of teams that tap member attitudes, values, cognitions and motivations which become "properties of the team that are typically dynamic in nature and vary as a function of team context, inputs, processes, and outcomes" (p. 357). Dechurch & Mesmer-Magnus' (2010) meta-analysis of team cognition supports that these emergent states occur in transition phases between instrumental actions and serve as opportunities for evaluation and reflection that "captures new construct meaning at the team level that cannot be observed solely based on its individual-level components" (p. 35). It is within these emergent states that teams reflect, evaluate, adapt and create new meaning constructs that offer new possibilities (Dechurch & Mesmer-Magnus, 2010; Decuyper et al., 2010; Hoever, Van Knippenberg, van Ginkel, & Barkema, 2012). Effectively, these emergent states are mediating mechanisms (Decuyper et al., 2010) which are intended to describe the team's overall state in being pre-disposed to learning. In Decuyper et al.'s (2010) model these emergent states grow from team learning processes and directly catalyse or reinforce them.

Decuyper et al. (2010) coalesce the above concepts in their "systemic, cyclical and integrative team learning model that organizes and combines team learning processes, outputs, inputs, catalyst emergent states and time-related variables into a coherent whole" (p. 114). They assert that there are three unique components of this systemic, cyclical model. First, they define eight categories of team learning processes: sharing, co-construction and constructive conflict; team reflexivity, team activity and boundary crossing; storage and retrieval. Second, they include time-related variables which, heretofore, have not been explicit in team learning models. Finally, they include the catalyst emergent states discussed above which contain learning specific variables that do not embody the trajectory or movement itself, but grow from team learning processes and directly catalyse or reinforce them (p.114).

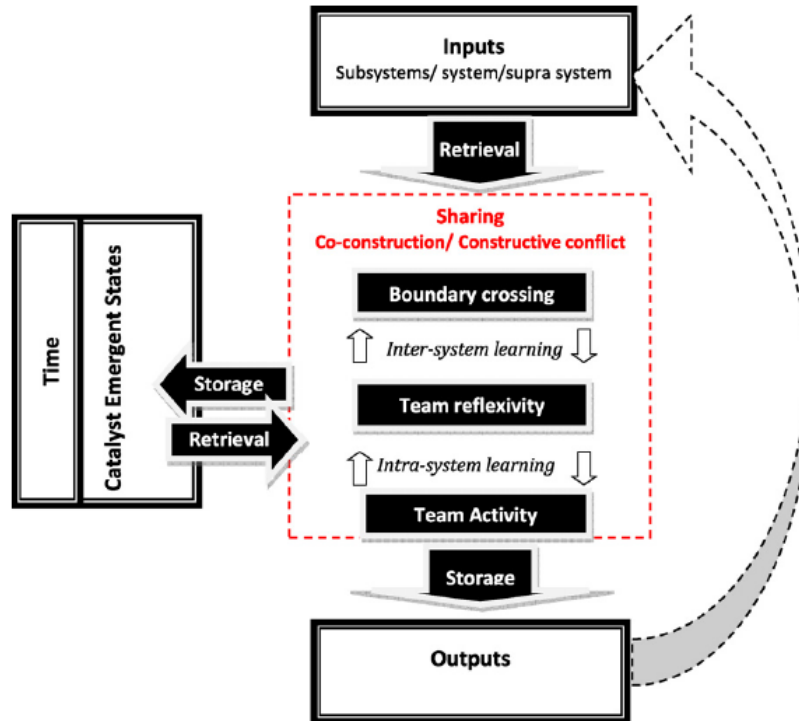


Figure 4. Integrative systemic model of team learning (Decuyper et al., 2010)

Decuyper et al.'s (2010) model appears to be the most comprehensive model to date. Though the model still follows a general linear flow moving from inputs to outputs, they account for cyclical feedback, co-creation of knowledge, and ongoing and concurrent learning activities including non-rational, temporal and emergent dimensions of learning. Decuyper et al. (2010) start to uncover how team learning is enacted through their discussion of team learning processes, though their emphasis is on *what* team learning is occurring rather than explaining *how* team learning occurs during these processes. Moreover, their discussion of emergent states does not suggest any influence on team trajectory (evolution or transformation) or team learning outcomes (e.g. emergence), just on the learning processes themselves. As Kozlowski and Bell (2008) note, “the literature has been far more fascinated with conceptualizing team learning outcomes or emergent states than with processes by which team knowledge is acquired and crystallized” (p. 17).

The open systems models of team learning are helpful in explaining team learning, noting two areas of potential clarification and expansion. First, in an effort to describe a number of variables in team learning, learning processes are conflated with other concepts potentially confusing learning with other team processes. The most visible example is both authors'

references to boundary crossing as a learning process. For example, Dechant et al. (1993) state that “boundaries refer to the intangible but very real lines which separate person from person, group from group, and group from organisation” (p. 9). I agree that boundary crossing is a team activity that may facilitate collective learning, and when new networks are created this inherently involves learning. However, the actual boundary crossing as an activity itself does not constitute learning. For example, teams may boundary cross to merely communicate or influence others and no knowledge is gained in the process. It would be more appropriate to discuss how the learning is enacted during the interactions that occur during boundary crossing activities. In a similar vein, Decuyper et al. (2010) refer generically to ‘team activity’ as a learning process. Indeed, learning is often embedded in team activity and, particularly as implicit informal learning, it may occur in absence of any conscious collective understanding that learning is occurring. However, team activity in itself does not necessarily constitute learning. For example, team activity may involve stable processes where there are regular ongoing functions that involve no learning, merely work and interactions where no new knowledge is introduced into or generated by the team.

A second concern rests with the abstract phrase ‘emergent states.’ Emergence is a concept stemming from complexity science and evolutionary theory that suggests that all things are viewed as mutually dependent, mutually constitutive and emerge together in dynamic structures. No clear lines of causation or human intention can be traced from these interactions to their outcomes (Davis and Sumara 2008; Fenwick, 2012; McMurtry, 2008; Osberg and Biesta, 2007). Decuyper et al. (2010) indicate that these emergent states “do not embody the trajectory or movement itself, but are closely connected to the team learning process, since they grow from team learning processes and directly catalyse or reinforce them” (p. 114). Marks et al. (2001), state these emergent states capture the psycho-social dimensions of teams but do not constitute learning themselves. In both references, the use of the term ‘emergent’ refers to the ‘state’ of the team and does not appear to appreciate that the team members, the team itself and the learning can all be emergent within the collective. The learning processes are intertwined with other team activities and the outcomes are often uncertain until they become visible or evident. Emergence implies a trajectory, though not necessarily unidirectional (McMurtry, 2008). However, that trajectory may not necessarily be aligned with organizational or team expectations as it is unpredictable and uncertain. While the introduction of emergent states

provides insight into the complexity of the team dynamic itself, it stops short of a richer discussion of team learning and emergence. In the case to be studied for example, there are indications that much of their learning is emergent as they create “revised and new patterns of interaction” (Sessa & London, 2008, p. 7) investigating and mitigating the activities of sophisticated threat actors.

The open system models discussed capture a more comprehensive view of team learning though they continue to represent team informal learning as a relatively linear flow from input to outputs/outcomes in support of organizational/instrumental goals. This tendency to view team learning as additive and linear, implies a forward trajectory towards expected team outcomes that may simply not reflect the reality; learning does not necessarily occur in uniform steps or stages, through linear additive building block sequences (Gersick, 1988). As well, from the social constructivist perspective, they are limited in capturing teams as social entities openly interacting and learning with and from other entities within and outside of their organizations. While they discuss various activities that may support team learning, their representations do not appear to capture the complex nature of both team learning processes and outcomes at the collective level of analysis. Moreover, acknowledging that the concept of ‘emergent states’ contributes to our understanding of team dynamics or attributes, how it actually influences team learning processes or outcomes remains abstract. Both of these models introduce new concepts into team learning discourse. In the end, however, there remains the need to elaborate on how team informal learning occurs and how it is enacted at the collective level of analysis.

Team as complex learning systems. Finally, within the breadth of theory and research related to workplace teams, a relatively new appreciation has emerged that situates teams as complex adaptive systems that learn and demonstrate team traits and capacities that are qualitatively different and go beyond the aggregate traits and capacities of the individual members (Arrow, McGrath, & Berdahl, 2000; Kozlowski, et al., 2013; Mathieu et al., 2008). In this sense, team traits equate to those characteristics or attributes that are visible within the collective, but are not necessarily evident at the individual level. As discussed in my introduction, these are often stated in terms of behaviours displayed by the collective. For example, a team as a plural subject may be described as fastidious and tenacious; even if each of the members may not be described as such. The collective works in such a way as to demonstrate

these qualities. Further, these traits may trigger or drive learning within the collective and, more importantly, may help influence how a team learns.

In viewing teams as complex learning systems, individual team members are seen at the micro level of experience within the team interacting with various settings and entities to which they are exposed. Referencing Prigogine and Stengers (1984) seminal work *Order Out of Chaos*, Karpiak (2000) relates this systems view asserting that living systems, including human beings and related social systems, are open systems in constant interaction with their environment. As part of this open, social system, the work team is at the meso-level of experience, interacting with and responding to the larger organizational (exo) and societal (macro) systems while including its members as micro-level sub-systems. This view places the team at intersection of the micro and exo/macro, interacting with both individual and organizational entities where there are multiple emergent phenomena which Kozlowski et al, (2013) state can provide a “rich slice of organizational life” (p. 591).

Borrowing from Garavan and Carberry’s (2012) description of collective learning, team informal learning can be understood to be “generally conceptualized as a dynamic and cumulative process that results in the production of knowledge. Such knowledge is institutionalized in the form of structures, rules, routines, norms, discourse, and strategies that guide future action” (p. 451). However, to consider the team as a system or entity that learns requires us to recognize that the “sum of individual learning does not equate with the collective level of analysis” (Garavan & McCarthy, 2008, p. 451). Primarily seen in terms of process interactions, team informal learning is embodied in the team’s activities and revealed in its artefacts. This conceptualization supports the view that collective learning emerges from and through social interactions and synergies (Hollan, Hutchins, & Kirsh, 2000; Garavan & Carbery, 2012) where the learning creates “possibilities that emerge at the level of the system as a whole” (McMurtry, 2008, p. 267). Of note, however, learning may not be ‘visible’ to all members and all members may not fully comprehend or agree with all aspects of what is being learned and subsequently enacted by the team (McMurtry, 2010). More specifically, while knowledge may emerge within the group, it may not be realized or acknowledged by individuals at all. For example, as a team adapts to a new situation, there may be adjustments by the team that implicate some, but not all members. Alternatively, as is often seen with cultural changes, the changes over time are so subtle that they go unnoticed at the individual or group level.

This line of thinking of teams as complex learning systems is relatable to social constructivist understanding of learning as emerging from social interactions, but goes beyond it. As noted by McMurtry (2008):

complex systems can be seen as a learner that emerges through the interactions of its component parts (which can themselves be seen as smaller scale complex, learning systems) and in relation to its environments (which can be seen as larger scale complex, learning systems). A company or academic discipline, for example, can be understood as a collective learner that emerges from the interactions of the people who compose it – and that is itself embedded in larger social organisms such as the education system or the economy. (p. 269)

Similarly, a team can be seen as a complex learning system and, as such, suggests potential for these ongoing interactions to result in teams emerging, renewing or even evolving and transcending themselves. Moreover, as teams learn, work and interact, they influence and are influenced by their sub-systems (team members) and influence and are influenced by the larger system (the organization) within which they are nested.

One model which captures the essence of teams as complex learning systems is Engstrom's (1999) expansive learning cycle as shown in Figure 5. While initially intended as an alternate view to Nonaka and Takeguchi's (1995) conceptualization of organizational learning, he derived his cycle from observation of organizational problem-solving teams. Within the context of his study, the teams were intentionally brought together to solve problems and were consciously engaged in learning about the problem. In this spiral of expansive learning, there is an ongoing dialogue within the team that includes questioning, reconciling contradictions, modeling the new solution, generating and implementing the refined model, reconciling remaining contradictions and consolidating the model into new practice. This expansive learning cycle supports questioning, ongoing dialogue and modeling activities as emergent and the result of group activity. It provides insights into how team informal learning occurs and integrates various contextual elements including organizational influences, contradictions and conflict that may arise in team deliberations. Notably, his research focused on deliberate learning during explicit problem solving activities to achieve specific organizational outcomes. Moreover, the 'expansive' suggests that there is an marked 'increase' in knowledge as a result of the learning and positive resolution of the problem investigated. This may not be the case. Learning may not

always result in an increase in knowledge, but may simply connote a change in perspective. Consequently, there remains an opportunity to look more concretely at the mix of implicit, reactive and collective informal learning in a natural work team environment that includes but is not restricted to positive organizational outcomes.

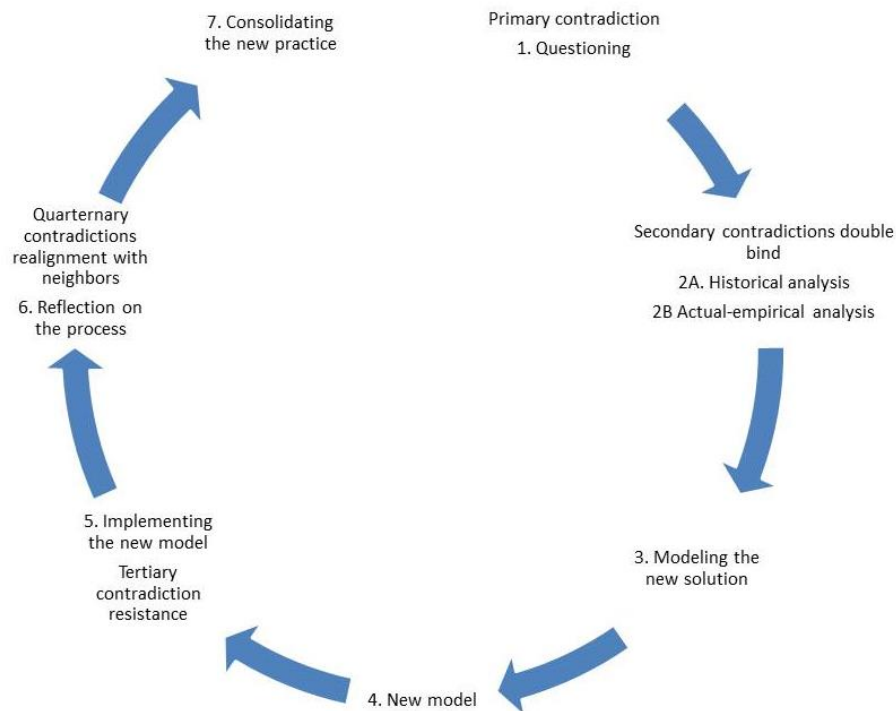


Figure 5. Engestrom's (1999) sequence of epistemic action in the expansive learning cycle

With the conceptualization of teams as complex learning systems, there are nuanced differences in how learning occurs relative to other conceptualizations. For example, when viewing teams as complex learning systems, it is understood that they are embedded in a context that will influence the team. McGrath, Arrow, & Berdahl (2000) report that few studies have been conducted in real context and often tended to treat groups as though they were simple, isolated, static entities. The degree to which context can have an influence on collective learning and outcomes has been well established (Clarke, 2010; Edmondson, 1999; Ellis, et al., 2003; Silberstang & London, 2009). Yet as Yorks, Marsick, Kasl and Dechant (2003) note, models of learning tend to be generic and decontextualized and that culture is “a critical contextual element that can have an inhibiting effect on the learning process” (p.104). Indeed, Hayes and Allison (1998) suggested that the team learning process may be fraught with structural, political or cultural issues that could significantly influence and even impede learning. The three predominant conceptualizations and related models, for example, are limited in the way they

capture the context in which the learning occurs and how the team is influenced by and influences the organizational context. These important contextual elements should therefore be considered in framing team learning. Teams viewed as complex learning systems are always integrated into and interacting with local and organizational culture.

With few exceptions (Arrow, McGrath & Berdahl, 2000; Janus, 1970; Sessa & London, 2006) another common theme of team learning concepts and models is the overly positive orientation and emphasis on the ideal where teams are often formed and situated as beneficial to the organization. The majority of the authors emphasize team reflection with the overarching assumption that these activities will result in improvements that produce organizationally positive outcomes. However, a team works within an organization and in a social reality where processes of interaction and negotiation exist that are not necessarily part of the rule-bound and concrete world of the functional structure established by the organization (Murray & Blackman, 2006). As well, team activities can be impaired by structural, political, or cultural factors which can highly influence the content, type and extent of team learning that may occur. Reinforcing this, London and Sessa (2006) state that the “interrelationships between individuals, groups and organizational learning are not necessarily mutually supportive” (p. 205). The totality of the team learning cannot be fully comprehended. Moreover, team learning may not necessarily be seen or interpreted as a positive force within the team, nor fully appreciated by the organization. In short, the overly positive orientation associated with most conceptions of team learning is problematic in that it ignores learning that may be occurring simply because it is not congruent organizational interests or expected outcomes.

Finally, the tendency to view team learning as additive and linear is echoed in the other conceptualizations. As noted in group development studies (Gersick, 1988), teams do not learn and develop in uniform steps or stages, through linear additive building block sequences; learning is not necessarily ‘continuous and cyclical’ as suggested.

Viewing teams as complex learning systems appreciates learning as a phenomenon in terms of multi-level processes and emergent outcomes where the team is embedded in a given context. It therefore includes context, does not suffer from positive or negative orientation based on a set value determined by the organization, and avoids viewing learning as additive or linear. Teams as complex learning systems, however, lacks substantive basis in research and lacks clarity and concreteness as a conceptualization.

Typology of team learning. As a final topic within the discussion of collective learning, Sessa et al.'s (2011) typology distinguishes between adaptive, generative and transformative collective learning. Their construct ties processes and outcomes together to provide a helpful framework to discuss team informal learning. They note, however, "that adaptive, generative, and transformative learning processes can occur at different times within the same group, and some behaviors and interactions may have elements of each process" (p. 150).

They describe adaptive learning as a process where the team reacts to stimuli from their organizational surroundings. These can include physical, cultural, practical, political, procedural or regulatory changes which "inform them about the new way to negotiate and get their work done" (p. 149). This type of learning can be conscious or unconscious and adoption or change tends to be incremental and aggregative driven primarily by the stimuli. They describe generative learning as proactively and intentionally applying new skills, knowledge, behaviors, and interaction patterns to improve the team's performance. Seen primarily as a conscious and participative process, the team participates in questioning, exploring alternatives, evaluating, and reflecting on actions that result in learning and change to achieve team goals. Finally, they describe transformative learning as:

re-shaping or altering the team's purpose, goals, structure, or processes...transformative learning requires experiencing disorientation and then reorientation for an entirely new direction for growth. This reorientation produces a new team structure, strategy, goals, and identity. (p.149)

As the focus in this study is on how collective informal learning is enacted within authentic work teams, the typology discussed above provides a foundation for discussing team informal learning processes and outcomes. It is also useful to distinguish the various types of collective learning that might be implicated in workplaces and brings focus on team learning at the team level of analysis.

Summary. In the discussion of collective learning, key distinctions are noted between societal, organizational, group and team level of analysis. These distinctions are central to appropriately bounding the discussion of team learning. Unlike other collectives, a team is a unique, social entity at the meso-level of analysis within an organization that is formed for specific tasks in support of organizational goals. The team interacts within the larger socio-cultural contexts within their organization and society. While a variety of definitions have been

proposed for team learning, this study borrows from the past to define team informal learning as contingently formed patterns of understandings and interactions within practical and situated activities where learning is discovered and generated together. This learning results in changes to the collective cognition evident in team activities, artefacts and other outcomes.

As mentioned, team learning is predominantly viewed as: aggregation of individual knowledge; participative activity; or an open system. While the more recent concept of teams as complex learning systems shows promise in helping to explicate team informal learning processes and emergent outcomes, there appear to be no expansions on this conceptualization found in the research that have been applied at the collective level of analysis for dynamic work teams in authentic work settings. This needs to be addressed if we are to come to a better understanding of team informal learning. As well, this study is also investigating the potential for collective transformative learning in the work team. Consequently, Sessa et al.'s (2011) typology may be helpful as it considers both team informal learning processes and outcomes in terms of adaptive, generative and transformative learning. The next section will provide an overview of the literature on transformative learning elucidating on areas of relevance to this study.

Transformative Learning

In the study of collective learning, there is a small, emerging area related to collective transformative learning that is also applicable to teams. There have been a few broad references to transformative learning in team studies literature. The degree to which these references align with the scholarly definitions of transformation is debateable. There is considerable hyperbole around the transformative learning phenomena yet, with regards to collective transformative learning very limited research. In this section, I will discuss Mezirow's transformative learning theory, distinguish transformative learning from other aspects of collective transformation such as organizational transformation and transformational leadership. I will then focus the remainder of the literature review on the application of transformative learning theory in group settings such as teams and close with a critical summary. In the end, it is hoped the reader will come to understand the need for additional theoretical expansion and research of collective learning and the potential for that learning to contribute to a team's transformation. Readers will note that I use transformative and transformational interchangeably often based on the author or reference used. For the purposes of this study, they are synonymous.

Mezirow's transformative learning theory. One of the questions in this study specifically intends to address how Mezirow's theory of individual transformative learning contributes to our understanding of how transformative learning may occur at the collective level within an authentic work team. Given this scope, the following will outline Mezirow's transformative learning theory and perspective transformation.

Through its 30 plus years, transformative learning theory has become one of the most influential theories in adult education (Choy, 2009; Merriam & Bierema, 2014). Closely linked with psychology and developmental theory, it was not until Freire's (1970) *Pedagogy of the Oppressed* and Mezirow's (1978) *Perspective Transformation*, that transformational learning achieved the status of a major theory of adult learning (Merriam, 2001). Considered the founding father of transformative learning (Franz, 2010), Mezirow supported a theory of adult learning which was influenced by Freire's (1970) conscientization and Habermas's (1971) domains of learning. Rooted in the constructivist world view, Mezirow's initial work was in response to the pervasiveness of behaviourism within the educational community at the time. In his article *A Critical Theory of Adult Learning and Education*, Mezirow (1981) states that "this misconception has become so pervasive that the very definition of education itself is almost universally understood in terms of an organized effort to facilitate behavioural change" (p.17). He suggests that the empirical, behaviourist tradition is likely sufficient where education is intended to modify behaviour such as competency-based education or skill training. However, it is when educators use this approach for social interaction – including the educational process - and perspective transformation that it has been "wrong and generally ineffectual" (p.18).

A central point in Mezirow's theory is that it shows "how we are caught in our own history and are reliving it. We learn to become critically aware of the cultural and psychological assumptions that have influenced the way we see ourselves and our relationships and the way we pattern our lives" (Mezirow, 1978, p. 101). To distinguish the difference between learning and transformative learning, Mezirow (1991) described learning as a process where one "uses prior interpretation to construe a new or revised interpretation of the meaning of one's experience in order to guide future action" (p. 162). He defined transformative learning as "learning that transforms problematic frames of reference to make them more inclusive, discriminating, reflective, open and emotionally able to change" (Mezirow, 2009, p. 22). He discusses two paths

for this process, sudden insight or a series of transitions, either of which causes an individual to reassess and resituate assumptions about oneself and/or others.

Mezirow's transformative learning theory has evolved since inception, but at its core is the concept of perspective transformation which emphasizes critical reflection of, and rational discourse about our taken-for-granted frames of reference or meaning perspectives. Stimulated by a disorienting dilemma, transformative learning requires that previously uncritically assimilated assumptions, beliefs, values, and perspectives are questioned and thereby become more open, permeable, and better validated (Mezirow, 1991, 2000). Mezirow (2012) asserts that we transform our problematic frame of reference to make it more dependable through discourse by generating opinions and interpretations that are more justified (p. 12). We then use the transformed frame of reference to act differently in the world (Cranton & Roy, 2003, p. 88).

The process of perspective transformation often occurs in some variation of the following: a disorienting dilemma; self-examination with related feelings of guilt or shame, sometimes turning to religion for support; critical assessment of assumptions; recognition that one's discontent and the process of transformation are shared and that others have negotiated a similar change; exploration of options for new roles, relationships, and actions; planning a course of action; acquiring knowledge and skills for implementing one's plan; provisionally trying out new roles; renegotiating relationships and negotiating new relationships; building of competence and self-confidence in new roles and relationships; and reintegration into one's life on the basis of conditions dictated by one's perspective (Mezirow, 1994/2012).

Definitional issues of transformative learning. The subject of significant critique and expansion, the discourse on the various theories and conceptualizations of transformational learning continue to evolve toward a more holistic theory of adult learning (Baumgartner, 2012; Illeris, 2004; Mezirow, 1996; Taylor, 1998; Taylor & Cranton, 2013). Despite the preponderance of scholarly work, there has been growing criticism and concern regarding the lack of theoretical progression (Taylor & Cranton, 2013). Various scholars have called for a most robust exploration and expansion of transformative learning theory and how multiple ways of knowing relate to transformation and change (Taylor, 1998; Taylor & Cranton, 2013; Yorks & Kasl, 2006). Research and other scholarly work continues to grow exponentially (Taylor & Cranton, 2013) and the discourse on the various conceptualizations of transformational learning continue

to evolve toward a more holistic theory of adult learning (Mezirow, 1996; Illeris, 2004; Taylor, 1998).

Taylor (1998) notes that the various conceptions of the transformational learning process make it difficult to provide a singular definitional outcome. Transformative learning theory is a humanist and constructivist conceptualization (Taylor & Cranton, 2013). Distinguished from learning that is the result of normal or expected developmental, organizational, or socio-cultural changes (Taylor, 2007), transformative learning theory is about learning and the processes that contribute to and result in significant change (Clark, 1993; Illeris, 2013; Segers & de Greef, 2012; Taylor & Cranton, 2013).

While this study largely references Mezirow's process of perspective transformation and the related transformative learning theory, there are other conceptualizations of transformative learning such as: Freire's (1970) socio-economic emancipation and process of conscientization; Daloz's (1986) developmental transformation; Boyd's (1991) psychoanalytic process of individuation; and Dirx's (2001) transformation as 'soul-work'. In addition to the different conceptualizations, there are a range of interpretations of the outcomes. As discussed, some refer to simply significant, qualitative change (Illeris, 2013). Others suggest that transformative learning can result in a more complex, qualitative and even intuitive change which acknowledges the interconnectedness of all things and produces a sense of responsibility to a wider reality (Clark, 1993; Dirx, 1998). The transformation entails the unfolding of human potential towards and through deeper understanding, wisdom and effectiveness in the world (Cook-Greuter, 2004). Clark (1993) states, transformative learning "shapes people; they are different afterward, in ways that both they and others can recognize" (p. 47). While evidently a significant change in one's life and view of the world, Merriam (2004) notes that studies have shown that some "transformed their perspective without being aware of the change process" (p. 66).

Distinguishing transformative learning from informational learning, Kegan (2000) states that information learning as that "aimed at increasing our fund of knowledge, at increasing our repertoire of skills, at extending already established cognitive capacities into new terrain serves the absolutely crucial purpose of deepening the resources available to an existing frame of reference. Such learning is literally in-form-ative because it seeks to bring valuable new contents into the existing form of our way of knowing" (p.49). Transformative learning, on the other hand, changes what we know in that "we change the very form by which we are making our

meaning” (p. 53). Lange (2004), suggests this change is not only epistemological; “it is also an ontological process where participants experience a change in their being in the world including their forms of relatedness” (p. 137). To be sure, there are various descriptive outcomes, they all, however, tend to be broad statements that are heavily subjective.

Suffice to say that despite the extensive literature on the topic there remain various conceptions and definitional issues associated with transformative learning (Taylor, 1998). Research that contributes to the theoretical discussion, enriches the understanding and helps refine the definition would be welcome (Taylor, 1997/2007; Traylor & Cranton, 2013). In addition to the definitional issues surrounding transformative learning, a variety of disciplinary literature sources discuss transformation as a collective phenomenon, the transformation of work, and as a style of leadership that need to be distinguished from transformative learning.

Concepts related to transformation within organizations. The term ‘transformation’ is used in many ways within the contemporary academic and management literature. Within the human dimensions of work, it has been applied to individuals, groups and organizations. It is therefore important to distinguish transformational learning discussed in this case from three other concepts: transformational organizational change, transformation of work, and transformational leadership.

Watkins, Marsick and Faller (2012) note that theories of transformative learning and theories of transformative organizational change arise from different disciplines with different purposes and processes (p. 375). Watkins et al. (2012) describe transformative organizational change where top-down goals and directions for change are designed by the change leaders and then spread down and are implemented within the organization. While described as transformative organizational change, their multi-level model discusses facilitating transformative learning and organizational change focused on organizational goals with interventions at the strategic, social-organizational, group and individual levels.

Henderson (2002) also distinguishes between individual transformative learning and organizational transformative change. He indicates that organizational transformation requires altering the basic elements of an organization’s culture including norms, values and assumptions under which the organization functions (p. 189). Highlighting the difference, he suggests that the two can be complementary as “both perspectives can contribute to a more holistic and effective approach to change in organizations” (p. 187); one at the personal level and another at the

organizational level. This explanation can apply equally to the team level as the team is distinct social entity within the organization. As well, he notes that organizational change can stimulate transformative learning within an individual and that the transformed individual may influence organizational transformative change.

A key issue is that the organizational transformative change to which Henderson (2002) and Watkins et al. (2012) refer does not arise from within based on a collective realization on the need for change. Rather, it is influenced by leader defined goals and processes, and individuals and groups become change agents (Watkins et al., 2012) intended to support the organizational transformation. While a multi-level change phenomenon, there is no insight provided to how sub-systems, such as teams, within an organization would also collectively change. Rather the general assumption is that individuals within these types of collectives change and transform as part of the organization.

A more specific form of organizational transformation may be visible at multiple levels – the transformation of work. Transformation of knowledge, experience, products or related processes is often discussed in team literature (see Bell, Kozlowski & Blawath, 2012). However, this speaks to transformation of organizational artefacts or work, not transformation of the team itself. Echoing Henderson's (2002) earlier suggestion, the two may be interrelated, but they are not synonymous.

Another popular concept that should be distinguished from transformative learning is transformational leadership. Transformational leadership is seen as a style of leadership focused on stimulating organizational, group and individual change. Bass and Riggio (2006) describe transformational leaders as:

...those who stimulate and inspire followers to both achieve extraordinary outcomes and, in the process, develop their own leadership capacity...help followers grow and develop into leaders by responding to individual followers needs by empowering them and by aligning the objectives and goals of the individual followers, the leader, the group and the organization. (p. 3)

Noting the low level of trust from employees or society at large, Caldwell et al. (2012) promote a redefinition of transformational leadership as “ethically based leadership model that integrates a commitment to values and outcomes by optimizing the long-term interests of stakeholders and society and honoring the moral duties owed by organizations to their stakeholders” (p. 176).

This definition aspires to provide for a virtuous, socially-aware leader whose actions are more congruent with larger societal goals. However, the degree to which the organizational groups, teams or employees are transformed as a result of the leader's activities is not determined.

Trust seems to pervade the discourse in team learning and transformative learning. Whether a component of the organizational leadership, manager - team dynamic, or distributed leadership within the team, trust, particularly at the collective level of analysis, appears to significantly influence learning as it underpins willingness to communicate and work together (Braun, Peus, Weisweiler, & Frey, 2013; Edmondson, 1999; Lee, Gillespie, Mann, & Wearing, 2010).

Weiner (2003) more concretely links transformational leadership with transformative outcomes. He suggests that transformative leadership is "an exercise of power and authority that begins with questions of justice, democracy and the dialectic between individual accountability and social responsibility." He asserts that it is "the responsibility of transformative leadership to instigate structural transformations at the material level that reflect a new hegemony" (p. 89). In this regard, his focus is to direct leaders' attention to questions of meaning such as: 'opportunity for what?'; 'learning for what?'; or 'power for what?' Such questions are intended to have transformational leaders engage in critical discourse, assume more personal and social accountability for their decisions as well as the role of their organizations and the employees. The focus, however, remains on the leader. Within transformational leadership, organizational, group or individual transformative outcomes, if they occur, are largely seen as a function of the leader's influence and is therefore defined in those terms. However, there may be personal, team or group transformations that may not be congruent with the intentions of the leader.

As a style of leadership, transformational leadership is focused on how leaders lead. While there are some assumptions that transformational leadership will result in changes at the organizational, group, or individual levels, the emphasis remains on leader actions and aligning organizational, group and individual efforts towards leader defined goals. In the end, however, significant qualitative change connoting transformation may not occur at any level despite the leader's intentions.

In summary, organizational transformation, transformation of work and transformative leadership are topical concepts within a diverse body of literature. As they contain 'transformation', there is often confusion on the relationship and the concepts become conflated.

They may be complementary and, depending on the level of analysis, they may be intertwined within the social realities of the workplace. However, to be clear, organizational transformation and transformative leadership are distinct concepts from Mezirow's transformative learning theory. Further, they are not within the scope of this research. With a clearer picture of what is out of scope, the following will focus on the discussion of transformative learning theory and its applicability to work teams.

Key criticisms addressed by this study. A popular theory within adult education, there are nonetheless a number of criticisms of Mezirow's transformative learning theory. Relevant to this study are:

- the is criticism regarding the emphasis on the cognitive rational process, ignoring the affective, emotional, and social context (Clark and Wilson, 1991; Cranton & Roy, 2003; Dirkx, 1997; Taylor, 1997); and
- the criticisms that the theory focuses on the unified self with minimal consideration socio-cultural influences or the potential for group transformation (Brookfield, 2001; Merriam, 2004).

Within this study, the workplace presents a unique socio-cultural context from which to explore transformative learning and as well as its applicability to groups.

To address the first criticism, Mezirow (2012) notes that our meaning perspectives, also referred to as mind sets or habits of mind, involve cognitive, affective, and conative dimensions, which selectively shape and delimit perception, cognition, feelings and disposition by predisposing our intentions, expectations and purposes. While potentially emancipatory, Mezirow's transformative learning theory is neutrally situated and emphasizes the process which includes critical reflection, change in perspective and ensuing action – it is not specific on the emancipatory effects nor does it suggest what assumptions are challenged or what perspectives are changed (Brookfield, 2001; Mezirow, 2012). Mezirow acknowledges that the assumptions upon which our meaning perspectives may be predicated are epistemological, logical, ethical, psychological, ideological, social, cultural, economic, political, ecological, scientific or spiritual or they may pertain to other aspects of experience (Mezirow, 2012, p. 85). Accordingly, there is potential for a wide-range of transformative learning situations within various contexts. In this case, the workplace is the setting which can provide a rich affective, emotional and social context (Boud & Garrick, 1999; Illeris, 2013) in which to explore transformative learning.

To address the second point of criticism, Mezirow (1978) recognizes the social aspects of transformation stating that “pluralism must be highly valued for it assures us of the availability of alternative ways of seeing, of multiple realities from which to choose” (p.106). He suggests that “[m]oving to a new perspective and sustaining the actions which it requires is dependent upon an association with others who share the new perspective” (p. 105). Mezirow also acknowledges that the process of perspective transformation can be individual, group or collective (Mezirow, 1989). While referencing group or collective perspectives he does not expand on how it applies and there has been very limited exploration of this in subsequent research. Accordingly, there is impetus to further investigate collective transformation particularly within the workplace.

Transformative learning in the workplace. The discourse around transformative learning has been situated in and predominantly influenced by formal higher education settings, “with little exploration in non-formal educational settings” (Taylor, 2007, p. 175). As presented, one context with tremendous potential for transformative learning is the workplace. Most conceptualizations of learning at work have been concerned with performative or instrumental outcomes with the emphasis on organizational requirements (Fenwick, 2004; Marsick, 1988). Boud and Garrick (1999) and Illeris (2013) note that work places physical, emotional and cognitive demands on us often becoming a significant part of our identity and consciousness. Further, personal goals can be integrated with organizational goals, so work may be a source of transformation within our working and personal lives (Billett & Somerville, 2004; Engstrom, 2001; Felstead, Fuller, Jewson, & Unwin, 2011; Fuller & Unwin, 2003; Matthews, 1999). As Merriam and Bierema (2014) point out, “though not often intentionally planned for, the workplace can also be a site for transformative learning” (p. 92). The increasing interest in the workplace as a context for transformative learning is therefore not surprising (Brooks, 2004; Choy, 2009; Diduck, Sinclair, Hostetler, & Fitzpatrick, 2012; Franz, 2010).

Despite the increasing interest, there have been limited studies relating to transformative learning experiences in work settings other than post-secondary institutions. There also appears to be no research investigating transformative phenomena in authentic, unfacilitated work contexts. For example, Choy’s (2009) study of worker-learners enrolled in a Graduate Certificate in Education were provided specific learning tasks that “tested existing assumptions and expectations (habits of mind, meaning perspectives, and mindsets) through reflective thinking,

reflective discourses, and reasoning that challenged them to change their perspectives” (p. 82). Chang, Chen, Huang & Yuan’s (2012) study of international service workers used “structured and deliberate review of a significant event” to encourage reflection (p. 263). Similarly, Franz’s (2005) research of intra-organization cross-profession partnerships featured facilitated discussions. Other studies (Diduck, Sinclair, Hostetler, & Fitzpatrick, 2012; Franz, 2010) reviewed extant literature to support transformative learning in the workplace. Given the potential for work itself to be transformative (Illeris, 2004; Merriam & Bierema, 2014), research in authentic, unfacilitated contexts is warranted.

Collective transformative learning. As noted, another criticism is that studies have focused on a single, often retrospective snapshot of the individual transformative experience with limited attention on cultural influences and applicability to groups (Baumgartner, 2001; Cranton, 2006; Servage, 2008). Recent research (Choy, 2010; Kasl & Elias, 2000; Yorks & Kasl, 2006) supports transformation in collective settings, but collective transformative learning remains under-conceptualized (Servage, 2008) and under researched.

Similar to the literature related to collective learning, some of the underpinning concepts that support collective transformative learning reach back over century. Returning to Durkheim’s (1858-1917) work, he describes collective consciousness as the “totality of beliefs and sentiments common to average citizens of the same society” that “forms a determinate system which has it (sic) own life” (Durkheim 1893/1964, p. 38). These collective beliefs and sentiments exist “independent of the particular conditions in which individuals are placed; they [individuals] pass on and it remains” (p. 80). Using examples from societal, political, and religious experience, he notes that there were situations and contexts where there was intentional influence on beliefs and behaviours such as schools, churches, and prisons. However, the development of this collective consciousness was largely non-rational or unconscious occurrence as individuals became part of a social community. He references not only the existence of such collective knowledge, but he points to how this is achieved: “We speak a language that we did not make; we use instruments that we did not invent; we invoke rights that we did not found; a treasury of knowledge is transmitted to each generation that it did not gather itself, etc.” (p. 146). In this, his concepts highlight how the significant social and perhaps transformative change becomes evident within collectives in social discourse, symbols and materials, often unconsciously.

Though the collective Durkheim describes is two levels of experience removed from the team learning within this study, his concepts help us to appreciate how collective consciousness and belief systems can change. Relevant to collective learning as well, it is meaningful in that we appreciate the transformative changes that have occurred or are occurring within Canadian society such as perspectives on smoking, marriage, and human impact on the environment. This underpins the concept of collective transformative learning and provides a means to help demonstrate how perspective transformation may occur at any level of analysis within an organization.

A more contemporary scholar who also expanded our understanding of social knowledge and collective consciousness is the educator, philosopher Paulo Freire (1921-1997). Freire's Freire (1970) seminal work *Pedagogy of the Oppressed* is offered from a critical pedagogy perspective and introduces an educational process that supports liberating and emancipatory effects as learners come to see themselves differently within their world through the process of conscientization or consciousness-raising. This represents the development of the awaking of critical awareness (Freire, 1974/2005, p. 15). While the transformation first occurs at the individual level, the expectation is that they will act to transform their world thereby influencing social change (Taylor, 1998, p. vii).

Acknowledging complexity and emergence, Freire (1974/2005) emphasizes that the human and historical-cultural world are not 'finished' but the two come together as unfinished products in a permanent relationship in which humans transform the world and undergo the effects of their transformation (p. 131). Human beings are beings 'with the world' and 'in-a-situation' and, therefore, humans cannot be apprehended without these relations. They are beings who work and transform the world, beings of "praxis", of action and of reflection (Freire, 1974/2005, p. 93). Fundamental to Freire's conscientization is that realizations and transformative shifts occur in individuals, but they do not occur in isolation; a change in one or a few can affect the many. In his view, individual transformation is therefore antecedent to collective change.

As discussed, Mezirow (1978) also recognizes the social aspects of transformation stating that "pluralism must be highly valued for it assures us of the availability of alternative ways of seeing, of multiple realities from which to choose" (p.106). He suggests that "[m]oving to a new perspective and sustaining the actions which it requires is dependent upon an association with

others who share the new perspective” (p. 105). And, as previously discussed, he acknowledged that the process of perspective transformation can be individual, group or collective (Mezirow, 1989). As his focus was on the perspective transformation and the transformative process of individual, adult learner, he did not elaborate on his theory for collectives, he nonetheless acknowledged the potential.

While not specifically discussed in terms of complexity, these authors all recognize a collective consciousness and how it can change. Referring back to the previous description of complexity and emergence, complex systems embody possibilities exceeding the sum of their components and possibilities emerge at the level of the system as a whole (McMurtry, 2008). Again, borrowing from Karpiak (2000), envisaged as a complex system, a collective can transcend itself and emerge as an entity that is “always becoming”, always a “work in progress”, destined to change and grow. Indeed it is accepted that collective social systems create new meaning constructs that offer new collective possibilities that otherwise might not have been realized; this, at least conceptually, has been applied to groups and teams (Arrow, McGrath, & Berdahl, 2000, Davis & Sumara, 2008, Dechurch & Mesmer-Magnus, 2010; Decuyper, Dochy, & Van den Bossche, 2010; Hoever, Van Knippenberg, van Ginkel, & Barkema, 2012).

The work of Durkheim and Freire, coupled with Mezirow’s acknowledgement of collective transformation, form needed theoretical underpinning for collective transformation. Collective transformation is also potentially an outcome as a complex system learns and emerges into something else. More recently, there has been greater interest in transformative phenomena in and through participation in groups (Boyd, 1991; Choy, 2009; Kasl & Elias, 2000; Illeris, 2013; Scribner & Donaldson, 2001; Yorks & Marsick, 2000; Yorks & Kasl, 2002). The following provides a critical analysis of four research efforts.

First, Kasl and Elias’ (2000) discussion of transformative learning in an organizational change effort uncovers changes in structure and group consciousness stressing the importance of “discernment [and] critical reflection” in the process of “creating a new identity as a praxis collective” (p.248). Drawing from their own personal experiences of a case study within the doctoral community, they discuss group consciousness, the development of identity and, using Mezirow’s perspective transformation process, identified how their group confronted their collective assumptions about diversity and, upon critical reflection facilitated the evolution of their understanding of diversity and their frame of reference on diversity had changed (p. 248).

Their conclusions support the utility of using models of individual learning for collective learning, the importance of identity, and they provide implications for practice for adult educators. In the end, they remained “with particular curiosity about what conditions to evoke and sustain capacity of groups” (p. 251). While they indicate that the group’s frame of reference had changed, this was determined through individual subjective accounts; there was a paucity of evidence supporting that there was a sustained and profound change to the group as a whole.

Scribner and Donaldson’s (2001) study of the dynamics of group learning found that within their participant group, transformative learning occurred especially surrounding issues of the utility of qualitative research and team member’s self-perceptions as leaders. Their results were based on individual, retrospective interviews of participant students who self-declared that their beliefs had changed. However, there is no indication that the group itself transformed, nor were there any evidence that the transformation was enduring.

Yorks and Kasl (2002) explored adult learning strategies and suggested that they can be linked to a group habit of being. They posited a theory to more closely tie the rational and effective learning together wherein they encourage fostering of “whole-person knowing of others” (p. 186) and “learning-within-relationship” (p.187) during adult learning that would create more empathic knowing of others. They introduce terms such as: team self-knowing, group made meaning, empathic connection, a group habit of being and development of collective new knowledge. The paper extends the discussion of the meaningfulness of the affective nature of transformative learning and supports an expanded more unified theory of transformative learning. Greater insight was provided to changing collective attitudes and habits and this may have provided some evidence of collective transformative learning, but other than individual testimony there seemed to be an absence of any confirming criteria that the collective had experienced an sustained transformation.

Finally, Choy’s (2009) study of worker-learners enrolled in a Graduate Certificate in Education had individuals perform specific learning tasks that “tested existing assumptions and expectations (habits of mind, meaning perspectives, and mindsets) through reflective thinking, reflective discourses, and reasoning that challenged them to change their perspectives” (p.82). As previously identified, this was a facilitated and organizationally enabled activity that resulted in some organizational changes. However, the criteria that identified transformative change was limited to individual retrospective assessment that the individuals demonstrated new perspectives

were more inclusive, discriminating, open and reflective, and acceptable to their colleagues. The claim does not support that the group had itself transformed nor that the transformation was substantive and enduring.

Other studies reviewed fell prey to the similar challenges where there was no clear evidence of either collective transformative learning or the associated collective transformation. This is not to suggest that the investigated phenomenon did not occur, but rather the evidence was not presented that supported collective learning that resulted in meaningful, enduring change of a transformative nature at the group level.

For individual transformation, realizing that the transformative experience may be internalized and subjective within individuals, it may not be necessarily visible to those who are not intimate with the individual. The same, however, should not be true for collectives – the transformation must be visible at the collective level of experience and, as suggested by Mezirow, must be supported by others. Individual claims should not suffice as one individual cannot speak for the collective experience they can only speak of their experience as a part of the collective. Moreover, other individuals and other parts of the organization should be able to see such a change. In short, I was unable to find research-based literature that identified used unambiguous criteria to determine if the collective had indeed transformed.

Team transformation. More specific to this study is transformative learning in authentic work teams. Work teams are a specific type of group that show potential for collective transformative learning. Evidence of shared mental models, shared understanding and shared meaning raises the possibility of a group meaning perspective analogous to Freire's (1970) collective consciousness. As well, within the team learning process and the expanded view of the team as a dynamic learning system, there appears to be potential for teams to undergo transformation (Decuyper et al., 2010; Gersick, 1991; Illeris, 2013; Paavola et al., 2004; Silberstang & London, 2009). Sessa et al.'s (2011) typology highlights the potential for transformative learning within teams “experiencing disorientation and then reorientation for an entirely new direction for growth. This reorientation produces a new team structure, strategy, goals, and identity.” (p.149) Notwithstanding the underpinning literature supporting transformative learning in teams, the research to date seems to have focused on collective decision-making and action in facilitated environments discussed in the previous examples.

There has been little attention paid to the transformative occurrences in emergent groups, such as work teams embedded in authentic work settings.

Unlike intentionally facilitated groups, work teams situated in their work, like the IT SIRT, are often faced with the unknown; they participate in generative learning, adapt and become of a part of an emerging reality to which they contribute. There may be situations that arise or conditions created that cause a team to re-assess who they are, how they think, and what they represent. This, in turn, can influence what they do and what they become. This may result in transformation that is qualitatively different than individual transformation where affiliated, but independently acting agents are brought together “into a unity in which personal aspirations contribute to grander collective possibilities...that none would achieve on their own” (Davis & Sumara, 2008, p. 38). It is this collective experience and potentially transformative phenomena that warrants further investigation.

Summary. As previously mentioned, determining whether or not the collective has experienced transformative learning remains elusive. The closest description that I have found that can help assess whether transformative learning has occurred is found in Sessa et al.’s (2011) typology of team learning. They state that “[t]ransformative learning requires experiencing disorientation and then reorientation for an entirely new direction for growth. This reorientation produces a new team structure, strategy, goals, and identity.” (p.149) However, questions remain as team’s can grow and change their structure, strategy, goals and identity yet still not necessarily experience true, meaningful, sustained transformation as intended by the mentioned transformative learning scholars. Accordingly, research into collective transformative phenomena in work teams within authentic work settings is warranted.

Summary of the Literature Review.

In 1993, Katzenbach and Smith stated that “while most of us are familiar with teams and team work, we are imprecise in thinking about them” (p. 61). Almost two decades later, Kozlowski and Chao (2012) asserted that the origins, processes and outcomes of team learning remain conceptually unclear and there is considerable diversity in the ways that researchers have represented and measured team knowledge and the related learning. It appears that despite the tremendous efforts of many scholars, only some of whom are mentioned here, there is an ongoing struggle to come out of the shadow of three predominant views of team learning. The continued view of team learning as a relatively linear system supported by inputs, processes of

acquisition, retrieval, and sharing and resulting in predictable outputs may suffice for simple work team functions in mechanistic processes. However, this does not appear to explain all of the collective learning that occurs within teams working in dynamic environments. More recently teams have been conceptualized as complex adaptive systems (Arrow, McGrath, & Berdahl, 2000; Davis & Sumara, 2008; Kozlowski et al. 2013; Mathieu et al., 2008). This may have more explanatory power. However, research into this conceptualization at the team level of analysis appears very limited. Further, no models have emerged that have captured this conception of team informal learning within work teams and how it is enacted in authentic work settings.

Similar comments pertain to the transformative learning. There has been extensive interest and debate regarding many aspects of transformative learning research and practice. It also suffers from definitional issues and, within organizational literature, is often confused and conflated with organizational transformation, transformation of work and transformational leadership. Notwithstanding, two areas of investigation are of particular relevance to this research: transformative learning in and through work; and transformative learning and its applicability to groups. While there is increasing interest in transformative learning in workplaces, there remains very limited research pertaining to transformative learning in collectives. In the relatively limited research conducted to date, they have almost been exclusively in educational work settings. As well, research into collective transformative learning in work groups has been within structured, facilitated learning settings. Consequently, there is a gap that exists in understanding naturalistic transformative learning that can occur in and through work within authentic work teams.

Conceptual Framework

Drawing on these two distinct but potentially interrelated areas of research, collective learning and transformative learning, the following outlines the conceptual framework in Figure 6 for exploring collective learning and transformation from the social constructivist world view. This framework merges the conceptualization of team learning as understood within this thesis with Mezirow's (2012) perspective transformation. This is the basis to identify and investigate theoretical gaps in the conceptual understanding of collective informal learning in authentic work teams as well as the potential for that learning to result in collective transformative outcomes.

The first component of the framework is team learning. In this case, team informal learning is a form of collective learning which I have defined as contingently formed patterns of understandings and interactions within practical and situated activities where learning is discovered and generated together. This learning results in changes to the collective cognition evident in team activities, artefacts and other outcomes. To identify this within the research, there are potential indicators of team informal learning that can help guide the investigation. For example, in their study of inter-professional learning, McMurtry, Rohse and Kilgour, (2016) identified markers for concretely enacted collective learning such as diverse contributions, social interactions and relationships, synthesis of ideas, integration of material elements, and relationships with larger organizations. Other markers including generation of team artefacts and changes in team structures and operations may also be evidence of collective learning.

The second component of the conceptual framework uses Mezirow's (2012) process of perspective transformation to explore team transformative processes. Mezirow (1991) and Cranton & Hoggan (2012) suggest that the focus be on the process itself. Accordingly, for the purposes of this study, Mezirow's (2012) perspective transformation process has been reframed to fit a team context. This allows me to identify potential team interactions, processes, activities, and artefacts that are potential markers of perspective transformation where the team: encounters a disorienting dilemma; conducts an internal examination of the shared experience; critically reflects and assesses their shared assumptions; recognizes their discontent and the process of transformation is shared; explores options for new roles, relationships and actions; discusses and plans for a course of action; determines the new capabilities to implement the plan; trials the plan; renegotiates relationships and negotiates new relationships; builds competence and confidence in new roles and relationships; and reintegrates into the organization on the basis of conditions dictated by the new shared perspective.

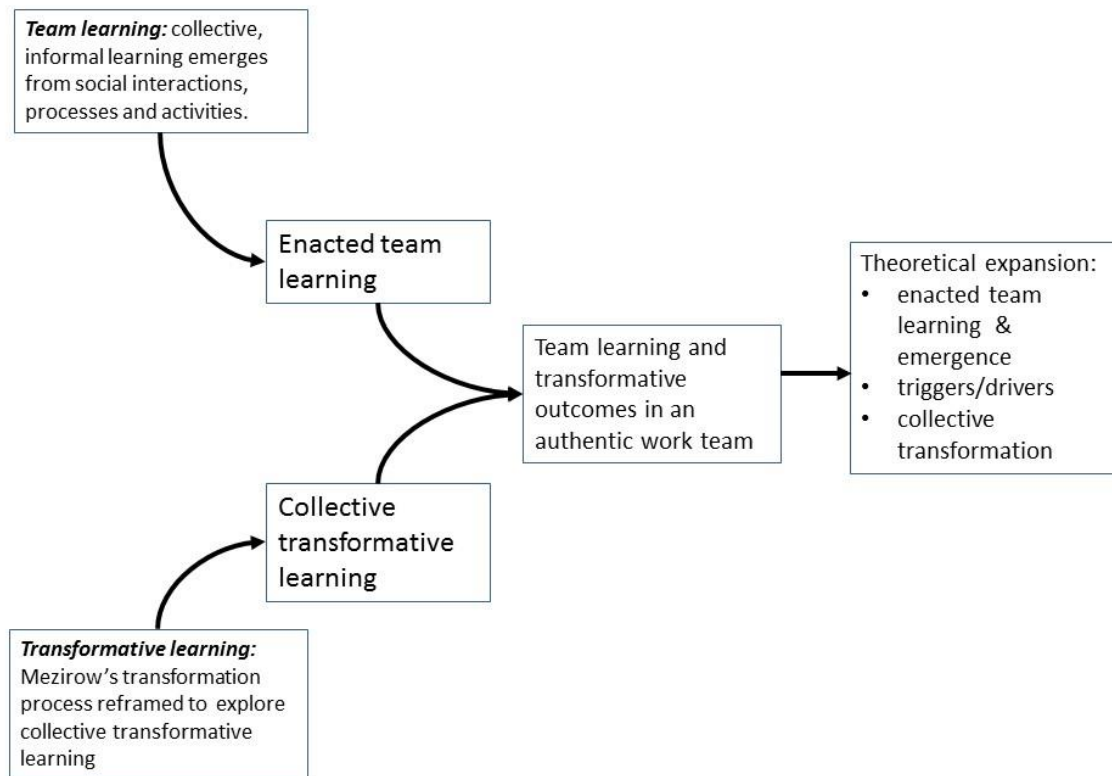


Figure 6. Conceptual framework

Importantly, the conceptual framework is intended to specifically view team learning and transformation in *authentic* work contexts. This is a critical focus of this study as it is intentional to differentiate team informal learning in and through work from those studies conducted in educational settings, laboratories, simulations, or supported by structured or facilitated learning activities. Moreover, referring back to the questions, the conceptual framework provides the context for addressing the main research question, “In what ways is collective learning enacted within this authentic work team?” As well, it supports the sub-questions: how can this collective learning be understood and articulated; what are the triggers/drivers for this type of learning; and how can Mezirow’s theory of individual transformative learning contribute to our understanding of how learning may occur in this authentic work team?

Chapter Three - Method

Introduction

A challenge in the study of informal learning is that it is primarily a social and cognitive process that may not be explicit or readily revealed in behaviours of the participants; many things we learn do not influence what we do. Within the workplace, there are various things that we may learn in other aspects of our lives that may influence our workplace attitudes and behaviours of which we are not aware or did not consciously learn. I recognize that I often reflect on my own actions in an attempt to understand a particular perspective of behaviour within a given situation. Accordingly, my approach to this study acknowledges that many of the concepts introduced within the literature are abstractions of what is believed to take place and my research is an attempt to concretize some of the concepts within an authentic work team setting. This chapter will therefore commence with my presumptions and assumptions. This will be followed with a discussion of the methodological approach, the design, participants, data collection methods, the data analysis and interpretation process, and my reflections on this process.

Researcher Presumptions and Assumptions

In educational research, the people and systems under investigation always involve human factors referring to meanings, values, behaviours, and histories, which are never indifferent to the researchers who study them, be it consciously or not (Deveraux, 1967 as cited in Alhadeff-Jones, 2012, p.187). It is therefore appropriate for qualitative researchers to position themselves within the research context. In doing so, they should appreciate that their own personal, cultural and historical experiences influence how they design the study, analyze and interpret the data, and report their findings. The researcher should therefore identify and reflect on his own prior experiences, assumptions, goals and what potential these have for influencing the study (Maxwell, 2005).

For this research project, I am situated within the social constructivist world view where I understand that knowledge is co-constructed in social interactions and that learning is a social process which is highly influenced by our biological, environmental, cultural and historical contexts (Berger & Luckmann, 1966; Creswell, 2013; Crotty, 1998). I view individuals as interdependent beings embedded in a complex web of intimate and larger social relations all of which cannot be captured, but that some of the interrelationships may be revealed in our personal experiences and our experiences with others. In my view, the team under investigation is a

distinct social entity that constructs its own meaning and has its own sub-culture, norms and practices that are developed in constant and reciprocal interaction with the organization and the larger social environment.

In addition to the above presumptions and philosophical assumptions, I have assumptions regarding the institution and context based on both my past experience with the team. The department in which the team works and the larger political and socio-cultural environment of government are implicated in the research as are my views regarding them. Within this research, the team is embedded in an evolving and dynamic work environment within an institutional context. The institution, Shard Services Canada (SSC), is evolving and changing with the intent to better meet their mandate and address the needs of their multiple Government of Canada (GC) clients. The political and socio-cultural environment and the associated bureaucracy of the Government influence the team's work and how the team engages with other groups, teams, and departments. Additionally, the work within cyber security is ongoing, continuous and challenging. I believe that the almost continuous organizational change over the life of the team to date poses numerous challenges that also influence collective learning and behaviours.

I appreciate that an environment rich with meaning existed before my arrival and I realize that my presence within the team's surroundings became part of that meaning. I also realize that I was implicated in knowledge production that occurred as I engaged with participants and they engaged with me. In this case, I am 'familiar outsider' who had a formal relationship with the team as a learning advisor, but that formal relationship ceased prior to the commencement of the research. Though I had a pre-existing relationship with the team and I also worked for the GC, I was not a member of the team, nor was I a member of the team's organization. That said, there was an established trust relationship with both the team and management and this allowed me to enter into the organization with limited difficulty. I realize, however, that an informal, collegial relationship continued to exist and that I could never completely separate myself as 'researcher.' To the team I would always be 'Randy from Communications Security Establishment (CSE)' regardless of my role as a researcher.

From the start, I understood that my social constructivist perspective, background, relationship with the team and intended approach would influence my study. Consequently, I was required to be constantly aware of my interactions with the team members and the potential influence that I might have on individual and team activities. While it was impossible for me

separate himself completely from the team, I attempted to the degree possible, to earnestly gather and report the participant's views. Where noticed, comments and reflections on how I interacted with the team and potential influences on the study were captured in my journal and my perspectives on research specific issues were captured in the field notes. Any significant issues that arose as a result of my interactions with the team have been noted in this report.

Methodological Approach

This study was a qualitative research project that centred on an instrumental case study of the Information Technology Security Incident Recovery Team (IT SIRT) within their actual work environment. As a social constructivist, I appreciate that knowledge generation and learning occurs within and arises from social interactions between individuals. This perspective is particularly suited to this research effort as I am studying collective learning of a work team in a naturalistic setting. I need to be able to capture learning at the collective level of analysis. Consequently, my research design needs to include ways and means to better understand the team's informal learning processes and outcomes by capturing their collective experience and collective perspectives. The following will outline the design, data collection methods, data analysis and interpretation that will achieve this.

Research Design

Denzin and Lincoln (2011) state that qualitative research is “a situated activity that locates the observer in the world” and that “qualitative researchers study things in their natural settings to make sense of, or interpret, phenomena in terms of the meanings people bring to them” (p. 3). In a qualitative approach, the researcher captures the multiple experiences and views of the participants to better understand the world in which they work (Creswell, 2013). As I was attempting to better understand team learning and transformative experiences in an authentic work context, I chose to conduct a qualitative case study.

To better understand team informal learning, I needed to capture the situated, localised learning of the team (Garavan & McCarthy, 2008). As Osberg (2015) also notes, “learning of learners can only be adequately understood as part of the learning context” (p.32). According to Yin (2014), case studies are a form of qualitative research intended “investigate a contemporary phenomenon (the case) in its real world context, especially when the boundaries between the phenomenon and context may not be clearly evident” (p. 2). Yin (2003) suggests that the inclusion of context “creates distinctive technical challenges including numerous variables at

play, the need for multiple data sources, and effective strategies for design and analysis” (p. 4). Yin (2003) further explains that case study is the preferred method in situations where there are how or why questions, the researcher has little or no control over behavioural events, and the focus of the study is a contemporary phenomenon as the situation in this case.

For this study, the research took place within a bounded system (Creswell, 2013, Merriam 2009) of the Security Operations Centre (SOC) with the IT SIRT as participants. In this case, the boundaries between phenomenon and context were not clearly evident (Yin, 2014) and the team was bounded along several dimensions including organizational, professional, socio-cultural, and technical dimensions. Within the organization, they were a concocted team (McGrath & Argote, 2001) with an assigned mandate, constrained to working within GC systems, using GC endorsed processes, and were limited in the tools and resources at their disposal. Moreover, their membership was defined by the management. However, their work was dynamic, their mandate evolving and their relationships both within the organization and with other external parties was emergent. Further, I had no control over the events and the variables were so embedded in the situation as to be impossible to identify ahead of time (Merriam, 2009; Yin, 2009). Finally, I was the primary instrument of data collection and analysis (Merriam, 2009) to “retain the holistic and meaningful characteristics of real-life events” (Yin, 2003, p. 2). Accordingly, case study was the most suitable method.

Case study is inherently multi-method and reflects an attempt to secure an “in-depth understanding of the phenomenon in question.” (Denzin & Lincoln, 2000, p. 7). Case study does not claim any particular methods for data collection or analysis, but a key concern is “interpretation in context” (Cronbach as cited in Merriam, 2009, p. 42). Moreover, this interpretation should be seen as trustworthy and rigorous as well as credible, confirmable, dependable and transferable (Lincoln, 1995; Lincoln & Guba, 1985; Merriam, 2009). Data collection and analysis therefore included techniques such as multiple methods and triangulation using multiple data sources (Denzin & Lincoln, 2011; Maxwell, 2012; Merriam, 2009; Yin, 2003). Appendix 1 outlines the techniques used in this case study to assure qualitative research integrity.

Case studies can support various research goals and outcomes. In this situation, I was looking for a general understanding of phenomena that are not necessarily specific to the team. Accordingly, I employed an instrumental case study (Stake, 1995). As Stake (1995) suggests, an

instrumental case study examines a particular case to provide insight into an issue or refinement of theory. The case is of secondary interest to the primary goal of facilitating understanding of something else; it plays a supportive role, facilitating our understanding of something else. In this situation, the case is used to investigate the main question, “in what ways is collective learning enacted within this an authentic work team?”

The case is often looked at in depth, its contexts scrutinized, its ordinary activities detailed because it helps the researcher pursue the external interest. The case may or may not be seen as typical of other cases (Stake, 1995, p. 237). This case was viewed as atypical. The team was new, the organization in which the team was employed was also relatively new, the team processes were continuing to develop and the context in which the team worked was dynamic and emergent. Further, in contrast to the majority of team studies which look at member interactions, the focus of this research was on the team at the meso-level of analysis noting interactions, processes, and history with particular attention to whole-team activities and interactions within and across team boundaries. While atypical and not generalizable to other teams in other contexts, there were insights into this specific team as a collective, the human condition, and to the phenomena being investigated (Stake, 1995).

A final design consideration was related to the context in which the study occurred. The IT SIRT supports a complexity of people, information, networks, technologies, and materials that change, evolve, and transform with the team as they perform their work (Fenwick, 2010). As I am investigating an authentic work team in their natural work context, the design should be sufficiently flexible to adapt to the changing context and situations as they arise. As noted by Stake (1995), while some decisions are made while designing the case study, some continue to be made through the final hours. Accordingly, the design was flexible and allowed adding of sub-questions and refining analysis as the situation evolved. For example, the results of the document analysis informed the initial focus groups, which, in turn, provided insights that required refinement of sub-questions or new sub-questions in subsequent focus groups and interviews.

Selection of the instrumental case. There were three characteristics that made the IT SIRT suitable for an instrumental case study. First, there was convenient access to the team and its work environment that supported the kind of qualitative study intended. I was afforded access to the team’s work space as well as adjoining spaces that were occupied by other teams within

the SOC. This allowed me to not only observe the team, but observe the various interactions with other SOC teams. Second, the IT SIRT was a relatively small, nascent team within a large, relatively new organization. Consequently, the team and the organization were still evolving. While the team's response and recovery mandates were generally clear, the actual scope of activities and the details of how they were to perform their role were not; these circumstances provided ample opportunity to observe team interactions, activities and processes that contributed to team informal learning. Additionally, there were multiple aspects of how the team worked within the culture of the larger organization and how the team's mandate was integrated into the broader organizational and GC mandate. Third, there were numerous limitations and constraints that had already influenced team activities and, at times, had an impact on their ability to effectively perform. Consequently, I was aware that the team regularly faced dilemmas that challenged the team and could result in team change and, potentially, transformation. These three qualities supported a rich team construct and work context for an instrumental case study into team informal learning and collective transformation.

Ethical considerations. As mentioned, as a result of my job within the Government, I was familiar with and had already established a collegial relationship with the case team, the IT SIRT, before the commencement of the research. Consequently, there were limited barriers between me as a researcher and the participants. The study followed the ethical guidelines of the University of Ottawa and the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*, 2nd edition (2010). The ethics approval is provided in Appendix 2. The letter of introduction is provided in Appendix 3, the management email approving the research within SSC Appendix 4, and the recruitment text is provided in Appendix 5.

Once I received ethics and management approval, I forwarded the recruitment letter via email to each of the IT SIRT members as prospective participants. This email included the consent form which is provided in Appendix 6 so they could review this prior to deciding whether or not to participate. If they agreed to the conditions and volunteered to participate, I requested they contact me. All IT SIRT members agreed to participate in the research. After agreeing to participate, I held one-on-one discussions with participants, reviewed the letter of consent with them, and answered any questions they had. I invited them sign the consent form, provided them a copy and retained the original on file to be safely stored with the remaining data and research materials.

Data Collection Methods

One particular strength of qualitative research case studies is the ability to focus on actual practice in situ, looking at how social interactions are routinely enacted (Silverman, p. 359). As a social constructivist, I appreciate that learning occurs in and arises from the social context. Consequently, the methods must be able to capture the team's social experience and collective perspectives that in turn provide evidence of team informal learning. As this is the case, the data on how learning is enacted is revealed through team interactions, activities and processes. The formulation of collective cognition and development of a 'team perspective' is realized through communication, coordination, and other team process behaviors (Cooke, Salas, Kiekel, & Bell, 2004). Arrow and Cook (2008) note that group learning processes involve various attention systems, information flows and exchanges and the generation and adjustment of related structures and can result in changes or improvements to knowledge, capacity and performance (p.47). Referring again to McMurty, Rohse and Kilgour (2016), they identified markers for concretely enacted or manifested inter-professional team collective learning such diverse contributions, social interactions and relationships, synthesis of professional ideas, integration of material elements, relationships with larger organizations. These and other markers, including evidence of team generated artefacts and changes in team behaviours and operations, were revealed in the case study and serve as evidence of team of the team experience and their informal learning at the collective level of analysis. As I have already acknowledged, however, the processes, activities and outcomes of team informal learning were not always visible.

In investigating aspects of transformative learning, a key concern is whether or not collective transformation has occurred. As previously discussed, Mezirow (1991) and Cranton & Hoggan (2012) suggest that the focus be on the process itself. Therefore, in addition to identifying disorienting dilemmas, the data collection attempted to capture: types and quality of reflection, evidence of planning for alternative courses of action, documented or verbal affirmation of new roles or activities, testimony on changes that have occurred and visible demonstrations of new team perspective such as new practices or approaches used.

This research explored how participants saw things and how they did things and any interconnections between the two. Acknowledging that no observations or interpretations are perfectly repeatable, triangulation helped to clarify meaning by identifying different ways the phenomenon is being seen and understood by me and the participants (Stake, 1995). Therefore,

the investigation into both team informal and transformative learning necessarily involved soliciting team perspectives, and the experiences and views of its members. As well, observed team activities, interactions, artefacts and history provided evidence of team learning and transformation. Using the multiple methods helped ensure trustworthiness of the study. The methods employed included: document analysis, focus groups, interviews, observation and reflexive journaling which are further detailed below.

Document analysis. For the document analysis, I reviewed a range of documents and team artefacts that provided a team history, a record of past and ongoing activities, understanding of the team requirements, insight into the team members and their experience, knowledge of how the team operated, and qualitative changes that may have been indicative of the team's transformation. The document analysis included: team charter, organization charts, team directives, charts, team training and learning documents, agenda and minutes, reports, member self-assessments, the case management system entries, the duty analyst log, and locally developed team artefacts such as job aids, standard operating procedures, case status boards and posters. Documents were also used to support and inform observation, interview and focus group activities. I noted that there was a preponderance of draft documents and multiple versions of organizational directives that related to the team. As such, the documents also served as a history of the evolution of thought on the team operations from a variety of perspectives, but primarily management and the team members themselves. However, when discussing the team's current state, the most recent versions were used.

All electronic documents were uploaded and placed in NVivo 10 and subsequently transferred to NVivo 11. Both were used to manage and analyze the documents. All relevant team documents that were available to me were reviewed. Only recent documents were analyzed unless historical reference was required. Looking for indicators of collective learning and transformation as well as triggers and drivers, I scanned and read related documents and gathered data from initial conceptualization of the team through to the end of the observation period. I also returned to various documents throughout the analysis that helped confirm or fill in gaps identified from others sources. This helped form a more complete picture of that is presented in the research.

Document analysis is particularly applicable to qualitative case studies (Bowen, 2009). As Cilliers (1998) noted, “[c]omplex systems have a history. Not only do they evolve through

time, but their past is co-responsible for their present behaviour. Any analysis of a complex system that ignores the dimension of time is incomplete, or at most a synchronic snapshot of a diachronic process” (p. 4). For this case, since I could not observe the history of the team, documents helped to provide a historical record of the team and its evolution since inception. Through documents and other published artefacts, I also gained a better understanding of the evolving context, how the team operates, team artefacts used in work, changes to the team and supporting organizational structures and interrelationships. In this way, the documents and the text that they contained went beyond mere words and provided a deeper look into the history, organizational context, decisions and evolving work environment of the team. Primary documentary sources reviewed are listed in Appendix 7.

Observation and field notes. I had the opportunity to observe team operations on average of two days per week over the course of 12 weeks. This included 20 meetings, three major recovery operations, responses to several minor incidents, numerous interactions with other teams and regular professional and social interactions amongst the team members. As well, when not in the SOC, I was in regular contact with the team and the team manager through email and phone and apprised of any significant events that occurred. Throughout, I was aware that my presence may result in a change in the team’s behaviour and greater attention to particular activities than normal. Where I sensed my presence was influencing the team, I noted and reflected on the potential impact.

For field notes, I used a combination of both hand written and electronic notes which were all subsequently merged into a single spreadsheet for analysis. These were refined during the analysis process. The field notes were entered into NVivo 10 and formed a data source for cumulative analysis. There was often a range of dialogue and activities that did not appear relevant to the study. For example, there were often discussions of a personal nature that naturally occurred between colleagues. Though in reflection there were non-work related activities, such as social events, where some form of team learning may have occurred, these were not captured within this context as the focus was on the work team in their work context as opposed to the broader social collective. Accordingly, only observation data of potential work-relevant learning was recorded. The information on the observation guide and field notes is provided in Appendix 8.

Appreciating the established collegial relationship between me and the team, I had already formed opinions and views of my own relative to the team and each of its members. My presence was always known to the team. However, my degree of engagement with the team often fell somewhere along the continuum from non-participant observer to complete participant (Creswell, 2013, p. 166) depending on the type of activity or event in which the team was engaged. At times, the team even solicited my insight to problems or issues that fell within my expertise. In contrast, I often intentionally moved into the background, remaining within ear shot, but out of direct sight of the team for extended periods of time to listen to the team's interactions. Suffice to say that the observation was far from objective, but that my exchanges with participants helped me capture a richer picture of team, their work and their learning context.

According to Stake (1995) "Qualitative case study is characterized by the main researcher spending substantial time, on site, personally in contact with activities and operations of the case, reflecting, revising meanings of what is going on" (p. 242). Observation, in this case, was a critical component of the research as it provided an opportunity to capture the team's internal and external interactions (Cooke, Gorman, & Rowe, 2004). I appreciate that no observer can capture everything (Merriam, 2009), but observation contributed to a richer picture of the work context and team behaviours in various modes of operations such as incident recovery operations and team meetings than otherwise would have been possible. Moreover, as previously discussed, team learning as a process can rarely be observed directly. As well, particularly during authentic team work in dynamic environments, there is often 'unconscious' and 'implicit' learning that occurs. Whether the team learning process was not explicit during team interactions or when there was implicit team learning going on, observation provided the means to capture learning outcomes that may not be evident through other means. There are markers or indicators that can be inferred from how the learning is enacted including use of team artefacts and tools, informal interrelationships, and changes in the group's behaviour or motivational states (Kozlowski & Bell, 2008; Kozlowski & Ilgen, 2006; McMurtry et al. 2016jNIA). For example, in cases where the team is learning 'in the moment' and are not aware of their learning or are not deliberately learning, these markers provide an indication that learning, unbeknownst to the team, has in fact occurred. Accordingly, observation allowed me to capture team activities that may have been

indicative of learning and change, but needed further explication through other methods such as interviews or focus groups.

Semi-structured focus groups. The focus groups allowed me to explore group norms and dynamics around issues and topics I wished to investigate (May, 2011). In this case, there were two focus groups near the beginning of the data collection phase to capture team history, perspectives and interactions to that point. Another two focus groups were conducted after the observation period to expand on the team chronology, conduct more informed discussions on team changes and provide an opportunity for me to ask questions about observed phenomena. The semi-structured environment allowed for participant exchange which was important as the answers the participants provided.

The focus groups were the primary means to draw out collective perspectives and meaning regarding team informal learning. Particularly during the latter focus group sessions, I had the opportunity to query some of the team's activities and interactions. For example, having the opportunity to observe the team's activities, then discuss their experiences in the second focus group helped identify implicit and unconscious learning that went unnoticed during the observation. The team's own retrospective testimony provided evidence of how and what they learned even though it may have gone unnoticed at the time. The focus groups also helped identify disorientating dilemmas, team responses and potential changes in team perspectives. In this way, the focus groups provided additional insight into what the team did, any rationale, what they experienced and their perspective on outcomes that may have not been captured by other means.

I facilitated all of the focus groups. They were digitally recorded and I also took hand written notes. The hand written notes were required to record non-verbal data such as nods of agreement, shrugs and other body language that helped indicate the degree of group consensus of particular participant statements. Data was transcribed and sent to the participants for review for member checking (Merriam, 2009). Only minor editorial changes such as spelling were suggested. The transcriptions were then entered into NVivo 10 for data management and further analysis. The focus group guide is provided in Appendix 9.

Semi-structured interviews. At the time of the study, the team was comprised of ten individuals. Individual interviews were planned for each of the team members at the latter end of the data collection phase. All but one member of the team was interviewed. While he had

consented to an interview, the individual's schedule did not allow for it within the selected time frames. It should be noted that, as presented in earlier discussion of the case, the manager was not interviewed as he was not considered to be a team member. He was a representative of senior management and he was not normally engaged in the day-to-day work in which the team members were regularly employed. While managerially responsible for team outcomes, he was rarely a personal contributor to the team outcomes and not engaged in the same interactions.

The interviews served three key purposes: to explore individual perspectives and issues related to the team norms and practices; to clarify issues that arose from the focus groups; and to validate the findings on collective learning and transformation. Hence they were semi-structured to allow for emerging insights and more in-depth discussion as issues of import arose. I conducted the interviews and took notes. The interviews were digitally recorded, transcribed and stored in the research data base. The transcriptions were entered into NVivo 10 for data management and further analysis. The interview guide is provided in Appendix 10.

As noted by Stake (1995), what the researcher is unable to see for himself is obtained by interviewing people who lived the experience. As well, May (2011), indicated that "(i)nterviews yield rich insights into people's biographies, experiences, opinions, values, aspirations, attitudes, and beliefs" (p.131). While the unit of the analysis was the team, the participants were components of that team and were able to offer insights on their experiences within the team that could not be captured by other means. Moreover, they were embedded within the team and the work environment and it was therefore important to capture their perspectives to identify if there was 'collective learning', 'team transformation' or simply another group dynamic at play such as dominant members or group think (Janis, 1972). Important to this case, semi-structured interviews allowed for probing and greater opportunity for participants to respond on their own terms, but provided sufficient structure to allow comparability across responses (May, 2011, p. 133). For example, interviews provided greater detail on individual roles and work that contributed to team activities and processes that had gone undocumented and were not acknowledged during the focus groups. As well, the interviews provided more candid perspectives of team members as well as their views of fellow team members and their work context.

Reflexive journal. To support researcher reflexivity (Creswell, 2013), I also maintained a journal to document comments, insights, reflections and decisions that were not necessarily a

part of the data collection efforts. As a very informal document, the reflexive journal included personal observations and reflections during throughout the study. As well, during the reporting, I was able to refer to the journal to help recall my experiences during the focus groups and interviews to situate my framing of data and the processes. Where appropriate, I have included such reflections and comments within the remainder of this report including a final summary of my key reflections on this research project.

Data Analysis and Interpretation

As the sole researcher in this instrumental case study, I was immersed in a complex work environment exposed to a range of data that included not only text and participant's words, but images, charts, presentations, and information from various media including specialized computer-based applications such as those used for incident handling or reporting, as well as my own contextualized observations, reflections and interpretations. As with any qualitative research, there was a necessary balancing act in finding a way to collect and interpret the data while ensuring credibility and trustworthiness. The following summarizes the main analysis activities within the data analysis and interpretation.

The data analysis and interpretation was bracketed by the perspective shared in my assumptions and presuppositions. From my social constructivist worldview, I was cognisant at all times that the words and texts were open to interpretation, and words and text were but artefacts produced by an individual or a part of the organization with purpose. These texts are part of the participant's reality rather than facts; they have meaning beyond what is explicitly written. Therefore, I analyzed the text and statements with a very different purpose than the original meaning intended by the participants and did so to understand more about the participants' experiences, context, work and learning. As well, I acknowledged my biases in the analysis and interpretation of the data including any observer biases that existed as a result of my subject matter knowledge in IT security. Where required, I provided an explanation on an interpretation that will help the reader to better understand why a particular lens has been applied.

Main analysis activities and data analysis path. Data analysis and interpretation are a critical part of any research. Referring back to the conceptual framework, certain evidence was being sought for each of the research questions. Enacted collective learning was visible in team processes and activities to include the markers discussed such as social interactions, integration

of material elements, and relationships with larger organizations, team artefacts and structural changes to the team operations. The triggers or drivers for collective learning were identified by individual, team, or organizational artefacts or events that stimulated collective informal learning processes. Finally, in determining how Mezirow's theory of individual transformative learning could contribute to our understanding of collective transformative learning, I needed to first see if there was evidence of the reframed perspective transformation process previously discussed. Beyond this, I also needed to determine whether or not collective transformation actually occurred through evidence of significant changes to the team or the team's perspective.

For each of the research questions, all of the methods contributed to addressing the questions in part or in whole. For example, in identifying enacted learning elements: document analysis helped to reveal a team artefact that was collaboratively researched and produced; focus groups helped elaborate on the team's process on the development of the team artefact; interviews identified individual contributions to the artefact as well as its value and use to the individual; my observations helped to situate the artefact within team's work, get an impression of its utility to the collective, and see how it was maintained or updated; and, in my reflective journal, I noted any personal opinions, issues or inferences that I might make about the artefact or the investigated process.

To provide an intensive, holistic description of the case, there was a significant amount of data from a range of sources which, at times, presented "disparate, incompatible, even contradictory information" (Merriam, 2009, p. 203). Effective organization and management of the data was therefore critical. The data analysis path in Figure 7 shows the initial organization and analysis of data from document reviews, focus groups and observation culminating in a second set of focus groups and the individual interviews. As the design supported emergence and the analytical process is largely inductive, the initial data collection and ongoing analysis was primarily to identify team learning activities, change and situations that provide evidence of transformative learning (sub questions 1-3). The latter end of the data collection and ongoing analysis was primarily to capture team perspectives on the information collected and to discuss the team's potential transformative experiences (sub questions 1-3). As per the plan, data from all sources was analyzed, interpreted and reported based on their relevance to my research questions.

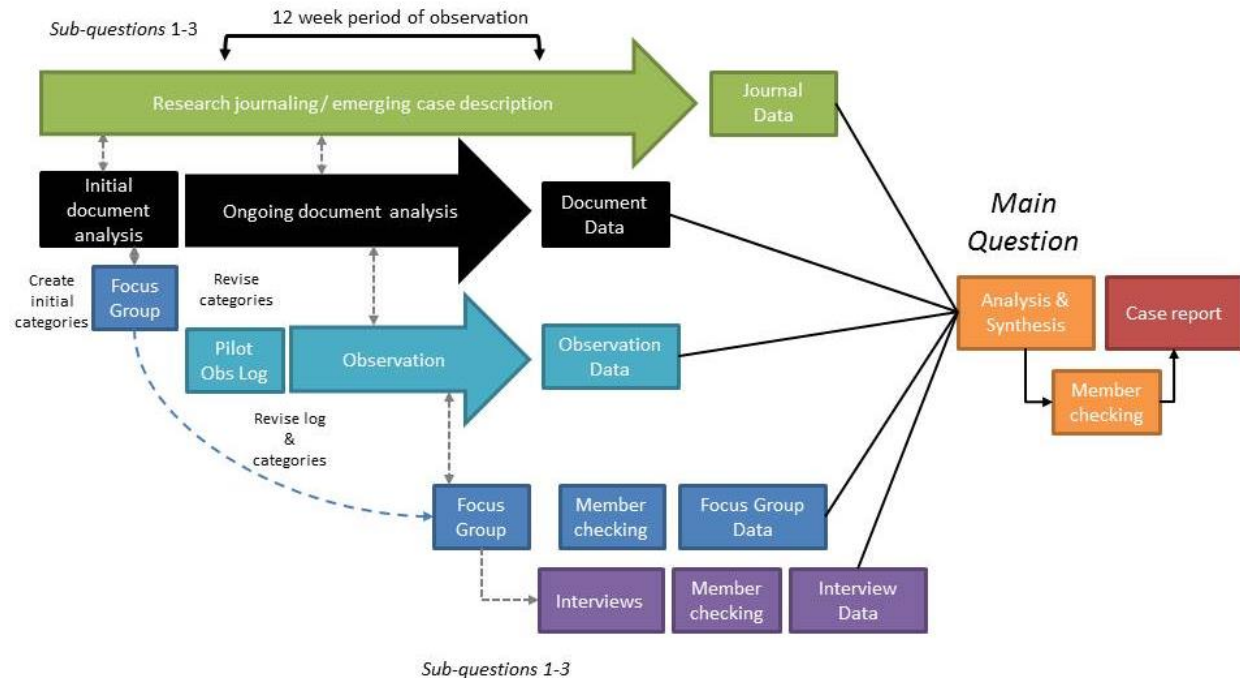


Figure 7. Data Analysis Path

To analyse the data, I used constant comparative method where the data is constructed with interacting interpretations which I used to find patterns in the observed actions, texts, images and multiple participants' words (Glaser, 2002). Throughout the data collection, I read, listened, watched and reflected upon the various data, annotating items of relevance to the research questions as well as looking for patterns or themes across all data sources. The analysis therefore started during collection and, continued through to the drafting of this case report. For documents and other sources of information such as team artefacts, I conducted an initial review then returned to the source and annotated them. Similarly, in the case of observations, interviews and focus groups, notes were taken at the time of the activity, but additional annotations were made during initial review of my notes and then subsequently during the analysis of the transcribed text. As well, I maintained my reflexive journal, commenting on specific insights, issues or questions that arose.

Upon completion of the data collection phase, to further enhance trustworthiness, I had focus group and interview transcripts 'member checked' (Merriam, 2009). There was limited feedback primarily consisting of minor editorial comments and no concerns regarding the import of statements in the transcripts. Once the transcripts were validated by the participants, all data

was reviewed, annotated, and initial categories were assigned as the research-relevant issues were identified. Some of the preliminary categories were retained while others were merged into other categories.

After the initial review, I analyzed the initial categories and then identified relationships across data sources within existing categories. Based on my understanding of the context and the subject matter, I found significant interrelationships across data captured; whether in a document, a phrase from an interview, a statement from the focus group, or an observation, data often fit into many different categories at the same time depending on the interpretation and context. Consequently, a data element from one source was often in more than one category. With initial categorization completed, I conducted another review of all relevant data sources. Additional themes emerged and I found that there were numerous co-occurring themes and interrelationships that represented the multi-faceted aspects of a complex work team.

During my analysis, I appreciated that even the simplest and most direct of statements hold significantly more information than was evident at first read and this demonstrated the complexity in analyzing the case. With each additional review other issues and relationships came to light which helped construct a richer picture of the case. Note that though the data includes individual statements and observation on individual work and interactions between individuals, all categories were established with the team as the unit of analysis. Individual data was not removed from the analysis as there were references to or inferences to collective behavior.

After the initial and subsequent manual analysis, all electronic documents, focus group and interview transcripts and field notes were entered into NVivo 10. Documents or other artefacts that were not in a suitable electronic format, were described in the field notes and analysed as part of that data source. At the outset, I was concerned with the use of computer-based analysis due to the potential de-contextualization of the data (Barry, 1998) and lack of ability to see nuanced interconnections and meaning that are revealed through different words, phrases and expressions of both the participants and me. This concern was realized in attempts to analyze data based on assigned codes or in attempt to use NVivo 10 for encoding the available text. For example, there were challenges with inconsistent terms and NVivo 10's inability to code within identified categories when the category terms were not aligned with textual elements. Consequently, auto-coding across sources or within codes did not provide any relevant

information that would help me to better answer the research questions. As well, as I neared the end of my research, I was notified that the license on NVivo 10 had expired and I was required to purchase a license for NVivo 11 to continue to analyze my data. While there were no significant problems in updating the software, I was concerned as I had not experienced a software upgrade in the midst of research before.

That said, while NVivo 10/11 automatic coding did not suit this multi-faceted, complex case study, NVivo 10/11 was very beneficial in managing the data sources and consequent data coding and analysis. It provided an excellent means to quickly analyze documented and transcribed data based on researcher assigned codes. NVivo 10/11 also allowed me to conduct key word searches and analyze coded data to do cross-comparisons, identify patterns, word frequency and other data attributes such as number of coded references in each node/category. These processes revealed relationships that may not have otherwise been identified and enhanced my understanding of what could be revealed through the data.

In the final analysis, further coding and cross comparison was conducted both manually and with NVivo 10/11 as I looked for relationships between the previously identified categories and data set as presented in the example above. In doing so, other categories were identified that provided broader, more encompassing categories than were previously used within each data set. As an example, a document statement from an April 2013 version of the IT Security Coordination Centre charter stated: “The IT SIRT team will handle the in-depth analysis aspects of the IT Security Incident response once escalated by the ITSCC.” In Figure 8, I first saw important information regarding the team’s task and scope.



Figure 8. Example A – Initial analysis of the text

In the following Figure 9, further analysis with the understanding of the team's evolution based upon the interviews and focus groups provides a deeper understanding of the many aspects of the documented text. In this situation the additional analysis, resulted in key statements being used in multiple categories that included team work requirements, capabilities, interrelationships and sharing.

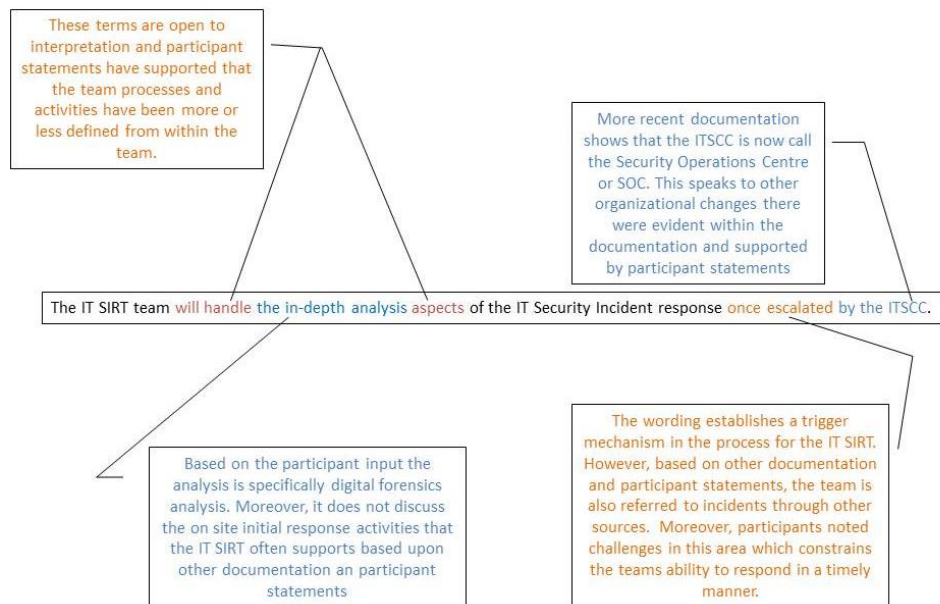


Figure 9. Example B – Further analysis with comparisons across sources

This resulted in coding and further analysis in the three key categories directly related to the research questions: triggers for learning, team changes, and evidence of enacted learning.

Additionally, as previously mentioned, I was looking for evidence of team informal learning and transformation within team interactions and artefacts. Accordingly, specific analysis activities were conducted related to potential evidence of team informal learning, the perspective transformation process and team transformation. The ability to triangulate data of a across multiple sources provided credibility, but also revealed other patterns, issues or behaviours that would have remained undiscovered if only a single source was used. For example, significant changes in how the team operated over time was not only discussed in focus groups, but corroborated though interviews and text within team artefacts such as Standard Operating Procedures (SOPs). This provided additional support for what I had already found and enriched

my understanding of the team tasks, interrelationships, change and sharing and how these are manifest in the team.

There was a progression from initial categories through identification of many interweaved issues and emergence of new categories and the aggregated, final categories with their descriptions. A significant amount of data was identified through the multiple sources and hundreds of data points were reviewed in numerous documents, transcriptions and field notes.

Assuring credibility and trustworthiness in qualitative research. The criteria for this study are based on Lincoln & Guba's (1985) criteria and techniques for establishing "trustworthiness" in qualitative research and are detailed at Appendix 1. Two important aspects contributed to the data integrity. First, acknowledging that no observations or interpretations are perfectly repeatable, triangulation was particularly useful to help clarify meaning by identifying different ways the phenomenon was seen by the participants and me. Second, given the breadth and depth of the data sets within this case study, systematic transcription and member checking (Merriam, 2009) support dependability and confirmability of the data.

The planned use of a peer to validate data categorization, was initially attempted. However, this exercise proved to be of little utility in providing credibility as I had to often discuss and describe category headings and subsequent categorizations as the peer was from a different research paradigm and was not fully familiar with the underpinning concepts, work context and terms. The peer was helpful in that she helped me think through the categories themselves, but ultimately there were no substantive comments that would have helped validate the actual categorization of terms. I believe that this can also be attributed to the complexity of the case and the way that words and phrases often fit within multiple categories as discussed above. This has been noted this as a limitation of the study.

Reflections on the data collection, analysis and writing process. During the focus groups and interviews, participants responded to questions and provided opinions based on their experience. It was rare that participants would reference a document or formal process. As can be seen in the transcripts, the participants appeared to speak freely. During the interviews, it seemed at times that the participants were confiding in me opinions about the team, its members, the organization, management and other related subjects. Given that the team was small and team members are well known within their disciplinary circle, I had to make special effort to assure confidentiality.

The analysis and interpretation process was far from linear. It was an iterative and a recursive process as shown in Figure 10. Even after I believed I had established a credible set of categories from the second review, further review prompted additional analysis and re-categorization of some data and generation of new categories. The level of interconnectedness of the data was also a challenge.

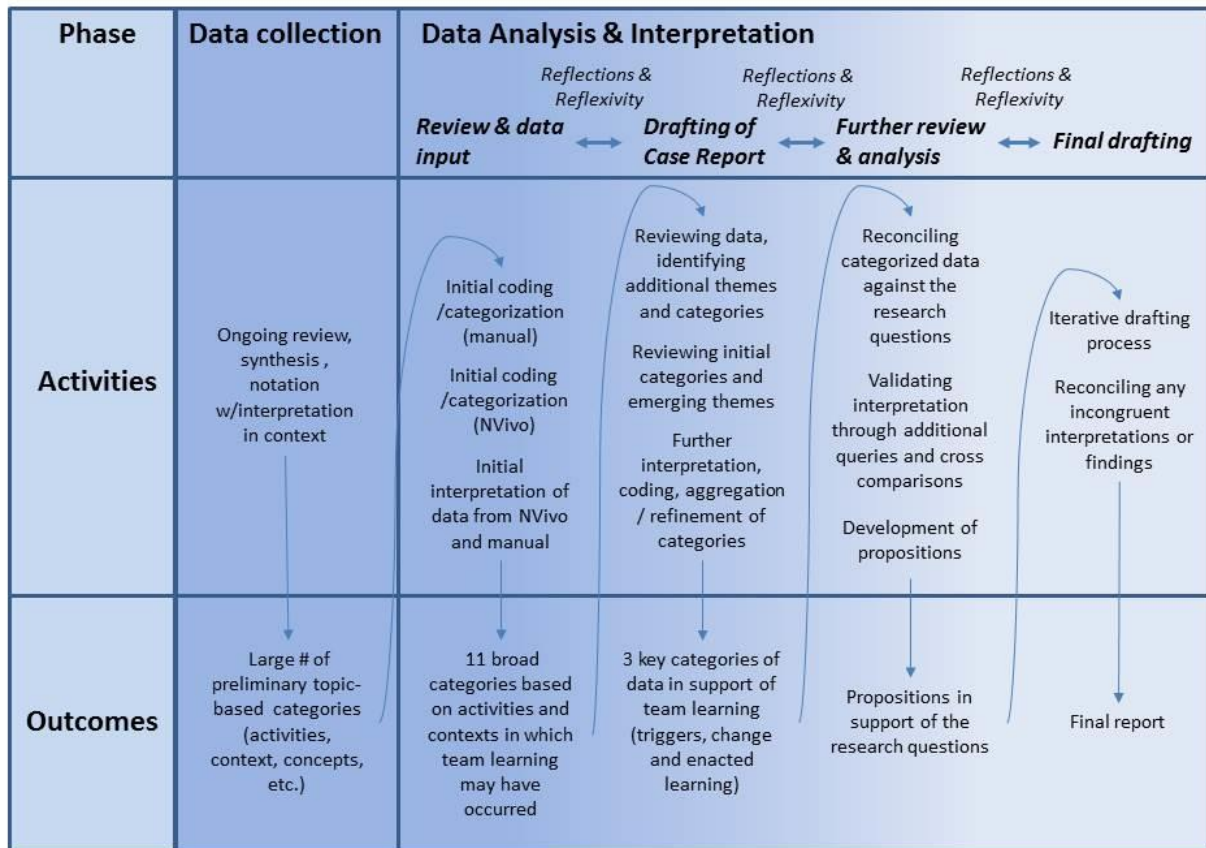


Figure 10. Data collection and interpretation process

As already stated, I entered the study with my own understanding and meaning of the team’s work and context. Once engaged in the study, there was a continuous ‘building up’ of the picture as I conducted the data analysis and this picture was iteratively revised as the analysis progressed up to the final draft of this final case report. While initially frustrated by not having the data present a clear and crisp picture that helped answer the research questions, I soon realized that this was the process up to and including the writing of this report.

Summary

Given the complexity of the case and the research questions, the data collection required the use of multiple methods to ensure that various facets of team informal learning and collective

transformation would be reliably captured within the data. The data analysis and interpretation was an iterative, recursive process that involved three distinct reviews of the data from the various sources and identified interrelationships amongst the data that resulted in three comprehensive categories that supported the research questions: enacted learning, triggers and drivers for learning, and team change. The next chapter provides my findings and the two subsequent chapters will present a discussion my findings and my conclusions.

Chapter Four – Findings: Revealing an Expanded View of Team Learning and Transformation

Introduction

As an instrumental case study, the Information Technology Security Incident Recovery Team (IT SIRT) activities provided ample data to help answer the research questions. The majority of workplaces are complex with myriad interrelations and connections among people. As with the analysis of any complex human system, there are multiple, interconnecting phenomena that arise from the interactions of the individuals within the team and, in this case, the interactions of the team itself with other teams, the broader organization and their environment. Noting that these interconnections are also avenues for collective learning, they were central to the data collection and analysis and form the common thread throughout the findings. Given the quantity of data, the analysis of the case became a process of analyzing, interpreting, and filtering to find and better understand the interactions, activities and processes that were relevant to team informal learning. In analyzing the data, the challenge was filtering the data because each phrase recorded, each word transcribed, and each observation held meaning. Knowing that I could not simply tag words and place them in a category without losing the participant's stories, I needed to find the way to articulate the case findings that would retain this meaning and help relate the context of the team's experience while ensuring that there was a credible case presented to the reader.

I start this chapter with a detailed description of the organizational and work context and a more detailed description of the participants that includes references to relevant local documents from multiple sources. I will then present three major work contexts: daily work routine, non-routine events, and incident response and recovery operations. Leveraging multiple sources throughout, I will also provide examples, supporting statements and observations that demonstrate how collective informal learning was enacted within this authentic work team. As will be seen, there are times when quotes or document excerpts are used to support the findings. This is a function of the complexity of the work environment and how many of the statements or references cut across more than one situation.

As well, where evident, I will categorize the team learning that may have occurred using Eraut's (2004) typology of informal learning. To remind the reader, he has identified: implicit learning where there is no conscious attempt to learn; reactive learning which occurs in the

middle of activity offering little to no time for reflection; and deliberate learning where there is a definite learning goal and time set aside for the learning and related activities.

Within each of the major findings, I will also identify triggers and drivers to collective learning. Finally, I will present the findings related to the phenomena of collective transformative learning which was reframed using Mezirow’s (2012) perspective transformation. This chapter will close with a summary of the case including the major findings related to the research questions. Table 2 provides a summary of the key findings related to team informal learning and transformation across different work contexts. This should help the reader navigate through the rich picture of the case that follows.

<i>Team learning is influenced by various work and organizational context such as:</i>	<i>Team learning is enacted in daily work routine activities such as:</i>	<i>Team learning is enacted in activities during non-routine events such as:</i>	<i>Team learning is enacted in activities during incident response and recovery such as:</i>
<ul style="list-style-type: none"> • Stress • Job aids and performance support • Collective and team traits (gender, age, bilingualism, seniority and common skill and effort) 	<ul style="list-style-type: none"> • Meetings • Issue-based discussions • Sharing • Engagement with others • Generation of team products and artefacts • Experimentation and problem solving 	<ul style="list-style-type: none"> • Development of the case management system • Interactions within procurement processes • Developing strategies to dealing with staffing shortages • Changing technical infrastructure 	<ul style="list-style-type: none"> • Adapting and self-organizing • Leveraging other resources • Interactions with other teams • Consultations
<p>Major triggers/drivers</p> <ul style="list-style-type: none"> • Mandate • Dynamic environment • Required skill and knowledge 	<p>Major triggers/drivers</p> <ul style="list-style-type: none"> • Formal, organizational mechanisms • Situations or team needs • Common motivations 	<p>Major triggers/drivers</p> <ul style="list-style-type: none"> • New tasks • Team constraints or capacity • Organizational processes • Overcoming a problem 	<p>Major triggers/drivers</p> <ul style="list-style-type: none"> • Discovery of an incident • The unknown or unanticipated • Organizational pressures and expectations
<p>Provided context and influences for transformative learning, but none identified.</p>	<p>No transformative learning identified.</p>	<p>Potential for transformative learning in:</p> <ul style="list-style-type: none"> • How they operated • How they saw themselves. 	<p>Potential for transformative learning in:</p> <ul style="list-style-type: none"> • How they operated • How they saw themselves.

Table 2. Summary of key findings

The Organizational and Work Context

The following is a detailed description of the team's organizational and work context that was drawn from multiple sources, though the emphasis is on documentary sources and observation. Given the team's unique role, this description introduces terms and concepts that are important to further understanding of the team. It also situates the team at the meso-level of experience and provides readers with insight into the language, culture, processes and events that influence collective learning within this authentic work team.

At the time of the study, the Government of Canada (GC) was in the process of merging and updating several disparate departmental networks and systems into a single large network of IT systems to meet the growing information needs of the Government and Canadians. This initiative, under the auspices of Shared Services Canada (SSC), aimed to improve the efficiency, reliability and security of the Government's IT infrastructure, increase productivity across departments and help build a more modern public service (Shared Services Canada, 2013a). SSC was formally established as a central agency within the GC on 4 August 2011 to fundamentally transform how the Government manages its information technology infrastructure.

Due to its global, economic, and political interactions, GC systems are an attractive target for foreign military and intelligence services, criminals and terrorist networks (Public Safety Canada, 2013). Consequently, GC networks and systems are under constant threat from deliberate attacks, accidental occurrences and natural hazards. At a government-wide level, security threats, risks and incidents must be proactively managed to help protect the Government's critical assets, information and services, as well as to support national security (Government of Canada, 2012). Though a majority of IT security incidents are relatively minor, a significant disruption or intrusion into GC systems and networks can result in significant financial, resource or personal risks to Canadians or Canadian interests at home or abroad.

The IT SIRT was formally established 1 November 2013. The IT SIRT is a nascent capability housed within SSC, though it has a mandate to respond to the advanced response and recovery needs of all GC departments and agencies. Not only is the concept of the IT SIRT new within the GC, it is unique within the Five Eyes security and intelligence community which consists of United Kingdom, United States, Australia, New Zealand and Canada. Consequently, at the time of the study, the team was still evolving and refining their work processes, tool sets, procedures, and connections with others.

The IT SIRT is part of an integrated incident response and recovery capability for the GC. A great deal of their learning is driven by this mandate. To appreciate the scope of the IT SIRT's mandate, at the time of the study, there were 43 partner departments and 170 other departments and agencies for a total of 214 including SSC (Government of Canada, 2016). Incident response and recovery are part of the larger incident handling process which includes preparation, detection and analysis, containment, eradication, and recovery (Government of Canada, 2012). Response is defined as an organized approach to identifying, categorizing and mitigating an incident. Recovery is defined as "restoring networks and services to pre-incident levels and the cause of the incident has been satisfactorily mitigated" (Government of Canada, 2011).

The IT SIRT scope of work extends beyond core GC networks and systems to include support for all GC departments and agencies. The IT SIRT is a unique, semi-autonomous work team "tasked in the recovery from complex and/or widespread IT security incidents to ensure the rapid restoration of services government wide" (Shared Services Canada, 2015a). The IT SIRT responsibilities span reactive as well as proactive and consultative services. These responsibilities continue to evolve. The most recent document indicates that the IT SIRT is responsible to:

...provide in depth analysis and direct on-site incident response supporting repair and recovery operations. The unit has the delegated responsibility to provide and/or oversee any forensic evidence collection and all phases of artifact handling in incident response activities. IT SIRT can perform vulnerability scanning and will also observe emerging technologies to maintain awareness and proficiency. The team will aid in the development of cyber intelligence and supply technical advice on security related information generated by the SOC, and will provide expert advice in the development, configuration and maintenance of security tools applications, infrastructure and services. (Shared Services Canada, 2015a)

As alluded to above, the IT SIRT does not work in isolation. The IT SIRT is co-located with the Federal Information Protection Centre (FIPC) and the GC Cyber Incident Response Team (GC CIRT) within the Security Operations Centre (SOC) at SSC. The IT SIRT is intended to "operate with a high level of integration with the FIPC and the GC CIRT" (Shared Services Canada, 2015a). The SOC concept of operations (CONOP) was still in draft form at the time of

the study and the team functions, roles and responsibilities continued to evolve as I observed in my review of the team's documentation up to summer of 2015. Of note, at the team's formal inception in 2013, there were only loose concepts of how the three SOC teams were to be connected and no firm organizational structure. As shown above, this situation has changed. This is one indicator of the evolving organizational context in which the team was immersed at the time of the study.

All three teams including the IT SIRT report through a manager, to the Director of Security Operations. However, as the IT SIRT has the mandate to support all GC departments and agencies, other communication and activity pathways depended on the type, extent, and source of the incident. For example, they also have an operational reporting relationship with Treasury Board Secretariat (TBS), also through their director. The IT SIRT also has a direct working relationship with the Cyber Threat Evaluation Centre (CTEC) at the Communications Security Establishment (CSE), and the Canadian Cyber Incident Response Centre (CCIRC) housed within Public Safety (PS). In the event of suspected cyber-crime, they are also required to work with the Royal Canadian Mounted Police (RCMP) (Government of Canada, 2011; 2015).

Unlike other IT domains, the IT SIRT members are required to have a high degree of situated expertise that is only partly predefined and evolves with the dynamically changing context of the environment in which the incident occurs (Shared Services Canada, 2015a). To perform the three-fold mandate of reactive, proactive and consultative services, there is a wide range of requirements as per the original IT SIRT Team Charter (Shared Services Canada, 2013) and expanded on in the more recent draft of the SOC CONOP (Shared Services Canada, 2015a).

The IT SIRT functions include: risk assessment; security audits or assessments; configuration and maintenance of security tools, applications and infrastructure; development of security tools; business continuity and disaster recovery planning; security consulting; awareness building; education and training, and product evaluation. All of these requirements differ considerably from the previous roles each of the members filled in other IT or IT security teams. Suffice to say, the IT SIRT is required to consistently work at the edges of their discipline, forming and re-forming past knowledge and generating new knowledge to respond to complex, high risk cyber threats to GC networks and systems. This drives a considerable amount of both individual and collective learning within the team.

Given that the team only consists of ten members, the reactive, proactive and consultative mandate is tremendously ambitious. Moreover, the knowledge and skills required to fulfill such a mandate is extensive (Shared Services Canada, 2015c). Rather than list all of the tools, technologies and skills required, Table 3 provides an extract from the draft human resources strategy (Shared Services Canada, 2013b) which shows the team's major tasks. For each task, there are knowledge and skills related to policies, processes, procedures, practices and tools that are required. Many of the knowledge and skills are interrelated with and facilitate other tasks. The table also helps to distinguish IT SIRT tasks and skills from those of the GC CIRT and FIPC. Within the table, 'C' represents a core capability, 'S' represents a specialized capability, and 'A' represents an asset to completion of the task.

Security Task	GC CIRT	FIPC	IT SIRT
Incident handling, analysis, management	C	C	C
Computer forensics	-	S	C
Network traffic analysis	-	C	C
Network infrastructure configuration	-	C	-
Threat monitoring and detection	-	C	-
Forensic evidence collection	-	S	C
Tracking or tracing	-	C	S
Vulnerability analysis	-	C	C
Malware analysis	-	C	C
Artifact analysis	-	C	C
Security assessments and audits	-	-	C
Development of security tools	-	S	C
Configuration management	-	C	S
Business continuity	A	A	A
Disaster recovery planning	A	A	A
Penetration testing	-	-	C

Table 3. SOC team skill requirements by role (Shared Services Canada, 2013b)

To address task-based knowledge and skills, team members have been developed through various formal learning activities such as participation in private sector technical skills training provided by commercial vendors, GC process and procedures courses, incident handling seminars and specially developed recovery operations workshops (Government of Canada, 2014). Further, as they integrated into the team, new individuals connected to new knowledge, networks, tools and sources of information through informal learning processes such as meetings, working groups, peer-discussions and online research. As with any team, their capability was limited. When issues arose that went beyond the team's capability, it triggered additional learning and they referred to sources of expertise external to the team which could be in another government department or from the private sector. Based on the documentation and observations, they often sought this type of support from specific GC security partners such as CTEC and the RCMP (Government of Canada, 2011; 2015).

As identified in the participant statements, the team's physical work environment was an important aspect of their learning environment. While photographs were not permitted, a graphic in Figure 11 has been created to provide a sense of the team's work space that was located within a government building in Gatineau, Quebec, Canada. The room consisted of approximately eighty square meters of floor space. The team members often commented on their room noting that "we don't have enough space to function properly" (Interview G) and that the room itself creates "high stress, high pressure" (Interview O). At each workstation there were at least three monitors, two portable computers, a chair and other pieces of equipment such as switches, keyboards, and other devices. It was common to hear that there's no room to "spread out" which is particularly important considering the frequent need to work with their own systems and other department's hardware (Focus Group 1 A; Focus Group 1B). The participants seemed to be in consensus however, that the small room was a benefit to intra-team communications in that the "room kind of brought us all together" (Interview C), "we all know each other" (Interview O), and "we often share a social environment...(information) spreads quite rapidly..." (Focus Group 2A).

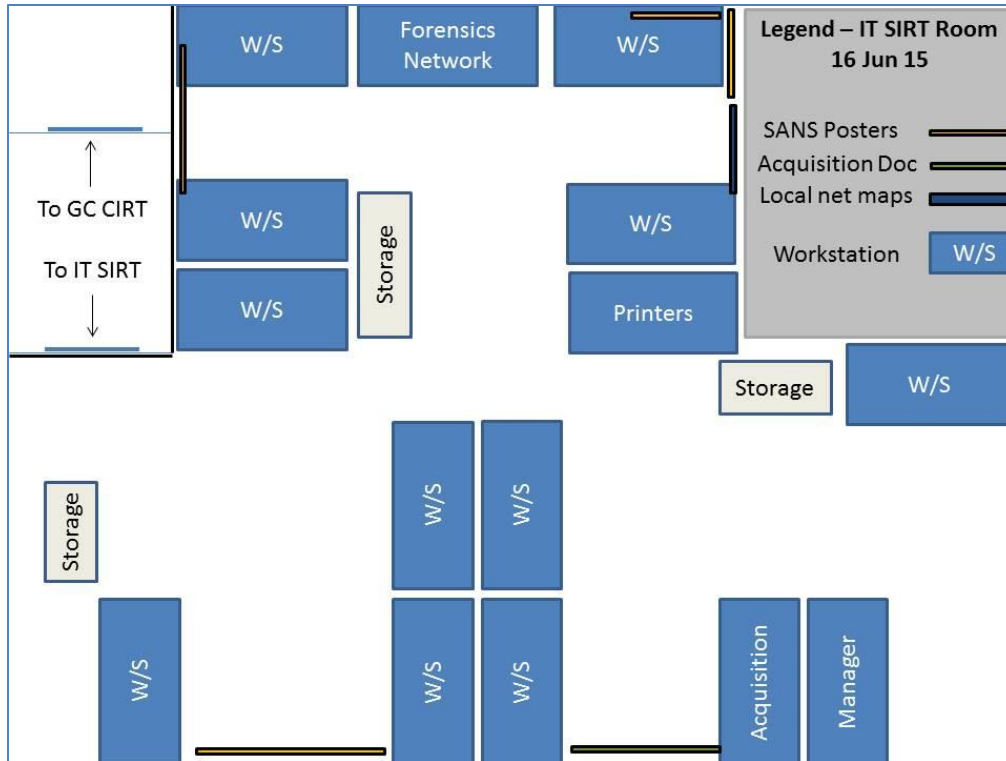


Figure 11. IT SIRT work space

The management has recognized the space deficiency and a new SOC facility was being constructed within the same building that promises to provide appropriate workstation set ups and space aligned with GC workplace 2.0 standards. Whether this will be sufficient and accommodate this unique team's needs remains to be seen. As of this report, the team has apparently moved into this new facility.

Beyond the physical environment, the IT SIRT was working almost continuously in cyberspace. Cyberspace is defined as “the electronic world created by interconnected networks of information technology and the information on those networks” (Government of Canada, 2010). It also includes the humans that are interconnected to these networks. As an emerging, dynamic work environment, cyberspace is only bounded by the networks and systems. There are no borders, enforceable jurisdictions or ways to contain illicit or illegal activities. It is truly a ‘global commons’ (Government of Canada, 2010) and all that entails. As a work environment, cyberspace comes with many uncertainties and vagaries that have not been previously experienced. In the broader context, cyber security is far more extensive than the systems and networks; as the work of the IT SIRT demonstrated to me, the human element plays an ever-increasing role in cyber security.

Another important contextual element was the global cyber threat situation and the power of the team to combat multiple, well-resourced threat actors. Both state and non-state adversaries are continuously engaged in trying to access GC networks and systems. The reasons for this are many, but include access to economic information, intellectual property, scientific information, information on GC employees or the Canadian public, and national security information. As well, there are deliberate threat actors, accidental occurrences or natural hazards that may disrupt or degrade GC networks. The number of potential adversarial actors and the resources they have far out-number those used by the GC (Government of Canada, 2010). This places the IT SIRT at a continuous staff and resource disadvantage relative to the threat. Accordingly, this drove team informal learning as they were constantly assessing and reassessing the threats, incidents and team capabilities, and prioritizing work to support the greatest threats to GC security. At times, they were assigned to respond to an incident that requires them to drop all ongoing cases and pour all of their resources into that incident. As noted in one focus group:

If we working on a case that's not as high a priority as something that comes in, that will definitely affect the way we...we do have to put some cases aside; if you're more just doing research type of investigation compared to something that's ongoing, so we got to prioritize. That's another area that can effect...where you have to simply put aside a case and start another one if that's deemed to be more important. (Focus Group 1B)

In another example during my observation, while the team was investigating a network compromise, they were asked by their Director to investigate and help mitigate an incident that occurred against a high profile department. Such events appeared to occur on occasion and help to demonstrate the needed flexibility and adaptability to work in this dynamic environment.

Understanding the threat context and at least some of the motivations of threat actors, the discussion of the risk environment is also important. There is rarely any unusual degree of personal risk to the IT professionals in their day-to-day, IT security work or incident response and recovery work. However, the IT SIRT is considered to be working in a high risk environment (HRE). Dietrich and Childress (2004) define an HRE as a context in which there is more than a normal chance for damage to one's own life/livelihood, the life/livelihood of others, or to property. As is commonly known, cyber space is rife with issues of security and privacy that we do not yet fully appreciate. Cyber threats are not only of concern to the Government. As stated in Canada's Cyber Security Strategy (Government of Canada, 2010):

Cyber security affects us all, in part because even attackers with only basic skills have the potential to cause real harm. Sophisticated attackers can disrupt the electronic controls of our power grids, water treatment plants and telecommunications networks. They interfere with the production and delivery of basic goods and services provided by our governments and the private sector. They undermine our privacy by stealing our personal information. (p. 3)

Indeed, the cyber security environment has the potential for a wide-range of threats to the Government and to the Canadian public. Due to the work they were performing, the IT SIRT was working in an HRE. Moreover, in extreme cases, they may also be subject to personal risk if they are targeted by a threat actor.

There are two other general areas of importance to the team's general work context prior to discussing the findings within the different work contexts: the influence of stress; and the job aids and performance support in team learning.

The influence of stress on team learning. Incident response and recovery activities were described as very stressful and the stress originated from different sources. As will be shown below, stress in these kinds of operations seems to be an important factor to team learning. In a text query, the word 'stress' in the work context arose 22 times and was a theme discussed during six of the nine member interviews. As can be seen through previous findings and quotes, it was also evident during the focus groups.

The team is often required to work under time constraints to identify, mitigate and recover GC networks and systems from a compromise so that the affected department or agency can safely and securely return to normal operations (Shared Services Canada, 2015a). As noted in the statements of the participants and seen through observations, there is always the potential for additional stressors (Shared Services Canada, 2015c). As I observed in one of the incidents that occurred within the GC network, team stress increases if there is a sophisticated threat actor using advanced techniques because they are not certain as to the extent of the compromise or threat. As expressed by more than one member of the team, stress plays a role in the team's effectiveness. As alluded to by one member, the IT SIRT is particularly vulnerable as there are "the larger, multiple system infections and breaches that can cause a lot of stress within the group" (Interview H). An added stressor directly related to incident handling is when the courses of action employed to mitigate a compromise do not work or they find that the incident is in fact

more involved than they thought. In one of the examples recounted, there was a situation where they thought their courses of action were sufficient and they had managed to eradicate the malware. Then they “started looking into it and we found stuff going back months prior to that... there was all this other malware sitting on (the department’s network)” (Focus Group 1B).

There are other stressors that are driven by factors that have nothing to do with the incident itself. For example, there are culture and power issues revealed when a department’s senior management directly engages in how or what response or recovery efforts are taking place. As one member noted during one incident “[w]e probably put a lot of pressure on ourselves”, but “[we were] getting pressure from our own management and [the other government department’s] management...” (Focus Group 2B). This may also trigger other unintended activities. For example, another stated that there are situations where they “get forced to work on things in certain ways or on certain timelines that don’t have a basis in reality” (Focus Group 1B). Another example of this type of induced stress relating to another work context, but is worth repeating. A team member recounted an experience where he discussed how:

executives will circumvent the intake method. So instead of the department contacting the GC CIRT or FIPC to look into an incident, they’ll call directly over to a Director over here and then it will come right down the pipe down to us so it immediately becomes a security incident before it becomes prioritized. (Focus Group 1B)

In observing some of these types of situations, the activities that had nothing to do with effective incident management distracted the team from what they believed was important. There were visible signs of frustration and it was acknowledged that this “increases the stress level as well” (Focus Group 1B) within an already stressful situation.

Another source of stress not specifically related to the incidents were the team’s challenges with procurement or when the team is short-handed. In both situations, the team’s work was frustrated by a lack of people, resources or funding and this created additional stress on the team. As noted by one member discussing the context surrounding the major incident in 2014, “There was a lot of stress and we didn’t have the needed resources” (Focus Group 2B).

As noted in my reflections, the emphasis on stress is important as it influences how the team works and its ability to learn. On the face of it, the stress seems to impair learning as the team behaviours change as do the individual behaviours when under stress. As an example from observation, the greater the intensity of the work environment during an incident, the less work-

related communications there were. In more stressful situations, I noted, and some members acknowledged that, in general, there was an increase in the use of expletives, arguing, resistance to work together, a 'turning inward' of some of the members, and "venting" (Focus Group 2B). Another noted, that "Occasionally, there's conflict within the team. Part of it though is being in a small room with high stress, high pressure. We try to diffuse it. The root cause is the stress in the work environment" (Interview N). The degree to which this had an impact on the team learning was not specifically identified, but as discussed above there is no doubt that with reduced interactions there were fewer possible instances of team learning.

Job aids and performance support in team learning. As previously presented, much of the knowledge related to the team's work is highly technical, perishable, and mutable. Accordingly, to support their incident handling and forensics work the team leveraged a wide range of job aids and performance support. These were quick references or tools that the team used throughout their work processes. The following were observed within the room and as the team members did their work on their workstations:

- wall posters depicting the steps related to various technical procedures. These were normally provided through vendors and technical training;
- team generated or commercially available graphical representations or checklists at workstations;
- a full suite of standard operating procedures (SOPs) on the team's shared system folder;
- tools, applications and help files on work stations;
- the case management board (the white board);
- electronic templates; and
- numerous online resources such as vulnerability data bases, threat profiles, malicious software signatures, and known mitigations.

These mechanisms for team learning and performance have found their way into team norms and practices. As an example, one member noted that:

When we had this recent one come in yesterday, we pretty much put on the white board [the case management board], based on our lessons learned from the last one, these are the steps we want to take, these are the things we need to do (Focus Group 1B).

In another example, one of the members stated that "We've got our own kind of template, through the SOPs and stuff, of how we go to acquire, we all try to do the same thing, to have a

template of how to get the job done so it's consistent" (Focus Group 1A). As observed during team incident handling activities, information from these sources were also available to or distributed to all members and often, to the FIPC and GC CIRT as per the SOC CONOP (Shared Services Canada, 2015a). As well, I observed the FIPC and GC CIRT contribute to the team's understanding of the situation; as noted by one member, "I think most of the stuff we're learning (during an incident) is from GC CIRT, FIPC" (Focus Group 1B).

In summary, there is evidence that team learning contributed to the development of some of the job aids and performance support mechanisms. As will be discussed later, there is evidence that these artefacts were key in supporting team learning, they provided a source of team knowledge, and provided ready access to various aspects of their incident response, recovery and forensics responsibilities. As well, they facilitated understanding, communications and learning of IT SIRT actions with other teams during incidents.

Summary. From the above, the reader should have a better understanding of the terms and concepts associated with the IT SIRT's unique work. This description should have also provided the reader with a general appreciation of the socio-cultural and physical work environment including the level of stress and the complexity of the work. Moreover, key drivers and triggers to team learning are evident from the mandate, the extent and type of knowledge required, the stress, and the dynamic environment in which they work. This provides supporting background information for the next section which discusses the team and participants in more detail.

The Team and the Collective Attributes

At the end of the period of observation, the IT SIRT consisted of ten IT security professionals with varying degrees of education and experience. Though it should be appreciated that the team manager was loosely implicated in team activities and contributed to major discussions, he was primarily representing the management, had various powers and responsibilities that others on the team did not have and was not directly involved in the team tasks or activities other than in a supervisory capacity. As an approving authority for the study, he was not considered a participant, was not part of the focus groups, nor was he interviewed in the course of this study.

Table 4 presents general information about each of the team members. The member codes used and limited amount of identifying information is to protect the identities of the participants. The names that match the codes are only known to me. The codes assigned are used

throughout this report when referring to specific individuals or supporting quotes to allow me to reference back to the original transcriptions. Potential identifying characteristics have not been included to preserve the confidentiality of the individuals within this small team.

Team member code	Gender	Age Group	First Official Language	Seniority on team (years)	Educational Background and Specialization
G	M	40-50	French(F)	2	Network Security / Information Protection Centre
C	M	20-30	English(E)	1	IT Security
H	M	30-40	E	2	IT Security / Information Protection Centre
S	M	40-50	F	3	IT Security / Information Protection Centre
E	M	30-40	F	1	Information Protection Centre / Forensics
P	M	40-50	F	2	IT Project Management
B	M	30-40	E	3	Application Development / Programming
N	M	30-40	E	3	Networking / Programming
F	M	30-40	F	3	IT Systems / Networking
L	M	40-50	E	3	Networking
O	M	40-50	E	1	Networking

Table 4. Team member Information

The individual team members all have a college education or equivalent, such as significant technical training in a post-secondary learning environment including commercial or vendor certification training, college certificate courses or college diplomas. Each of the members of the team were recruited to the team with specialized IT knowledge and expertise from various sub-disciplines including: network administration, computer forensics, IT security, computer programming, project management, information management, and software development. As one member put it, the former manager was looking for diversity in the team, therefore, he hired people with “different skill sets, just to make the team very well rounded” (Focus Group 1B). Consequently, while half of team members had IT security background and incident response experience, the remainder were IT practitioners with education and experience

that would support other types of activities in the team such as IT networking and project management. Notwithstanding, this latter group participated in all team tasks and were continuing to develop their skills in IT security and digital forensics through formal, non-formal and informal individual learning. Equally, those specializing in IT security appeared to gain additional understanding of the respective IT specialisations through informal engagement with the other team members.

At the team level of analysis, there are five collective attributes that are relevant as they may have influenced collective learning and how it was enacted. First, while there was some ethnic and linguistic diversity on the team, it consisted entirely of males. This is of relevance because it appears to have directly influenced the type of interactions. As some of the participants noted, the team was “a boy’s club” (Interview G) where “it’s a bunch of guys, it’s a man cave mentality” (Interview B). Their behaviour might have been considerably different had it been a mixed gender team. In fact, one noted that with the upcoming move to co-locate with the other teams in one large room that “when we go into that new room, it’s going to be an awakening or something, it’s going to be very different” (Interview B). At least in the opinions of the participants, this dynamic of an all-male team influenced the types of interactions that occurred and therefore would have influenced the learning in various ways that one could surmise would be different than more diverse teams.

Second, I noted that the team member age may be relevant to team interactions and learning particularly as this was an IT workplace. At the time of the study, only one member was below the age of 30; the remainder were almost equally distributed between 30-40 and 40-50 age groups. I observed only minor generational perspectives evident within the team in the informal and work-based discussions. However, in my observations and through the review of the work logs I did not detect any significant generational differences related to the work, though generational differences in learning should not be discounted.

The third attribute that influenced the team learning was bilingual nature of the team. In this case, half of the team was fully bilingual Francophone and the other half was unilingual Anglophone. As observed on many occasions and as noted in interviews (Interview O) and focus group statements (Focus Group 1A) there were often times where Francophone members would be discussing a case or situation and while the remaining Anglophone members could overhear

what was said, they often did not have the language skills to understand. As noted by an Anglophone member:

It's like when E and F, they have this great conversation (in French) about X-ways, well we (Anglophones) were no longer involved in it and all of a sudden we have a link going to X-ways, 'hey guys, this is the software we talked about.' Sometimes it's the nuts and bolts within the engine that you really want to know about. Nothing against E and F, that's their mother tongue. (Focus Group 2A)

While it was common for French colleagues to discuss issues in their primary language during work, in my observations and as supported by the quote above, any conclusions arrived at that were of relevance to others were disseminated to the remainder of the team. Based on the participant statements and my observations, such exchanges were frequent, often daily occurrences that were recognized as another way that team learning was influenced within this specific work team (Focus Group 1A; Interview L). Accordingly, language was also an influence on team learning.

Fourth, the members' seniority on the team is relevant to collective learning. At the time of the study, two of the members joined the team within the last year and another had recently rejoined the team after a year-long assignment to another department. This was beneficial to the study as I was able to obtain three broad perspectives on the team. I had the opportunity to hear from: individuals who were with the team since inception; individuals who had recently joined the team; and one individual who had been with the team and returned. The views of these three informal groups within the team were enlightening and helped in identifying team changes. This was also instructive as it helped me to find out how new members were indoctrinated and integrated into the team.

Finally, the team requires specialist skills to perform their functions. The list of skills and tools used to perform their jobs varies from member to member based on specific tasks, interests, and preferences. Referring back to the team tasks in Table 3 and the IT discipline experience of each member in Table 4, it is evident that each of the team members brought different skills and experience to the team, though not all members were able to perform key tasks on the team. This meant that there were some members who were able to immediately step in and perform required tasks while others needed a significant amount of additional knowledge and skill which provided an ongoing driver for additional individual and collective learning.

For example, the experienced forensics analyst who had limited experience on the team, was able to walk into the job with little difficulty and assume a key mentoring role on the team as he was familiar with a majority of the tools, applications and techniques the job required. As noted in interviews and focus groups, he was considered a key source of shared knowledge in the team. As one members noted “I leverage (name) because he’s higher in the forensics knowledge than I” and another echoed “(name) is very adept at forensics and incident handling” (Focus Group 1A). Though he needed to learn about local processes and procedures, he was comfortable with the main technical operations within the team.

As noted through the interviews, others not only had to learn about the local processes and procedures, but had significant learning gaps in the technical operations of the team that triggered further learning. For example, in one interview a member noted “The gap we have between experience and skills. I mean, me being new to forensics, I don’t have any experience so I’m probably one of the newbies as far as skill set there and there’s a huge gap between me and one of our top guys. Huge” (Interview P). In such cases, this can impact on a member’s ability to contribute. There was definitely a desire to have opportunities to gain skill and knowledge to identify “what an individual is missing so he can pull his own weight so he’s not just sitting around” (Interview O).

Based on my understanding of the team’s history from the documents reviewed, the team training record (IT SIRT, 2015) and observation, the fact that all members did not have the minimum skill and knowledge to fully contribute to the team is a function of the work load, priorities and pace of work in the team over the past two years. It would have been difficult and costly to provide the full suite of needed technical and process-based training to these individuals while the entire team was struggling with multiple incidents. That said, even though they could not perform advanced IT security and forensics tasks, the less experienced members were able to contribute by performing supporting tasks and help with various tools and applications related to their past work and experience.

As well, in absence of formal training, they commonly participated in self-directed and other forms of informal learning. A behaviour observed time and again was the individual exploration into a new tool or technique that was introduced by another member as in the example discussed in Focus Group B: “[Name] really like’s X-ways, so I’ll look into X-ways and see what it does and next thing you know I’m using X-ways.” In another instance, there may be

an operational driver to the learning. One member recounted his experience: “when I started in this group, I pretty much immediately got put on a case. And [name] said, OK ‘you’re going to use Encase...here’s a link to some videos.’ And that’s how I originally learned Encase” (Focus Group 1B). Similarly, when individuals were not fully involved in a case, I observed individuals doing online research and experimentation with tools and applications.

As I observed and reflected in my journal, I believe that each of the team members was a dedicated public servant who was earnest and forthright in their desire to do the best job possible. Even when there were no ongoing cases, I saw individuals working quietly at their workstations on work-related matters such as online training or research. I also regularly saw individuals volunteering to work on activities, making suggestions for improvement or exercising initiative to develop or create new tools or systems to support the team’s work. This was also supported in statements from the members that noted a strong work ethic such as “there’s an expectation for you to do something and you do it the best you can” (Interview B). This attitude evidently drove some of the individual and collective learning within the team.

Notwithstanding, there was a perception that the workloads were not necessarily equally shared. For example, one member stated that “I would say that we have a core group of people who are more productive” (Interview G). Another stated that “the work isn’t evenly distributed” (Interview O). Perhaps painting a slightly clearer picture, another stated:

[W]henver a major incident happens, there are just a few people that will stay and work the extra hours and come in on the weekend. But it seems to work itself out quite well, because the people that stay to work those hours are the people that want to. They want to be there, they want to be involved and have their hands in the pot for major incidents. (Interview C)

This latter view is congruent with my observations; everyone appeared to meet the required expectations and there were a few who occasionally went ‘above and beyond.’

Overall, the collective attributes or traits of gender, age, bilingualism, general seniority, and common level of skill and effort provides a global view of the team. The influence of each of these attributes or traits on team learning was apparent through member statements and observation. There were evident drivers to collective and individual learning such as gap in skill and knowledge noted in less experienced members. This description also helps the reader to better understand the character of the team as a unique entity within the organization. The

description of the team and the key team attributes and traits are relevant as they have an influence on collective informal learning and how it was enacted. With this richer understanding of the organizational/work context, the team members and the team as a collective entity, the next section will delve into three specific work contexts in which team learning was evident.

Three Observed Work Contexts

As previously mentioned, the following will delineate findings in terms of three broad work contexts: the daily work routine; non-routine events; and incident response and recovery operations. Within each of these contexts, there are different issues with which the team has to contend and the conditions under which collective learning occurs are dramatically different such as urgency, stress, available resources and other factors. In addition to the attributes previously discussed, these all influence what collective learning occurs and how it is enacted in this authentic work team. As the reader will also see, regardless of the context, some of collective learning processes extend across all three work contexts. Within each of the work contexts below, I will provide a general description of my findings and present how the team learning was enacted, identify triggers and drivers to the learning, and outline the transformative learning that the team experienced.

The findings below are drawn from documents, observation and team member input during interviews and focus groups. As well, I drew upon my record from my reflexive journal and included my comments where I believed it contributes to the reader's understanding. The findings are intentionally delivered in a narrative style to provide additional context and further explicate member's responses or the learning situation.

The daily work routine. The bulk of the team's work occurred during normal working hours, 0700 to 1700, throughout the traditional business work week, Monday through Friday. However, during the period of observation, there were several occasions where the team, sub-teams or individuals were required to work outside of normal hours and on weekends. A large majority of the team's work was conducted by individual members though this work was often contributing to a task of an assigned sub-team or the team as a whole.

The word 'routine' connotes normal work environments where the predominant activity is often thought to be work generally free from special, unique or stressful situations. Despite the moniker 'routine', this was anything but the case with the IT SIRT. Every day, routine or not, was rife with learning opportunities.

From the casual observer's perspective, the team's daily work routine might look similar to any collegial office-based work environment. In any given day, the team was engaged in working at their workstations, exchanging work-related information, participating in minor social interactions, responding inquiries from outside the team, completing correspondence with others, and attending meetings. The main tasks within the work routine included the daily "Y meetings" that involved representatives from all three SOC teams, separate IT SIRT team meetings, work on ongoing cases, assigned administrative and logistical tasks, formal learning and self-directed learning and research.

During the observation period, team members were regularly interacting with each other face-to-face and through their local or GC IT systems. The number of actual interactions was not tracked as it was almost continuous for the first half of every work day. Generally, if there were no ongoing cases, face-to-face interactions seemed to dwindle after the initial meetings. As the day progressed, there appeared to be more independent and work-station focused activity. Within the routine work day, the team members were typically engaged at their workstations for roughly 70% of the time. Though I was not provided access to the individual system logs, through my observations during routine work, it appeared that while at their workstations, individuals spent the majority of their time engaged in legitimate work activities such as investigating and working on ongoing cases, conducting research, reading professional articles, experimenting with or developing new tools and applications, maintaining records and logs, maintaining systems, and participating in web-based learning. As I noted in my observations, at least some of each day appeared to be dedicated to some form of self-directed learning or more formal form of professional development.

As noted through observations, focus groups and interviews, there were frequent peer-to-peer discussions throughout the day. Most visible were the daily engagements that included interactions with other individuals/teams either face-to-face or via the phone or email. At the team level, there were similar activities. In addition to the frequent dialogue, collective learning occurred through:

- meetings;
- issue-based team discussions;
- peer-sharing expanding to team practice;
- engagement and exchanges with others or other groups/teams;

- generation of team artefacts and products; and
- collective experimentation and problem-solving.

Each of these will be discussed separately with related examples.

Meetings. One of the most regular team activities was the daily team meeting. Every work day, the duty analyst and other members working on cases of interest to the other teams, would attend the Y meeting which normally included multiple representatives from each of the three SOC teams: the IT SIRT, GC CIRT and FIPC. The agenda for this inter-team meeting was almost exclusively related to new or ongoing incidents of relevance to the GC that were being managed within the SOC. Each team would provide a status report on cases that were within their purview. In review of the team logs, interview and focus group statements and as observed, there were often times where there were no significant incidents or pressing issues arose during team meetings. The Y meetings were normally held in the GC CIRT office spaces and almost all attendees stood during the meetings. In such situations, the Y meetings were primarily about information sharing and the primary outcome was increased situational awareness of all the teams.

However, the Y meetings were more than just a mechanism of information sharing. Though not through any formal or explicit means, the Y meetings also reinforced collective identities. As observed, the teams participated in the meetings as a visible collective; they tended to arrive as a group, stood together as group and generally left as a group. It was also common that the team members from the respective teams identified themselves as a collective and referred to others in the collective sense as well. Whoever was in charge of the meeting would acknowledge the others stating “IT SIRT and FIPC are here” – the individuals were part of the IT SIRT or FIPC but recognized as representing the team and identified as such. This also occurred within the IT SIRT, they often referred to both themselves and others in collective terms based on either the function or the organizational they serve: “GC CIRT is our main line of communication” (Focus Group 1B); “we also work in conjunction with tippers that are being received from CSE and sometimes the RCMP” (Focus Group 1B); “(we work with) SSC Server Ops” (Focus Group 1A); “we work with CSE, CCIRC and RCMP” (Focus Group 1A); “I think now that the IT SIRT name has gotten out there quite a bit” (Focus Group 1A); and “I’m not talking about the SOC, but IT SIRT, with what we’ve done since 2 years” (Focus Group 2B). While perhaps not as explicit as other learning outcomes, in the cases of the Y meetings and the

references to other collective entities, new members within the teams appeared to quickly assess and learn the status of their teams during these meetings and discussions.

The IT SIRT team meeting followed the Y meeting each day. The team meeting was typically led by the Duty Analyst (DA) who attended the Y meeting and briefed the remainder of the team on any salient points from the Y meeting. During this meeting, the DA also reviewed the ongoing case list from the case whiteboard, and solicited input from the team leads for ongoing cases. As described by one member, “the morning meeting is a good area where we share information about what we’re doing and about the case” (Focus Group 1A).

The IT SIRT team meeting was often relatively brief lasting from five to ten minutes with limited discussion. There was always an opportunity for questions or comments which may stimulate additional discussion. While individuals shared their knowledge and perspectives, the result was a collective understanding of the team’s efforts, priorities and concerns for the day. This appeared to be an excellent vehicle for the team to solidify their shared understanding of ongoing cases and coordinate individual activities within the team. In one example, the DA briefed issues that arose at the Y meeting and, during the team meeting the Acting Manager tasked him some activities to support an ongoing case. The ensuing discussion included input from subject matter experts in the team on forensics and server architecture that helped the DA better understand the situation and progress work on the case. This type of activity was common during the team meetings as noted in a focus group:

All the other persons are resources available to him, the DA is going to share what needs to be done and then other people are going to jump in in order to do some tasks. And there is a good rotation. It’s not always the same guy being the DA, in my opinion when you’re the DA and you’re dealing with a big incident, this is where you get a lot of heat. So having collaboration of your colleagues helps you a lot. (Focus Group 1B)

The meeting was adjourned when everyone acknowledged that they were clear on the tasks for the day. As the meeting tended to be very informal, member acknowledgement came in verbal forms such as “yes” and “got it” as well as physical forms including head nods or facial expressions reflecting that they understood. After the team meeting adjourned, the team members would normally continue with activities in which they were previously employed.

Again, more was learned than simply the knowledge shared or issues discussed. During the observation period, I noted that the team meeting always included all members present and

provided an opportunity for members to learn more about each other and build internal relationships. As one member in a focus group stated, “the 15 minutes every day that we get is helpful as kind of a team building exercise. This is where you can share what you currently have or what you currently face, troubles or issue” (Focus Group 2A). As previously discussed, the Y meetings were also useful in supporting team cohesion and identity.

As seen during the observations, the Y meetings and team meetings were often a catalyst for follow-on discussions or activities. For example, during the meetings there were regular discussions on problems with tools and technology that related to a specific case. This was important as part of their mandate was to formulate of a comprehensive technical solution (Shared Services Canada, 2013a). As stated by one member, “[their work] changes so much because the scope of the incident varies and everyone has a different methodology or tools of choice, how to find specific artifacts in your evidence; it’s different every time” (Focus Group 1B). Consequently, there were often cases where they needed to define new processes. They acknowledged, however that their work is “so technically specific” that the tool or technology they were working with often defined the process (Focus Group 1B).

In one instance, the meeting was adjourned, but the three members who were engaged in a case continued the discussion on processing the case with a particular tool. The three team members formed an informal sub-team to tackle a technical challenge that they had encountered during the case. One member summarized the need for this type of activity within the team, “you explore other tools or leverage other people...we have all this knowledge, but we can’t know everything” (Focus Group 1B). As observed, through multiple discussions they had identified the key issues and arrived a common understanding of how to more effectively use the tool based on the merging of their collective knowledge and experience.

I also observed that this information was then shared with others in the team and documented in the case management system. In this situation, the learning was collaborative and deliberate as it was intended to resolve an ongoing problem within a case but allowed the sub-team to research and reflect on their options. This was also an example of collective learning that resulted in a technical process change that was adopted as practice at the team level.

Meetings were also opportunities for the team to navigate through uncertainty in case management or when there was a contentious issue. For example, a team member would raise an issue and other members of the team would contribute to the discussion. The sharing of multiple

perspectives and subsequent challenges and discussion helped the team move forward on the issue even without consensus. As one member stated:

there are times when we are paired down to one incident – the conversations back and forth, you can't absorb, you can sit there and read all of the tippers, read every single email that comes in and be updated. If everyone did that on their own, there would be a lot of lost information, I think. The fact that we have those conversations and meetings, it reinforces the turning points that someone else might not have picked up. Someone might have glanced over it and not realized the importance. (Focus Group 1B)

In these situations, the meetings served as a means for the team to deliberately share knowledge and generate new ideas about the situation and come to a collective understanding on a case or issue before progressing. It also allowed for the formulation of a team approach which may be based on previous experience or something completely novel.

In summary, the meetings served as a discussion space, a platform for dialogue and decisions on the collective way forward on a variety of issues and problems that arose during their daily work routine. Several of the meetings observed seemed to be only sharing of information. However, there were also several team meetings where topics raised required a team response or introduced a recurring or novel problem. It was the team's engagement in coming to a common understanding, negotiation, decision-making and, if required, resolution of a potential response where there was collective learning as they created a common understanding of a particular situation and how they would address it as a team. Depending on the topic, the learning could have been either implicit or deliberate. Finally, the meetings themselves, particularly the Y meetings, were also exercises in collective posturing which seemed to contribute to team identity.

Issue-based team discussions. External to the meetings, the team was often engaged in discussions related to issues that arose. When they weren't immersed in a case together, they had time to consider such issues and, as one member noted in a focus group, "we write our SOPs, we have our conversations about how to make things better, change our infrastructure" (Focus Group 1B). Topics included technical, process, procedural, social, business and client-based issues. As observed, the way the team often addressed common issues was through an individual raising an issue with intent to deliberately engage or learn something from one member. Due to

the close proximity to others, this regularly resulted in others engaging in the discussion and implicitly being involved in the ongoing collective learning. As noted in one focus group:

having everyone on the team and having people that are specialized and not specialized in other areas, it's good to have a quick conversation, use them as even just a sounding board and they can either reaffirm your assumptions or your understanding of it. And that quick conversation can save you hours of research. (Focus Group 2 B)

I observed this “sounding board” effect often. If the issue being discussed was of sufficient interest, the team entered into unstructured dialogue that included an airing of perspectives, exploration of options, and, if required, a decision for action. However, there were members on the team that had subject matter authority on certain issues and, provided time-permitted, any action would await their consideration of the issue. Unless there was something that seemed politically sensitive, the manager rarely interceded except to include his own perspective.

Many of the issues the team dealt with were not internally driven, but driven by external influences such as administrative requirements, maintenance requirements, and other routine activities. Often there was a requirement for the team to understand others' perspectives and refer to resources or expertise outside the team. Individuals would either volunteer or be assigned to do find out more and report back. In such cases, I observed how rapidly the team arrived at a team perspective on a given issue when it concerned external influences on the team's work. As observed and captured during focus groups and interviews, the team already had what seemed to be a shared perspective on many issues and had started to formalize team norms and practices within their SOPs. The rapidity in arriving at a common understanding and perspective is therefore not surprising.

One example of a routine issue that the team was dealing with on a daily basis was the conditions in which they worked. In this situation, the environment had both a positive and negative effect on the team and influenced how the collective learning occurred. The negative influences on the team were many. The team was unanimous in their disdain for the physical conditions in which they worked. Ten men were working within a limited office space and, despite the wide range of equipment at their disposal, they were required to work within a standard office footprint; an individual work space was approximate five feet by four feet including the desk and chair space. One of the team members had five monitors, three PCs beneath his desk top, and two switches and an external hard drive on his desk. This did not

include peripheral machines and devices from other departments that were required when he was conducting forensics activities.

I had observed team members leaving the room often to stretch and simply get out of this space so they could breathe and de-stress. In such cases, there is no doubt that their absence from the room meant that issues that arose during their absence did not involve their input. As well, the stress and the physical conditions may have inhibited learning. If one is concerned about the noise, lack of privacy or work conditions, such as “the pain in your knees and back” (Focus Group 2A), then it is likely going to influence one’s personal behavior and perspective in dealing with team issues. Various members of the team noted the tension that they occasionally experienced and some acknowledged that the physical conditions contributed to these tensions (Focus Group 1B, Interviews L, F, N & G). As one member expressed:

Well then the other side is that it is hard to concentrate when people are talking and laughing and yelling over the wall half the time. Either they’re talking about work stuff that you may or may not be interested in, or taunting A with an apple (laughter) and we’re all laughing about that. Whatever the case might be there’s always something going on, you can never just get into the zone and just tune it all out. (Focus Group 1B)

As observed, the physical environment and the associated work conditions also triggered team activity towards resolving some of their space issues. For example, realizing both an equipment deficiency and lack of physical server space, this localized dilemma precipitated a few of the team members to team up, deliberately undertake research and take administrative steps to acquire additional server space for the team.

There was also a common belief that the conditions facilitated team work and, in turn learning. This was demonstrated in comments such as: “I think that room kind of brought us all together. It has a lot of negatives, but the positive is that it’s brought us all together” (Interview N); and “We’re in such close quarters we always know what’s going on because everyone is always talking” (Focus Group 1B). Indeed, the number of small discussions which grew into full team discussions or the number of rhetorical comments that resulted in the engagement of other team members appeared to result in a greater degree of dialogue. While difficult to quantify and compare in absence of the team’s work in other environments, the team was under the impression that there was greater sharing as a result of the close proximity of all the team members. As one member indicated, “Just sitting in that room together, we often share a social

environment. Something that happened that you thought was really interesting, you pass that knowledge around and it spreads quite rapidly in a non-formal set up” (Focus Group 2A). As well, based on observation of daily discussions, this regular, often unchecked flow of opinions and views seemed to foster more rapid adoption of collective perspectives when the team gathered to decide on something as most were already aware of the concerns or issues – learning had already occurred on the subject.

The physical conditions in which the team worked were not only a routine issue that the team was challenged with resolving, but it influenced the quality and quantity of collective learning that occurred on a daily basis. The conditions appeared to trigger the team’s initiative to find more space, facilitated increased collective engagement on issues and, as a consequence, enabled the team’s knowledge of each other’s capabilities. As stated by one member during Focus Group 2A, “We know about each other’s capabilities, but we know about each other’s limits also.”

Another routine issue that was resolved at the team level was incident coordination. This issue was triggered by the team’s challenges with increasing team task load, limited staff and number of incidents. For all cases, the DA did all of “the monitoring of the inbox and reads all the information coming in or all the work coming in and capturing all the information to ensure that different tasks or different cases get assigned” (Focus Group 1A). Since all team members were required to fulfill the role of DA, there was a collective interest that was fully congruent with the team members’ individual interests. The confusion around initial incident coordination triggered activity within the team to explore options and find a reasonable solution that helped reduce the DA’s workload while supporting ongoing incident management through an incident coordinator. As stated by another member,

[The DA] can’t be the busiest guy on the team and take on the busiest assignments. So, we’ve kind of decided as a group, yes the initial DA gets everything going, the contacts, all that kind of stuff, then you assign an incident manager for that case and then he will step up and be the main contact after that. (Focus Group 1 A)

As stated by another, “[the DA]is busy with all his other work, so he can start the case, get the ball rolling and get everything into our JIRA which is our system and then assign tasks” (Focus Group 1A). The outcome in this situation was a deliberate effort by the team to identify and

collectively agree to a different approach to changing how incident coordination was conducted on the team. This will be discussed in further detail related to potential transformative learning.

Other routine issues arose on almost a daily basis. As observed, all IT SIRT members were quite open about issues and problems they encountered in their work and realized that bringing such issues out in the open often resulted in greater information sharing. As stated by one individual in a focus group, “sometimes if you’re working on a case, and you’re coming to a dead end sort of thing, we can make suggestions to each other on places where you can find some valuable information” (Focus Group 1 A). As already presented, the close proximity to each other enabled this type of activity and assured that other team members overheard and were aware of the issue being discussed.

Some of these issues in which learning was evident involved improvement in team processes, tools or procedures. For example, a common concern was the consistency of the team’s products and the forensics tools used to support this. As noted by one member, “just me looking back when I joined the team, everybody was just doing their own thing in terms of tool set” (Focus Group 1B). Another complained that they had difficulty “analyzing a lot of the evidence was very difficult because of tools, how we did it, and even our training” (Focus Group 1B). As noted more than once during the interviews and focus groups, this created inconsistency in the team products and how the team worked. Through several discussions, often adhoc, the team made a concerted effort at developing a “more defined tool set” that supported their forensics tasks and “more defined and mostly a standard approach” (Focus Group 1 A). This occurred over time well beyond the period of observation, but even during the short time there I noted dialogue amongst the team on the pros and cons of a particular tool. As some of the more experienced practitioners had been using tools for quite some time, there was often conflict regarding whether or not a particular tool should be adopted as part of the team’s tools set. In conjunction with the discussions, there was evident implicit learning regarding the tools used, changes to tools, and what would be best in which situation. For example, one member reported that through exposure to one of the senior members using X-Ways he said to himself “I’ll look into X-ways and see what it does and next thing you know I’m using X-ways” (Focus Group 1A).

Another example was the format or template for the team reports: “Even our reports, depending on who did it, it would be a different format” (Focus Group, 1A). Now they have a

common format. The same dynamic occurred with information management. As a result of loss of information and storing of information in various locations, the team had numerous discussions on information management and eventually, they created “a shared folder that we all go to” and which contains “client reports that they all go in zipped and encrypted” (Focus Group 1 A).

Issue-based discussions were a common source of deliberate and implicit collective learning within the team. In resolving issues, collective research was common and accompanied by dialogue and negotiations that allowed the team to decide on a course or courses of action that satisfied those engaged. Whether triggered by an issue within or outside the team, issue-based discussions that occurred throughout the day or over time supported collective understanding, development of a team perspective and team-level problem solving.

Peer-sharing expanding to team practice. Through my observation, and noted throughout the focus groups and interviews, there were regular interactions and learning that occurred across the team related to work-related procedures, tools and techniques. Peer sharing was a very common occurrence in the team. In some of the situations observed, a peer approached another typically more experienced peer with a problem or question. The experienced peer would offer either an answer or a suggested approach to achieving the answer. The importance of these types of exchanges to supporting individual and team operations was made clear in another statement:

You can be working on a case that maybe involves different levels of firewalls that maybe (name) can be a little bit more comfortable helping out, it might not be our case, but if I have time. I leverage (name) because he’s higher in the forensics knowledge than I am, so yes I leverage him whenever I can and he’s got time and he’s good enough to supply it. It’s very important to share the knowledge that way. (Focus Group 1A)

Repeating the quote from another member that reinforces this thought:

[H]aving everyone on the team and having people that are specialized and not specialized in other areas, it’s good to have a quick conversation, use them as even just a sounding board and they can either reaffirm your assumptions or your understanding of it. And that quick conversation can save you hours of research. (Focus Group 2 B)

The peer-to-peer engagement was also evident in less formal ways. Knowledge gained through self-directed learning activities within the team stimulated peer exchanges. For example, a key driver for individual learning was for the team to remain current on threats, vulnerabilities and

the tools and techniques to mitigate them as noted in the SOC CONOPS (2015a) “The staff will require a high level of knowledge in IT Security domains encompassed in the individual unit mandates, including: incident response, cyber security, malware analysis, threat analysis, etc.” The team members were aware of this requirement as appreciated by one member, “You need to be current with the threat out there, what’s the latest trend, so through blogs, public information, research” (Focus Group 1A).

Another reinforced both this requirement and the continuous learning that was required stating, “I study up on a certain tool, or a certain malware, that’s non-stop” (Focus Group 1A). While this is an example of individual self-directed learning, what is of note is the follow-on phenomenon; as observed, when someone found new information they readily shared it with the rest of the team. As stated by one member, “When somebody finds a good article or something, we fire it out to share amongst the group” (Focus Group 1A). Another echoed this remark stating, “Something that happened that you thought was really interesting, you pass that knowledge around and it spreads quite rapidly in a non-formal set up” (Focus Group 2A). There was a clear team value in contributing to and maintaining the team’s knowledge current.

This applied not only to self-directed learning. As documented in the team’s training records and observed, it was commonplace for a team member to research and register for other work related formal and non-formal learning events. While there was intentional individual learning that might have been triggered by any number of potential reasons, there was an expectation that the member will bring knowledge back to the team. For example, one member discussed an event at another department: “events at (another department) that I was lucky enough to attend, was a really good experience and really good information to bring back a better understanding of the organization. It influences the way that you’re responding to that organization because you know the way they work” (Focus Group 1A).

In another example, one individual was discussing how he came to informally learn about a new forensics tool through a colleague, “Now we’re all getting trained the appropriate stuff and stuff that’s evolved and that’s the most effective; we share that as a group and, (name) really like’s X-ways, so I’ll look into X-ways and see what it does and next thing you know I’m using X-ways.” (Focus Group 1A). Deconstructing this statement helps shed light on several team activities that support collective learning. As interpreted, the team was: standardizing tools and training as they were “*trained on the appropriate stuff*”; maintaining currency of knowledge and

choosing what was “*most effective*” based on team experience and improvement; sharing knowledge “*as a group*”; and ensuring the efficacy of the previous practices in supporting individual proficiency as shown in the comment “*next thing you know I’m using X-ways.*” Further, to this point, my documentation analysis, the team’s acquisition of more licenses and my observations of team activities also indicate that X-ways, a relatively new forensics tool, has been adopted across the team as part of their standard forensics tools box.

Another example is the adoption of log-to-timeline as a collective practice. An experienced forensics analyst who had used this technique in the past was brought on to the team and used it in his own practice. I had observed another team member asking the analyst about this practice. He then demonstrated it to him and then two other colleagues converged around the area to listen and observe. Another individual who recently joined the team went on a course and learned log-to-timeline and thought that it was a useful technique and showed different peers. He stated that “I never used log-to-timeline and I’d never touched log-to-timeline. But since starting using log-to-timeline, I absolutely love it” (Focus Group 1A). Noting the adoption of this practice across the team, one member stated that it was “pretty core to everything we do these days” (Focus Group 1B). Beyond adoption of the practice of log-to-timeline, it has become embedded as team practice as an “unwritten SOP” (Focus Group 2B). This adoption process was summarized by one of the team members:

I’d say a year ago, only two or three people knew about [log-to-timeline], what it was or even how to use it. And now it’s the defacto starting point for us when we get an image in. We’ll handle the evidence accordingly, and the first thing we do is create a timeline so we can all jump in and help as soon as that’s done. We’ve created our own SOP without actually documenting it. (Interview C)

The X-Ways and log-to-timeline examples were primarily triggered by capability gaps within individuals who deliberately sought out how to use these tools in the best way possible to meet their job requirements. They did this through dialogue, demonstrations, and further individual experimentation. These tools were eventually adopted into team practice as more and more team members became comfortable with the tool and understood how it could improve their work results.

Beyond informal and self-directed learning that was shared amongst peers, team members were also regularly involved in some type of formal learning and drew upon their

learning experiences when communicating within the team. The IT SIRT Learning and Development Plan, (Government of Canada, 2014) was designed “to respond to individual skill and knowledge gaps and provide appropriate learning solutions to learners who have varied education, competencies and experiences” (p.4). Training came in the form of courses, seminars and workshops from Government organizations such as the IT Security Learning Centre or from commercial vendors. As recorded in the IT SIRT Team Training Record (Government of Canada, 2015), all members of the team participated in the formal learning, but often at different times and quite frequently on their own as only a few of the team members could be absent for training at any one time due to ongoing operations. Even though they often participated in training alone, these formal learning activities appeared to support collective learning in four different ways according to the team members.

First, as noted by one member and echoed by others in both focus groups and interviews, the training they received was viewed as “extremely valuable....It gives you the framework...It allows us to...it’s a jumping off point” (Focus Group 1B). Another stated “we know because we all understand them because we have the similar training.” In their view, the training provided a common framework and understanding of terms, concepts, and practices that enabled individuals to participate in and contribute to team discussions.

Second, those who participated in training were considered to be a team resource; as one member stated, “We all know who’s going on what courses, so we all know who to ask” (Focus Group 1A). Third, the formal training was also viewed as a source of expanding the team’s knowledge and understanding. One member noted, that “whenever you take training, whatever you can pull from that training is leveraged to the group...(name) might have taken that specific training a year ago, and another member just took the training lately, but there is some new information, new content, new tools. It’s good to just go and grab what can be leveraged by the team” (Focus Group 1B).

Fourth, as mentioned by another member, participation in training occasionally triggered team-based discussions on the value of the training received:

“...if someone had gone away for training, that would be one of the first things is that person would sit down for 15-20 minutes and go over what they learned and what they thought we could use eventually or now; just get the feeling for the course, whether it’s

important for the rest of us to take the course. There have been a few people come back and say “don’t waste your time” or “don’t waste your effort on that” (Focus Group 1A). Consequently, based on the statements from team members and observed occurrences, individual formal learning experiences contributed to collective learning and shared understanding of both the content and the value of the training received.

Without doubt, the most frequently observed collective learning dynamic throughout the period of observation was peer-sharing. The interviews and focus groups reinforced this finding. Peer-sharing was most often triggered by an individual inquiry into a tool, technique, or practice. Due, in part, to the close quarters in which the team worked, peer sharing often expanded into team wide discussions and then, if consensus was reached, it was adopted into team practice. The most visible example was the discussion stemming from formal or self-directed learning activities that resulted in a broader exchange and contributes to the overall knowledge of the team. This discussion also contributes to collective perceptions on the utility of that knowledge. Moreover, when the team was in close proximity, such peer-to-peer exchanges tended to trigger a larger collective discussion which could influence collective understanding and meaning in the team. As a note, the cycle of activity that stimulated the adoption of the team practice included all members present. When absent members returned, it was not unusual for the some of the members of the team to walk them through an abbreviated discussion and decision cycle that resulted in the adoption of the new tool or technique. These examples provide insight to how issue-based discussion can result in development of or changes to team cognition evident in changes to frameworks, processes, procedures, tools and practices.

Engagement and exchanges with others or other groups/teams. The IT SIRT, as a social entity, engaged with other groups, teams and organizations every day and throughout the day. The team was in multiple relationships and, based on mandated functions as well as informal functions, became different things to different organizations. This was explicit in their mandate to provide reactive, proactive and advisory services (Shared Services Canada, 2013a) to not only SSC, but the broader GC clients.

In some cases, an individual represented the team for client inquiries via telephone or email, in other cases, multiple representatives were present in situations such as meetings and operational briefings. As I observed in all cases, whether one or ten members were present, IT SIRT was the collective label used when engaging with other teams. Based on the documentation

and observation, the IT SIRT was equally referred to as a single entity that other teams could engage through a common distribution list, a central telephone or the generic email account monitored by the DA. This was represented by one member who stated “I think now that the IT SIRT name has gotten out there quite a bit.” (Focus Group 1A). As well, as seen in other statements presented, this collective label was used for other groups and teams. Team members often referred to: “talking to CTEC”; processing requests through “Procurement”; briefing “the Executives”; or “working with IT.” They also reported working “SSC Server Ops, SSC lines of business in terms of support, network guys, application, like databases, like people, and department support people” (Focus Group 1A). These generic monikers for collectives were commonly used within the IT SIRT and in the other teams observed during team interactions.

This sense of the team as a collective is important and, this, along with references to the connections with other teams was embedded within GC documentation. In the GC, the IT SIRT is represented as a collective with organizational functions within the governance framework articulated in the Cyber Security Event Management Plan (Government of Canada, 2015). The SSC SOC CONOP (2015) indicates that the IT SIRT is part of the SOC and, as such, responds to and works with GC clients, interfaces with key partners such as Treasury Board Secretariat (TBS), Communications Security Establishment (CSE), Royal Canadian Mounted Police (RCMP) and Public Safety (PS).

More specifically in the security domain, the team had direct relationships with various GC cyber specialist teams with security partners as one member noted, they “work in conjunction with tippers that are being received from CTEC and CCIRC” (Focus Group 2B). The relationships they had with organizations such as Cyber Threat Evaluation Centre (CTEC), RCMP Technical Crimes Units, and the Canadian Cyber Incident Response Centre (CCIRC) often involved an exchange of high priority, sensitive or classified information. This placed the team in a slightly different position relative to other GC incident handlers receiving information to which others did not normally have access. They also connected with cross-functional peers such as other cyber incident response teams in other governments or industry, the intelligence community and other subject matter experts to perform these duties (Shared Services Canada, 2015a). Based on the several references to these organizations during interviews and focus groups, these relationships were often used to support and expand team capability. To extend to these various parties, specific communications protocols, escalation procedures, and

dissemination processes were required to maintain and maximize these relationships (Shared Services Canada, 2015a).

The IT SIRT often crossed team boundaries and these occasions were also opportunities for collective informal learning. For example, in engaging with security partners mentioned above, the team could rely on these other teams to offer unique perspectives or different information that provided unique knowledge and context. As one member noted, “We learned from others... others from CTEC” (Focus Group 2B). As these exchanges were normally classified or sensitive in nature, specific details have not been provided. However, the information the team received either contributed to the shared knowledge of the team or, at times, challenged the team’s current perspective on a given situation. In the latter cases, the team would explore the meaning of the new information and trigger critical discussion that included forms of dialogue such as questioning, probing, challenging, exploring and arguing, in an attempt to reconcile it with their perspectives. As noted in the frustration in one member’s comment, there may have been a lack of understanding of who was supposed to do what:

With (department X), their teams say ‘here is information guys’ at the same time they’ve already got it figured out. We’ll go back ‘yes, we saw this.’ [They] would say ‘Yes, yes we did too’... we’re the same government, we should be learning from the people who know what they’re doing. Why are we both working on the same thing and why am I taking a month to produce a report when their experts have already figured it out? (Focus Group 1B)

As observed in the IT SIRT exchanges with other security partners, there seemed to be reciprocal learning as each team sought to better understand each other’s work context, culture, situational perspective, needs and priorities. As well, as observed on several occasions, the IT SIRT received important technical and intelligence information about specific adversarial techniques and in one particular situation observed, one of the organizations provided a classified SOP on how to mitigate an adversary’s activities on the network. While only one individual on the IT SIRT initially used this information in their work, the knowledge of the existence of the SOP became common knowledge within the team and became another ‘tool’ in the team’s tool box. Each exchange provided the team with different information than they typically had available; the information was often new to the team. These examples demonstrate that these deliberate exchanges with other teams triggered collective learning about new information and new

perspectives as well as important knowledge about the other team, their culture, and their capabilities to the team that may trigger other collective learning processes.

As well, the team worked with other government departments and agencies, noted by one member, “We work regularly/non-regularly with different government departments that are under the SSC umbrella and sometimes even outside of the SSC umbrella.” (Focus Group 2B). The team was aware of the various challenges on the team that triggered learning. As well, there was an appreciation that the client department would also learn. As noted in one member’s statement the requirement to know “how to deal with other groups and outside people in a different way because generally we’re going into someone else’s environment and they’re uncomfortable with that” (Interview O). Consequently, there was a reciprocal learning relationship between the organizations. This relationship is synthesized from observations and member statements and illustrated in table 5.

The IT SIRT team or sub-team would learn...	The client team would learn...
The organization’s concerns regarding the threat and potential compromise	The informed concerns of the IT SIRT regarding the threat and the potential compromise
The structure of the effected network, systems and protections	The tools used by the SOC and IT SIRT to scan their systems what was and was not identified
The extent of the compromise	The details of how the compromise occurred
The risk tolerance of the organization related to the compromise	The depth and breadth of the compromise and potential losses based on the IT SIRT assessment
The resources that the client organization would apply to mitigate/eradicate the threat	The capability of the IT SIRT to mitigate/eradicate the threat

Table 5. Reciprocal collective learning during incident case management

In more specific situations while doing case work, the team was trying to respond to a client group, such as an IT department and the management or executive cadre and their expectations (Focus Group 2A). As well, since they have a GC mandate, but work within SSC

they sometimes get caught “between the department and SSC; that causes some really interesting challenges” (Focus Group 1B). As an example, one member stated that sometimes:

“executives will circumvent the intake method. So instead of the department contacting the GC CIRT or FIPC to look into an incident, they’ll call directly over to a Director over here and then it will come right down the pipe down to us so it immediately becomes a security incident before it becomes prioritized” (Focus Group 1B).

Their engagements with clients often included what might be viewed as less than positive encounters, but these were nonetheless learning opportunities. Based on observation and member statements, it appears that there was reciprocal learning in these cases as well. One member recalled a situation with a client stating that:

I went to do the imagining and they were only going to give us a particular set of data, so I had to convince the person that the data that we were looking at would not contain any documents because there was memory capture and protected files. So I had to convince them that ‘no we’re not reading any of their documents.’ (Focus Group 1A)

Similarly, another member provided insight to a situation where there was no understanding on the part of the client’s team of what was required:

I’ve also found a few cases where the sharing of knowledge, the knowledge transfer, the transfer...sometimes it’s very hard to get indicators or what are we looking for, what exactly do you want as an end result from the client? Like half the time they don’t even know. (Focus Group 1 A)

Ultimately, through a dialogue with the members of the client departments, it was identified that in both situations the departmental teams were not fully aware of the IT SIRT’s roles and responsibilities. As observed, this lack of knowledge on the part of the local teams identified an area of improvement for the IT SIRT which led not only additional educational effort within those specific departments, but triggered review and subsequent bolstering of their communications and marketing within the GC. Concurrently, the local teams learned about the IT SIRT and were able to better leverage the IT SIRT in addressing their incidents. In this situation, collective learning was triggered by lack of knowledge and resulted in a mutual exchange between the groups.

While the primary purpose of these relationships was to support larger GC goals and exchange group relevant knowledge and information to support these goals, the situations in

which the team was placed could occasionally be highly politicized and this changed the nature of the cases they worked on. As noted by one member:

whenever anything gets public or with a lot of visibility, then without the vetting through the team, doing the triage, and feeding up the information on it, it's senior management coming down asking for update, 'what's happening with that', so that influences the way that we [work]. (Focus Group 1A)

There were numerous other similar examples that could have been provided based even on the relatively short period of observation. I had observed this dynamic on several occasions where it seemed that the IT SIRT was in a continuous learning cycle throughout these types of client engagement activities as the collective to collective exchange was required with each new client. As presented previously, there are over 200 departments and agencies within the GC and the challenge as noted by one member, though somewhat exaggerated, was that "everybody's got a different network and infrastructure" (Focus Group 1B). In addition to the technical elements, departments had "diverse levels of funding, knowledge and resource expertise" (Shared Services Canada, 2015a) to meet their cyber security requirements.

As explicit in the names of each of the departments such as Natural Resources Canada, Parks Canada, Department of Fisheries and Oceans, Canada Border Services Agency, Supreme Court of Canada or Employment and Social Development Canada and in the unnamed cases observed, each department had unique business, political and organizational requirements of which the IT SIRT needed to be aware. The approach used and behaviours of the team changed with different clients. Therefore, to be effective, the IT SIRT was effectively learning about the client both at the start and throughout the case.

Whether another organization within SSC, a security partner or a client department, engagement and exchanges across team boundaries with other groups were an essential part of IT SIRT business. Based on the statements and my observations, it seems that almost every instance of boundary crossing the team encountered opportunities for learning as new people, perspectives, systems and cultures were implicated. While some of the learning was deliberate when the IT SIRT was looking for information, a greater extent of the learning was implicit as part of work exchanges or reactive when faced with the unknown or unfamiliar at the first point of engagement. As I also observed, descriptions of these encounters would often be distributed within the team through routine collegial discussions and information exchanges that contributed

to a collective understanding of the relationship for even those who did participate in the direct experience.

Generation of team products and artefacts. Collective informal learning was also visible in the generation and maintenance of team artefacts. Some examples have already been mentioned in support of other collective learning including SOPs, tools and applications, DA logs, and reports. As a routine task within the team, the generation and maintenance of team artefacts was an ongoing activity feeding multiple team requirements. As will be shown below, collective learning can be seen in the collaborative development and updating of team artefacts as described in the two examples below: the Standard Operating Procedures (SOPs); and the case status board.

One of the best examples that shows the multiple dimensions of learning that can be drawn from team artefacts is the team SOPs. The development and maintenance of team SOPs was a dynamic process which depended on the topic of the SOP and the team's priorities. As captured in interviews, focus groups and observation, while a single individual may have initiated a SOP, the development and updating process generally involved collective learning and effort. As observed during a case of memory capture from a remote site, the team's SOP for "First Responder Memory and Custom Live Acquisition using FTK Imager" (Focus Group 1B) had to be updated. The primary author of the changes was a senior team member. However, as observed, it was not completed by one individual, but over half of the team was involved in contributing to and developing the SOP revision.

I observed that before the SOP was even discussed within the team, there was a variety of discussions during the case on how to proceed which involved between five and six members of the team including the individual who was going to be the first responder. With the discussions came the collective realization of those involved that their SOPs did not cover some of the unique aspects of the case. More specifically, the concern was that "Large geographical distances between SSC and partner sites, lack of local IT Security trained resources and the need for rapid response and evidence gathering requires the need to leverage local resources in support of IT Security incidents" (Shared Services Canada, 2015b). While others continued to work on the specific case, one of the senior team members developed the revised SOP using an existing document. Following these discussions, the drafter informally coordinated input to the SOP from those engaged with the case and established what changes were required. Once the original draft

was done, it was distributed to all collaborators for review and comment. While I was not a part of the interceding correspondence, I was aware that there were not any substantive comments and only minor edits were required. The final revision was then placed within the team's electronic SOP folder on the shared drive and everyone was verbally made aware that the SOP was updated.

Within this process there were multiple opportunities where information and knowledge exchange occurred as a team collaborative activity evident in discussions and the editorial process. Those who were not directly involved in the case, including myself, learned about the specific challenges in dealing with remote sites. The outcome was a collaboratively created team artefact that included multiple perspectives from the team based on their collective experience during the recent case.

Extending the discussion of the utility of team artefacts in support of learning, the SOPs are also a good example of how the document itself facilitates collective learning and learning within other teams. For example, the Memory Acquisition SOPs, including the one mentioned above, provided foundational processes and procedures for explaining various types of memory acquisition using different tools and techniques. Such SOPs served to support enduring, common understanding of team procedures and processes, even for the more experienced members. As discussed by one member:

“it goes back to that ‘hey (name), when you did this, what did you do?’ We’re all sitting beside each other. I know sometimes it’s tedious to always ‘hey (name)...’. And I’m sure he’ll get frustrated and say ‘will you just go look at the SOP’” (Focus Group 2A).

The SOPs also provided detailed instructions for new team members and local departmental IT teams on how to conduct memory capture when an IT SIRT member was not available. In this way, the team's knowledge and procedures were extended to others through their artefact. The SOPs also served as a means to ensure a rigorous process within the team and a means to refresh procedural or technical knowledge that had faded. One member explained it this way:

the SOPs work even for us that have been here for a while because our duties are so varied. It's so rare that we do the same task over and over again. One guy might go get images once a month or once every few months. The quick refresh of the steps that you want to do to prevent an issue. Because, there are always...one check mark, one missing

zero will change the evidence entirely. It really keeps us...especially for the intake process, the acquisition of the evidence, that's the key part for us. (Focus Group 1B)

Finally, the SOPs served as a body of documentation that provided a source of team history as versioning of the SOPs recorded changes in the team approach and how the team performed certain functions in the past. This was seen in the Memory Acquisition for FTK Imager (Shared Services Canada, 2015b) example discussed as it was the third version. While the team was still relatively young at the time of the study and the development of SOPs had not begun in earnest until late 2013, I had noted that at least six of their SOPs had been updated. Through the SOPs, the team was able to see how they have changed and what procedures have evolved. As described by one of the members during an interview "our SOPs have come a long way too in dealing with incidents which makes incidents a lot easier" (interview L).

Similarly, the focus group (Focus Group 1A) statements highlight how the team used the SOPs as a source of reflection and learning about the team itself. For example, one member stated:

"Yes, more defined and mostly a standard approach. As opposed to...and that's just me looking back when I joined the team, everybody was just doing their own thing in terms of tool set, in terms of process. We did have some SOP, but lots of stuff was depending on who was doing the work."

Another went on to say, "Yes, we would get different results, now... We're more familiar, more standard results..." Stressing the point that their SOPs were not static and were also subject to either retirement or destruction, another followed up, commenting that, "We have some SOPs that we don't do very often any more like the error report, there's an SOP on the error report. We don't even do that stuff that much anymore."

Another example of a team artefact that facilitated learning was observed in the use of the case status board. The need for the status board itself was triggered by how the team managed their incidents and cases. As the case and team descriptions detail, cases were often managed by one or two people on the team, yet may require the contributions of others. As previously mentioned, there were also times when individuals who were assigned to a case were not present when others wished to know the status of a case. As well, as I observed, when team members were looking for additional work, they referred to the case status board and talked to the incident coordinator or case lead to see where they could help.

As observed, the case management board was maintained by all of the members as their cases evolve. Again, because the information on the board was sensitive, pictures were not allowed. However, the types of information displayed are unclassified. At the time of observation, the information on the board offered team members an understanding of the progression of cases over time, identified distribution of case work within the team, showed active, pending and deferred cases, provided a recent history of case work, and was used as a guide for discussion during team meetings.

The case management board triggered collective informal learning primarily when things changed. When a new case was assigned and placed on the board, there were inquiries from others on the team about the case. Since the team was a small, close knit unit and typically assigned high profile, complex or advanced persistent threat cases, there appeared to be professional curiosity from all members about a case when initially assigned. Team-wide discussions often ensued about specifics of the case, what type of approach would be used and who would best contribute to the case. As observed, new information on the case management board often triggered this type of discussion.

As shown with the SOP and case status board examples above, team artefacts were often sources of collective learning. As well, if team artefacts were collaboratively produced and maintained, they inherently involved implicit learning exchanges not only with respect to the artefact topic, but aided in arriving at an outcome of collective understanding and perspective on the topic being discussed. The artefacts themselves were often leveraged as deliberate learning aids for new individuals and other groups. Finally, the artefacts served as a source of team history that was used in collective reflection and learning. For physical artefacts, the end of life is also a team decision. However, I saw that in the case of electronic artefacts within the team, they were more likely to languish or be replaced by something new. This meant that they were an accessible part of the team's history. In short, artefacts like the SOPs and case status board were the team's collective knowledge and changes to that knowledge captured in a sharable artefact.

Experimentation and problem-solving. Another way collective informal learning occurred within the daily work routine was through collective experimentation and problem-solving. Similar to the other routine activities such as peer-sharing, learning through collective experimentation and problem-solving was often manifest in team dialogue. Unlike peer-sharing, the learning that occurred was not the dissemination of existing knowledge. Rather, the

knowledge was newly discovered or emerged through team activities. Due to the dynamic nature of the environment, the knowledge may have only had temporary utility at the team level so was rarely captured in concrete terms at the outset. As discussed by one member “[the work] changes so much because the scope of the incident varies and everyone has a different methodology or tools of choice, how to find specific artifacts in your evidence; it’s different every time” (Focus Group 1B). Another noted the dynamic nature of the tools as well, “changed a lot in what tools we use and how we use those tools” (Focus Group 2B). And, as previously mentioned, each new case and each new department brought different problems to bear particularly as “everybody’s got a different network and infrastructure” (Focus Group 1B).

Experimentation and problem-solving was particularly noted during case work which could continue for days or even weeks after the initial incident response has been conducted and initial mitigations have been applied. Once the incident has been contained, the team conducted detailed and intensive forensics investigations coupled with research on the compromise, the vulnerability, and potential longer term mitigations that supported their proactive mandate (Shared Services Canada, 2015a). As previously mentioned, the information required was not always evident or available “I’ve also found a few cases where the sharing of knowledge, the knowledge transfer, the transfer...sometimes it’s very hard to get indicators or what are we looking for, what exactly do you want as an end result” (Focus Group 1B). In addition to the case information they would be working from, they often referenced each other, other teams and other sources of information as they attempted to identify what, where, when and how the incident occurred.

As an example, the members of a sub-team mentioned that they were looking into a case that had already been responded to stating that “We started looking into it and we found stuff going back months prior to that.” (Focus Group 1B) As observed, they consulted an external team which provided them new information about the case and new knowledge about the specific tactics of the malicious code (malware) on the affected system. They did some additional research and found additional malware that had not even been detected. In observing other team activities, the sub-team raised this issue of the additional malware at an adhoc meeting, discussed the malware characteristics and, through multiple interactions involving almost every member on the team, they identified an approach to review all past work and

evidence to see if there was other information that would help assemble an accurate history of the incident.

As shown in the team statements and example above, experimentation and problem-solving were part of the team's daily work whether as part of ongoing forensics activities, when encountering new or novel situations, or dealing with the diversity of situations that arose with their many clients. While the team's response to the situations that arose was initially reactive learning, once they have identified a problem, the actual experimentation and problem-solving processes became much more deliberate and could include multiple smaller cycles of researching, deciding, implementing and evaluating the results. The collective informal learning triggered in these situations arose as they moved through the research problem, discovered new information, applied new knowledge to the situation, awaited the results and responded if they did not achieve the desired effect.

Summary of analysis of collective informal learning in daily routine. Within the daily routine, there were various ways in which collective informal learning was enacted primarily through multiple interactions while the team engaged in meetings, issue-based discussions, peer-sharing and team practice, interactions with other teams, generation of team artefacts, and experimentation and problem-solving. These interactions were triggered by formal mechanisms such as meetings, tasks, or client engagements. At a more granular level, there were a variety of situational triggers to these various interactions that included collective perception to: address a need, resolve a problem, correct a misunderstanding or a lack of knowledge, address a novel situation, or share information. Underlying these instances of collective informal learning within the routine work, there were also drivers such as the team's mandate, organizational requirements to support routine administrative procedures, and a common motivation towards continuous improvement within their work. The informal learning appeared to include all three forms: reactive, implicit and deliberate. Associated with the collective informal learning, there also appeared to be cycle of activity, conscious or unconscious, as the team addressed issues, opportunities or problems encountered which included some form of collective analysis, decision-making and resolution.

While there were no clear transformative outcomes that could be identified from the daily routine, there was a wide range of changes to collective cognition. These included coming to a collective understanding on an issue, collaboratively generating team artefacts, changes to team

perspectives or activities, changes to tools, processes or procedures, and changes to communications within the team and across team boundaries.

Non-routine events. In addition to collective informal learning in daily work routine, non-routine events established another context to present the findings as to how and in what ways team informal learning was enacted. For the purposes of this study, the non-routine events were distinct from incident response and recovery operations which will be discussed in the following section. Non-routine events were, for the majority, stimulated by external requirements. They included post-incident discussions and follow-up, document or presentation review, or other administrative activities that involved sharing and collective knowledge generation. By their nature, non-routine events provided opportunities for learning as they were unfamiliar to those exposed to the event. Learning, including the embedded feedback, was the means through which individuals and collectives navigated their way through the unfamiliar event.

During the period of observation and as revealed through interviews and focus groups, there were several examples of learning as part of non-routine events. The following will discuss four key examples that demonstrate different ways that team informal learning was revealed in non-routine events. The first is the adoption of the team's case management system and the second is the team's management of procurement issues that was briefly discussed above.

The first example was the team's realization of the need for, development of and eventual whole-team adoption of network-based case management system called JIRA. As noted by one member during a focus group. "We used to have a [case] book. You used to have to look through 300 pages to find a matching [case]" (Focus Group 1A). The case book may have been sufficient for smaller incidents managed by one or two people, but based on the member statements during the focus groups and interviews, the team had apparently agreed that more complex incidents involved the whole team in various capacities over time which demanded a more rigorous means of recording and sharing case information. Even for smaller incidents, the members had apparently expressed that the information should be able to be readily accessed and viewed by all to support reporting and help ensure continuity of information should the case lead not be available. For example, one member mentioned:

When we first came in, a lot of it was taken care of through spreadsheets and email and conversation. A lot of times, information wouldn't be related to the whole team, because

people wouldn't be here and they were off site, performing other tasks. So they would come back and be in the dark about a lot of stuff. If someone was taking care of the spreadsheet or the method of tracking an incident, if they weren't here, it would be very difficult to coordinate. (Interview C)

Three options for case management were informally explored by various team members and discussed: an enhanced Microsoft Excel capability, ARCSIGHT Incident Management software, and JIRA project management and coordination software. Through a dialogue, the members had the opportunity to discuss which application would best fit the team needs and express their views. As noted during some of the focus group discussions, there was some contention around the use of JIRA. As stated by one member of a focus group - "we needed better information management and that's when we started to introduce JIRA and CONFLUENCE" (Focus Group 2B).

According to the company's website JIRA is a project management tool for agile teams (Atlassian, 2015). Intended for software development teams, there are a variety of add-ins that can assist with knowledge management, intra-team communications and work flow management. As well, the team adopted CONFLUENCE, a partner software, to help with electronic document collaboration. Two team members initially created and configured an instance of JIRA within the IT SIRT network as a stand-alone system. It was subsequently modified and customized in response to other team member inputs including micro processes and procedures as evidenced both in the observed JIRA content and identified in the four separate SOPs that have been developed to support JIRA operations.

There appeared to be consensus during the interviews and focus groups regarding the utility of JIRA to support case management. One member discussed the previous process stating "There were more one offs and there was not really any identity and then there was the whole SOC thing and that solidified a lot into who does what into our little silos. But how we worked (then) is completely different." He added, "Now we actually track our work" (Interview B). Another expressed that "JIRA does make our life much easier" (Focus Group 1B). Yet another expanded on some of the positive outcomes with JIRA implementation:

So, now that we have a centralized method through JIRA, that person could be gone, someone could come back from a vacation or haven't been involved, they can jump in

quite quickly by going into JIRA, reading up on everyone's progress, how the incident started. I'd say our team just moves a lot better. We're more organized. (Interview C)

Finally, another provided additional insight that references how JIRA contributed to team sharing and learning:

JIRA has evolved a lot since we had a major incident. This is where we leveraged the tool to capture the information about a specific case, but also to distribute all the tasks within an incident. And there's more collaboration and sharing of information amongst [the team] for information/intel. So what's the status about that incident, where does it sit? So, that's the tools to sit down and look, OK what has been done, and what do we know about that incident? (Focus Group 1A)

Based upon the participant statements, the observations and review of JIRA content, it is apparent that the entire team eventually came to rely on and support JIRA for various aspects of work. This example demonstrates the collaborative knowledge sharing and learning related to case management system development and implementation that better met the team's needs. While initiated by a sub-team of two, had it not been for the collective input, the system that the team uses today would not likely have been as successful. Further, it may not have been adopted by the remainder of the team were it not for the collaboration and the associated learning that the team underwent in preparation for JIRA implementation.

As a note, I had the sense that the team's identity was reinforced with development and implementation of the case management system; it was based upon the unique team requirements and was not used outside the team. There were also smaller similar examples such as the team's stand-alone malware analysis system that was unique; they named it "Bane" (named after a fictional character who was an adversary of Batman). These unique tools created and maintained within the team they are indicators of the team's special status within the SOC and GC.

The second example pertains to the team's interactions with procurement staff and processes. Within the documentation, including higher level policies and directives, there is a contracting process "to acquire goods and services and to carry out construction in a manner that enhances access, competition and fairness and results in best value or, if appropriate, the optimal balance of overall benefits to the Crown and the Canadian people" (Government of Canada, 2013). However, there was a common concern across the team regarding the responsiveness of procurement processes.

In the focus groups and interviews, negative affective response towards procurement staff and processes was noted through 23 statements within focus groups and interviews. One member succinctly posed the problem with procuring equipment and software “to get it and to get it to get a timely fashion. You need to have access to some resources right in the middle of the incident and not two months after the incident is completed” (Focus Group 1A). This sentiment was echoed in other comments such as: “procurement is definitely a constraint” (Focus Group 1 A); “a good example is that the (Director General) is aware that we need that, we need to go and he’d pre-approve it verbally, say ‘go ahead and file it’ and you’d do it and the process just fell through” (Focus Group 1A); “we have other difficulties like procurement. That’s one major issue that we currently have, we are still waiting for stuff that we ordered 12 or 13 months ago” (Focus Group 2B).

Interestingly, even the newer members of the team who had no direct experience with procurement assumed this perspective. One of the new members stated, “We need tools right? We need the best service, with the least amount of complex procurement. [There’s] inconsistent service” (Focus Group 1 B). The most junior member expressed his sentiments this way:

A lot of our tools take a long time to get approval and funding for it. And, once we do have it, when the licenses come up for approval or renewal, they’re not renewed, they expire and then we spend months without those tools that we’ve come to rely on. It’s a regular occurrence. Half the tools that we are currently on are expired and we’re waiting for razzes and other processes to approve them and get them to us. There should be a vehicle to automatically renew them on a regular basis. We know they’re about to expire, we’re asking them to be renewed, the vehicle should just be there. (Focus Group 1B)

Indeed, there was a singular team perspective on procurement processes that was revealed in both focus groups and interviews. In this situation, the tension between the team’s mandate and the ability to acquire needed equipment and software in a timely fashion created a shared perspective regarding procurement staff and processes.

This brings to light an example of how collective informal learning enacted within the team could be seen as negative from the larger organization’s perspective. In accordance with the *GC Contracting Policy* (2013), the procurement process is rigorous to ensure that acquisition is responsible, ensures a fair and competitive process, and is cost-effective. Notwithstanding, as noted in the member’s comments there was a common perception within the team that

“Procurement”, as a collective entity, did not understand the IT SIRT requirements and were not enabling their work within the timeframes required. One member highlighted the frustration of being questioned by a non-expert stating:

Going through this whole procurement thing, when you’re being questioned by an (Administrative Specialist) ...I’m just saying don’t question the security expert. I don’t have a security expert on the other line saying ‘why do you need this tool.’ To be honest, I shouldn’t really be questioned. We’re all (Computer Specialists) especially at our level above 1, we should all be able to procure things based upon our experience. (Focus Group 2A)

Another expressed, “We’re struggling in here, and when we reach out for help out here, their struggling or their not coming with what they have” (Focus Group 1B). Other statements discuss how this issue has influenced the collective learning and work. For example, one member described how these challenges changed team responsibilities:

(Name) quit doing procurement because he just couldn’t...all the razzes and stuff, he’d get so frustrated because one person would move along and then they’d have to restart the whole case from the beginning, it was like three months into the case. (Focus Group 1A)

Others stressed how they had to adapt: “...because of that, we’ve had to adapt by moving over to another, available software” (Focus Group 2A); and “We need to do something. We cannot just sit down and wait for something to come by itself, it won’t happen. We are a high ability or high professional team so we will figure something out and do our best” (Focus Group 2B). Finally, one of the members discussed the personal lengths he took to meet a short notice requirement:

I know personally, I went out and bought stuff with my own credit card. So, I was out of pocket for that and I never got reimbursed for it. Now, that might have been my own decision, but it was because of the task at hand that required so much of my time as far as overtime and my work life balance wasn’t being met. (Interview O)

Of note, there were some authority and process issues with regard to this type of team activity. Despite policies and directives to the contrary, this shared perspective influenced both individual and team action including those that were not endorsed by the organization. This shows that not all team informal learning is seen as positive or organizationally endorsed. As previously discussed, it is notable that even those that have not directly experienced difficulties with

Procurement nonetheless have the same sentiments. Moreover, this latter outcome appears to have been an instance of implicit learning within the team.

The third example of team informal learning in non-routine events is the sentiments expressed and the team's way of dealing with reduced staff during the summer. This coincided with the period of observation, so I was able to capture a majority of the issues. When the former manager was recruiting individuals to the team, he "was not looking for the typical security background, but different skill sets, just to make the team very well-rounded" (Focus Group 1A). As the team approached an incident, they "agree on doing certain tasks, spread the workload and all that, to accomplish our tasks as quickly as possible as opposed to what's done here site" (Focus Group 1A). So, with a full team, the tasks are assigned and this approach can be relatively well supported.

That said, during the summer period and on other occasions such as holiday periods, team members take leave. Since they were a small team, even the absence of two or three members could have an impact on the team's capacity to complete all of their tasks. Not unlike previous summers, in the summer of 2015, there were several members who were absent on vacation or training. The team generally noted that this "has a big impact on what we can handle, what we can produce" (Focus Group 1A). In particular, one member noted that the "trend seems to be that our busy season is the summer and half our team is off" (Focus Group 1B). This generally aligns with what I had observed during the observation period which covered the entire summer months.

The team employed various strategies to overcome the challenges of reduced staff during these periods. Strategies primarily driven by the team manager or other leadership included re-distribution of work, prioritization of team activities, or temporary assignment of personnel from other teams to the IT SIRT. There were, however, two strategies that were primarily the result of team activity where the team adapted to meet the work requirements.

First, there was recognition that a priority incident required whole team focus. While the team recently re-structured how they approached incidents using sub-teams with complementary capabilities such as a forensics analysts and a network analyst, they realized that if a priority incident arose, "we have to drop what we got and, as a team, go in together. You have to have all hands on deck for an incident like that" (Focus Group 1A). While normally a case would be assigned to a sub-team, if the sub-team encountered issues or difficulties in handling the

workload, others would readily stop what they were doing and help out where required to ensure that the incident was effectively handled. This was observed on a number of occasions.

The other strategy that was developed was using standardized approaches. As observed and noted in focus groups and interviews, standardized approaches helped individuals through infrequently performed tasks or non-primary tasks. As previously mentioned, the way the team works has changed. Before, “everybody was just doing their own thing in terms of tool set, in terms of process. We did have some SOP, but lots of stuff was depending on who was doing the work” (Focus Group 1A). This was problematic as they would “get different results” (Focus Group 1A). However, standardization of processes and procedures helped those who are not necessarily experts in one area to learn new processes, procedures, and accomplish key tasks. For example, when there were only a few of the team members available during the summer, I observed team members assume roles or functions where they were required to work outside of their specialty and learn unfamiliar tasks. In one instance, one of the senior forensics analysts stepped in to support initial intake and recording for an incident while the sub-team dealt with client specific issues. While he had not performed those tasks for some time, he was guided by peers, was able to refer team SOPs, and followed examples and protocols established for JIRA.

A fourth example of team informal learning through non-routine work was the expansion of the team’s technical infrastructure. The team members were almost continuously engaged in various activities to improve their technical capability. As mentioned by one member, “we have our conversations about how to make things better, change our infrastructure” (Focus Group 1B). The team worked with a wide range of tools and applications and had four different networks in which they operated a wide range of servers, switches and other IT equipment. As previously identified, due to limitations in their current space, several team members who were responsible for a certain aspects of the teams infrastructure needed to come together to set up “a lot of our infrastructure in a different room which is obviously required because we don’t have enough space” (Interview C). As observed, this primarily involved the team’s network and application experts and included ongoing activity and engagement of these experts as maintenance and change management activities were required to keep the systems and networks operating.

Though I was not present for all of the discussions and decisions, the evidence is in an outcome that resulted in an expansion of their infrastructure that satisfied the remainder of the team. This work included: requisition and acquisition of a separate server room; acquisition of

the required servers and switches; installation of the team's equipment in the server room; and setting up the required networks to support the team. More importantly, this was all completed using team resources with occasional support from IT experts from the other teams. I often saw three of the team's IT experts working and discussing team IT system issues together and visiting the server room throughout the period of observation.

The team informal learning enacted in this case was triggered by both the physical limitations and a team need for additional server space and increased functionality. Although the network and application experts on the team were not necessarily familiar with the SSC processes, they engaged in largely deliberate learning activities that leveraged and expanded their own knowledge and expertise, found and established relationships with other SSC network experts to support their work, discovered and worked within SSC processes and developed a collaborative solution that has been well received within the team and accepted by the larger organization.

Summary of analysis of non-routine events. As discussed, non-routine events may give rise to learning as they often introduce the unknown or unfamiliar. There were several other examples within the data, but the ones presented highlight special, non-routine circumstances in which the team found themselves. Whether it is the generation of a unique case management system, procurement issues, managing work load when short staffed, or addressing infrastructure issues, these types of non-routine events tend to fall outside the capability of a single individual to address. They provided an opportunity for collaboration and learning across the team to identify the problems, adapt, and overcome or reconcile themselves as a team to the event.

In these situations, collective learning included arriving at a common understanding, collaborative research and discovery, formulation of shared perspectives on what was perceived as a common problem, and the negotiation of potential courses of action and the inherent navigation, trials and mid-course corrections to arrive at a collective approach to managing the non-routine event. The associated learning for these non-routine events was triggered by the event itself or driven by organizational pressures. In all of the examples noted, the team was in situations in which the team or parts thereof chose to find strategies to overcome the issues encountered problem. For example, in the case of adoption of JIRA the event was the team's failure to effectively manage the case information during an incident; it was not the incident itself. This non-routine failure triggered the search for and discovery of a better platform to

manage case information that would meet the team's needs. Subsequent learning was driven by this goal.

Similarly, the challenges when procuring tools and software and staff reduction situations both triggered collective learning to find ways of addressing the situations encountered. This constitutes adaptive learning where the learning resulted in changes in how the team approached the situations encountered. The collective learning was largely deliberate as the team identified problems and explicitly found ways to overcome them. Throughout there was evidence of leveraging shared knowledge, connecting with other sources of knowledge and working through team challenges to arrive at a common approach. Noted drivers to learning in the situations discussed included the motivation to improve how they managed their information and the constraints under which the team were required to do their work.

While there were no clear transformative outcomes that could be identified from the non-routine events, there were elements of non-routine events that contributed to the teams' perspective on their role, their identity, and how they operated as a team and with others; this was evident in the tool development, procurement and the technical infrastructure examples. There were also numerous changes to specific aspects of the team's work that could be seen as adaptive learning to support improved performance, but none of these could be considered transformative in nature.

Incident response and recovery operations. As already presented, the IT security incident handling and response function within any organization is very dynamic and often complex. Investigating team informal learning in this work context was critical to understanding the main issues around the team's primary tasks and the situations in which they were placed.

Referring back to the team's context and work relations with other SOC teams, a majority of the incidents that affect GC systems and networks are resolved either by the department or the FIPC; cases are escalated to the IT SIRT when they are too complex for other departments or the FIPC to solve (Shared Services Canada, 2015a). The escalation of incidents to the IT SIRT is based on a wide variety of factors as stated in the SOC CONOP:

Escalation of incidents to initiate IT SIRT deployment will be based on established trigger criteria that categorize: impact, severity, breadth, state of the attack, attack methods, source and target, technical ability and expertise of the responsible department

– effectively, through a mechanism for prioritization/sensitivity and urgency reflected in a reference tool such as a matrix. (p. 8)

Based on observation and experience, incidents that involve sophisticated threat actors, unknown malicious code or compromises effecting multiple departments are typically referred to the IT SIRT.

Specifics of incidents, departments engaged and number and types of compromises is sensitive or classified information. However, to provide the reader an appreciation of the volume of activity that the team experiences, at the start of the observation period the team had six cases on their status board. Over the course of the twelve weeks, three cases were closed or passed on to another team for final disposition, two cases were pending further investigation, and six other incidents arose of which three were seen to be significant and engaged several team members at one time. During the 12-week period, I observed no less than four occasions where a team member or a sub-team was required to work outside of normal working hours for a considerable period of time. In short, it is important to understand the breadth and depth of initial incident handling and response activities and the ensuing forensics activities required. This work context was where the IT SIRT spent most of their effort and time. As well, it should be appreciated that this was the primary activity of the team and the function upon which the reputation and professional identity of the team rested.

Rather than pull narrowly situated examples from the breadth of incident handling operations that were observed and recorded, I will provide an account of one particular incident that highlights the issues and the collective learning that occurs in this work context. For this incident, I was present during much of the initial response, observed the team activities and overheard many of the team member conversations. The incident occurred during the observation period and while some of the details are classified, the following provides an unclassified version of events that resulted in a successful outcome.

In a GC CIRT report, the duty analyst learned of a new intrusion on a GC network. The duty analyst initiated an initial investigation, conducted the triage and during the course of his preliminary analysis, learned of the complexity of the intrusion and identified that this was above his skill and capability to manage alone. He assigned the case as a priority to the senior forensics analyst to do the preliminary network analysis. In his investigation, the senior forensics analyst learned about some unique attributes through a partner security team and found the initial

infected machine or 'client zero.' Through an adhoc team meeting, this information was passed to another individual who was tasked to obtain a memory capture from the infected workstation. Through dialogue with the four other team members, he learned about the general client culture regarding IT security, the client's systems in use, and potential ways that he could capture the memory without significantly interrupting client operations. In observation, there were other between-member interactions and behaviours including nods, acknowledgements and similar body language that seemed to confirm that the other members understood the situation and agreed.

Under normal circumstances, SOPs dictated that the local IT staff would be instructed to conduct the memory capture. However, as noted in observation of the team discussions at the time, there were no local IT staff members and anyone who conceivably had the knowledge and skills to do the memory capture was hundreds of miles away. According to statements, this was the first time that the team had faced such a challenge. Given the time constraints and the significance and sensitivity of the incident, one of the team members volunteered to travel to conduct the memory capture. As the machine was in a remote location, the individual had the additional task of learning how to make expeditious travel arrangements to a remote location which was a new experience for both him and the team. The observed exchange about travel included the manager, the senior forensic analyst, another team member and also engaged others external to the team including the director, the travel administrative authority, and a client authority. Multiple exchanges of information occurred clarifying the requirements, confirming the processes, ensuring that the tools were available and ready to go which were all discussed within the local team environment and in which several members were engaged.

I reflected on and noted a web of interactions that supported both the learning needed by the analyst who was travelling, the learning needed for the team to support the analyst in his task and the learning to handle the needed administration that was shared by three members on the team. As well, throughout the event, it was observed and reported by other team members that the analyst called or emailed back to the team several times to help clarify specific information and relate new information about the situation at the remote site.

As noted in the DA log and through observations, when the analyst returned from the remote location, he brought the stored memory arrived back at the IT SIRT facility. It was then provided to another member to do a memory analysis. During his analysis, the analyst apparently

discovered interesting signatures and contacted a partner security team to learn about some of the tradecraft employed by the advanced threat actor. As observed, the analyst was able to isolate the malicious code. Then the team went about tracking the degree of infection to various client servers. During team meetings and as observed in the numerous minor exchanges between team members, each of the team members implicitly learned the attributes of the malicious code and learned about the client networks and systems that could have been infected.

Based on team member inputs, the sub-team leader provided recommendations to the client to mitigate any further infections and discussed the potential business continuity issues where he learned about the client concerns and requirements in greater detail. When these concerns and requirements were communicated to the team, I observed various responses within the team and, based on a re-negotiated approach, team members assumed new tasks and roles to better support the analysis and significantly reduce the extent of the compromise and isolate the malicious activity. While individual learning was ongoing, there were also multiple, concurrent learning interactions between team members and across sub-teams. All the while, I saw that the team members were also keeping the affected department and other GC security teams apprised of the situation and their intended approach.

As synthesized from observation during this specific incident, the learning involved questioning, discussion, critical feedback, researching, outreach to other sources, and internal team debate and negotiation to address the challenges raised with the memory capture and the forensic analysis. There was a complexity of learning including deliberate learning activities pertaining to ferreting out the actual malware, reactive learning in responding to the initial challenge in obtaining the server memory, and implicit learning across many aspects of the incident, but notably how the information about the incident and the malware informally spread across the entire team. As mentioned above, there was also evidence of the team re-organizing, shifting and redistributing tasks during the mitigation of the incident. Overall, the response and outcome was due to collective effort through not only aggregative knowledge and experience of the team, but discussion, negotiation and generation of team responses in the face of unfamiliar and uncertain circumstances.

Another incident-based example arising primarily from observation was how the team self-organized during the initial intake process and response. At the onset of any incident, the team has only limited information on the incident and there is rarely an observed 'collective'

response. As is common, this new incident appeared to pique the interest of all team members regardless of whether or not they were engaged in the case. As more information became available, certain members of the team became engaged without being specifically assigned.

In this situation, the other team members provided their views on the case to the DA. Even after the initial exchange, three other team members formed an informal sub-team to collect additional information, conduct research and analyze the existing data; there was limited information available and there was no clear route forward. While the duty analyst and a forensics specialist were working on the initial response to the incident, the informal sub-team developed and assessed their own courses of action based on the information available. At some point during this process or after the preliminary analysis and initial courses of action were developed, the manager assigned a sub-team to lead the case. The assigned sub-team then planned, discussed, and identified their approach. They then engaged others on their plan as their investigation and analysis. At this point, the informal sub-team provided the information they had gathered to the assigned sub-team and offered their views on the planned approach. I observed that after the assigned team took over the incident, the other informal sub-team disbanded, but each of the members appeared to remain interested and engaged.

Much of the activity by both sub-teams was deliberate learning activity though they were reacting to the specific incident. The informal sub-team self-organized to efficiently and effectively address the threat until another sub-team was formally assigned. Based on my observations, the dynamics in this example were not uncommon and reinforce the previous findings the dedication and inherent curiosity of the individual team members.

Given that the IT SIRT was typically only engaged with incidents suspected of originating from advanced threat actors, the entire process was normally one of discovery as the breadth and depth of the compromise was seldom known early in the process. Throughout this process it was not unusual that the sub-team would find new information that could either result in them refining their approach or completely redirecting their approach. This would also likely mean changes to the team structure, processes, or tools used during the incident. As well, as mentioned in the literature review, distributed leadership was a potential dynamic within this work context perhaps more than any other. There was evidence of distributed leadership particularly during incident response activities as team members demonstrated expertise in specific functions and the team self-organized around the defacto leader for that particular part of

the evolution whether it be the DA or the more experienced forensics analysts. It is an interesting team dynamic, but there was no evidence of collective learning directly related the transferring of leader functions within the team.

In incident response and recovery situations, what occurred was highly dependent on the members of the team, their specialisation, their perspective and work habits. The sub-team boundaries were very fluid and the sub-team membership flexible so as to match the needs of the situation rather than any prescriptive process that limits team agility. As shown in the examples above, fully engaged and partially engaged team members often self-organized and merged together to create a situationally unique, synergistic capability to respond to the incident. Throughout the incidents, individuals worked together in sub-teams to accomplish a task or learned together to address situations like complicated memory capture or response to newly identified threat actor activities revealed during their investigation. Beyond the examples provided, there were other occasions where I observed the teams and sub-teams discussing courses of action and arriving at a negotiated consensus on the approach to be used.

Summary of analysis of learning during incident recovery operations. Through my observations and referring back to my reflexive journal, I had the impression that the most difficult challenges for the team were revealed in and around the team's primary mandate - incident response and recovery operations. Incident response and recovery operations appeared to be the work context that provided the most extensive amount of team informal learning where various forms of reactive, implicit and deliberate learning were enacted to address the complexity and uncertainty that arose during the response and investigation processes. The major trigger in this context was the discovery of or assignment to an incident. Shortly into the investigation, however, the learning was stimulated by situations that arose during the incident. The learning triggers at this point were associated with the unknown, the uncertain, the non-concrete and the unanticipated. Examples of such triggers include: receipt of new information; changes to the malware or threat actor behavior; and understanding and responding to the affected department's local situations.

Multiple drivers were evident. Clearly the team's mandate and the pressures to perform influenced the learning that occurred. In each incident, there was also what I called the team's 'thrill of the chase' and a collective tenaciousness evident in their activities and behaviours in finding ways to mitigate an intrusion; they were aware that senior management was interested

and their reputation was often on the line. These expectations, both within the team and from outside the team, appeared to be significant drivers to team learning. There were also clear influences from management during incident handling operations that would drive team activity and the associated learning.

Many of the mechanisms of learning and learning processes used were similar to other non-routine and routine situations. However, was far more dynamic and often the learning itself was emergent. Throughout, there was evidence of existing shared knowledge, generation of new knowledge, and leveraging of the knowledge of both internal teams and other external sources to support their work. Within this work context, the learning was considerably more fluid as the team encountered and worked through the incidents assigned. As noted in the first example presented, during more complex and sophisticated incidents, not all information was available and courses of action were not necessarily clear. The learning was emergent as the team would go through a process of discovery, consultations with other sources of expertise and various internal and external exchanges to identify and assess the best course of action. What was quite apparent through observation was the variable way in which these activities occurred depending on the incident. In some situations, the degree of urgency required rapid often reactive decision-action cycles. In others, there were opportunities to be more methodical and deliberate. It was within incident response activities that the team's ability to adapt and self-organize around an incident became apparent. This is also when there was evidence of distributed leadership within the team as responsibilities for work shifted to those best to lead the task. When sub-teams formed, the interactions within the sub-team became more nuanced as they worked a particular aspect of the incident, while using more visible channels to engage the larger team and obtain feedback on their approach and work.

Regarding the potential for transformative learning, looking narrowly at the incident response and recovery operations, there are instances where the team faced significant challenges and, at times, discourse and reflection resulted in changes to the team structures, changes to approaches used and self-organizing behaviour. However, these were singular responses to address situational issues and did not, in themselves, contribute to perspective transformation within the team. Therefore, within this work context, I did not see any evidence that suggested that these specific activities or events were in any way transformative. That said, in a general sense, the team's reputation and identity are tied closely to these types of activity. As will be

reported later, the team's history in this broader work context is relevant to the question of transformative learning.

Finally, as I reflected on my observations during incident response and recovery activities, I noted the importance of observation within the study. In this situations described above, much of the activity went unrecorded as the activity was generally spontaneous and time sensitive; recording was not a high priority. As well, context was critical and these activities would not likely have been identified within the focus groups or interviews without significant probing on this or similar incidents.

Summary of team informal learning in three work contexts. The intention of this section was to identify team informal learning in three different work contexts that provided the reader with additional insight to the case and the conditions in which the team worked: the daily work routine; non-routine events; and incident response and recovery operations. Within each of these contexts, there were different issues with which the team had to contend. As well, the triggers and drivers for the learning and the conditions under which collective learning occurred were different. In general terms, collective informal learning was enacted in various ways in all contexts and was primarily visible through team activities, interactions and their related outcomes. Within the team activity, however, there was a pattern of underlying activity that became visible. Though not all of the processes were visible or revealed by member statements in every situation that arose, there were common processes that the team experienced. I use the word 'experienced' because it appears that, for the most part, it was tacit as the team did not appear to plan or intentionally follow any specific process as they collectively learned and worked towards a team outcome. In general terms, the process included some form of: encounter; analysis, however brief; decision; action and some reflection or evaluation on the effect of the action. As noted, however, there were no indications that transformative learning had occurred in any specific work context. The next section will review the triggers and drivers for collective learning.

Triggers and drivers for collective learning

Throughout the findings, various triggers and drivers have already been identified for collective learning within this authentic work team. In all, there 115 unique triggers and drivers were identified and coded into NVivo 10. As discussed, triggers stimulated collective learning in the moment and often relate to problems, issues, or changes that influence team activity.

Common triggers for collective learning were drawn from the data and examples identified within the three work contexts. While not exhaustive, examples presented included: a lack of collective knowledge; overcoming resource challenges; the need to adapt to existing or changing work conditions; encountering new or novel situations; entry into new environments such as unfamiliar departments or systems; poor or unsatisfactory team performance; new directions or new tasks; or changes to other teams or their systems. The following provides more detailed examples of triggers for the team's collective learning.

Within the findings there was evidence presented where new direction or management requirements triggered discussion and formulation of a team perspective on the new direction or requirements. Similarly, changes in other teams or organizations that had an impact on the team required the team to learn, assess and, if necessary, change how they interrelated with other teams. A new work setting or environment would also trigger learning. In one situation, an impending departmental site visit triggered interactions with the local site team which in turn provided the IT SIRT with an appreciation of the local culture, processes, systems and issues prior to arriving on site. As well, any time a new member joined the team, the individual had a significant amount of learning to meet their work and team requirements whereas the team collectively learned about the individual's capabilities, capacity, experiences, history and personality characteristics as the individual was drawn into the team.

The team was also faced with numerous changes to their processes, technologies or tools. These changes necessitated not only learning about the change itself, but the impact on and changed required to other team activities, processes, and approaches. Collective learning was also triggered when team capability was unexpectedly changed such as a lack of people or resources to perform their mandated task; they needed to consider alternatives, learn and adapt so that they could continue to accomplish their mission. New or different incident handling information including threats, vulnerabilities, and compromises also triggered collective learning. Finally, as a last example of a trigger for collective learning, a problem, issue or failure that would occur in team work would trigger reflection and discussion on lessons learned. This occurred not just in incident handling contexts, but in daily routine and non-routine work contexts.

As alluded to in the three work contexts, there were also drivers to collective learning. For the purposes of this study, drivers are context-bound and, as opposed to arising from the

work, they background the work and *drive* the team to learn. There were several drivers to the collective learning of the team. The ones that were clearly evident were the team's mandate, organizational requirements, socio-cultural environment, expectational forces and team traits. The following will discuss some examples of drivers in more detail.

Perhaps the clearest driver for much of the collective learning is their mandate to “provide highly specialized response and recovery of complex and/or wide-spread IT security incidents” (Shared Services Canada, 2015a). In conjunction, there are numerous other references that discuss the team's capability requirements such as providing technical advice, conducting vulnerability assessments, and consulting. These drive the formal learning agenda and provide some scope of potential job-related and collective informal learning as formal learning only provided a fraction of the knowledge and skills required within the team.

Many of the drivers for collective learning were derived in the documents that guided team activities. For example, statements from the SOC CONOPs (2015) imply that the team needs to remain current in their discipline such as: “The unit will aid in the development and provide technical advice towards the content of programs aimed at generating popular awareness of IT Security”; “[The] IT SIRT will be engaged in the formulation of a comprehensive technical mitigation and/or rectification solution”; or “the team is required to stay current on the threat, emerging trends, and security tools and techniques.” These all imply that extensive learning on explicit knowledge before the team can meet the mandated output. Related to this is the need to stay current on the threat, emerging trends, and security tools and techniques (Shared Services Canada, 2015). As one member exclaimed, “You need to be current with the threat out there, what's the latest trend, so through blogs, public information, research...” (Focus Group 1 A). However, the amount of information that the team requires is highly dynamic and growing well beyond the team's capacity to handle; the team was required to find a way to know how and where to find this information. Consequently, the teams' transactive memory system is invaluable and, as discussed in its relationships with security partners, extends well beyond the team boundaries. This access to the various sources was often a critical factor in the team's learning and performance. The documents are rife with similar drivers that describe capability requirements that the team must meet.

Tied into the mandate related drivers discussed above is also the breadth and depth of client knowledge required. This is evident in both the client base and the threat context. First,

there is the quantity and diversity of clients. As previously identified, at the time of the study, there were 43 partner departments and 170 other departments and agencies for a total of 214 including SSC (Government of Canada, 2016). Most of these departments and agencies have very distinct mandates and their own organizational priorities and cultures that are markedly different from SSC; to name a few, some examples are the Fisheries and Oceans Canada, Global Affairs Canada, and Natural Resources Canada. It would be very unlikely that the team could obtain and retain all of the relevant information needed on that many departments. The IT SIRT must understand the resources, processes, and people required to get important information about their client base to better prepare them in the event of an incident. Notwithstanding, they do not have the capacity for all of this information and must be able to rapidly access and retrieve information.

The organizational requirements also drove the collective learning. The team was required to follow formal internal processes, connect with other teams or organizational groups, work within their organizational structures, address issues related to the facilities, resources, and supporting processes and produce required deliverables in the media, format, tone and style that suits the organization. These requirements posed many challenges particularly for this mission-focused, largely technical work team in that they have typically not been well prepared for these tasks. For example, the development and presentation of executive-level reports has been acknowledged in several statements as a team shortcoming. As one member said, “We get a lot of people within the team who are a bunch of geeks, right; nobody likes to write reports, but that’s part of our job. I don’t think anybody on the team, maybe one or two have had actual technical writing courses and training” (Interview P). Identifying specific shortcomings, one discussed inconsistency stating “...our reports, depending on who did it, it would be a different format” (Focus Group 1A). Echoing this sentiment another stated “Like...every single report is different, if it has a strong French accent or not grammatically good, another one is nicer and the client starts getting these reports and their not filtered through a central [editor]” (Focus Group 1B). Another, identified a specific constraint to reporting in that “there doesn’t seem to be enough time to deliver really good reports” (Focus Group 1B). An organizational requirement for well written, timely, properly formatted reports places additional learning requirements beyond the mere mechanics of report writing, but also on team processes for assignment, collaboration and review.

The socio-cultural environment also drove collective learning within the team. As discussed at length, the team was required to work within their own organizational context as well in other organizational contexts with other teams. Beyond the formal networks and structures, there was a myriad of informal social and power structures that were observed and reported. The sensitivities around the issues in dealing with the Procurement group were one example already discussed in detail. Additionally, there are concerns in dealing with clients. As described by one of the team members, “Sometimes working with clients can be difficult. It’s a challenge when you go into new environments. It can be new departments, new technology...” (Interview N). For example, before the team could formulate programs or advice it was necessary to identify and understand the client organization’s culture, context, and needs. To do this they were required to pull from a broad range of team-based knowledge on the issues to be addressed, and collaborate on a collective solution that would address any of the sensitivities related to the incident while solving the problem.

Expectational forces also drove collective learning. For example, the senior management expectations of the team to operate with a high level of integration with the FIPC and the GC CIRT (Shared Services Canada, 2013) while separated by walls and secure doors. As well, there was the expectation of the team to work long hours in a cramped work environment without access to proper classified communications channels, yet do very high quality work on very sensitive cases. Another pertains to the previously discussed example where the team’s work was disrupted to respond to senior management requests that may not be aligned with the team’s mandated priorities.

Albeit that the IT SIRT team was mandated to “operate on a hierarchical basis that will create clear chains of command during an IT Security Incident” (Shared Services Canada, 2013), I observed this hierarchy and the mandated processes (Government of Canada, 2011, 2015) being violated on occasion. As reported by one member, “whenever anything gets public or with a lot of visibility, then without the vetting through the team, doing the triage, and feeding up the information on it, it’s senior management coming down asking for update, ‘what’s happening with that’, so that influences the way that we [work]” (Focus Group 1A). Another expressed his frustration in regarding a specific incident:

...it’s optics and politics right? I mean, you get a call Friday night saying you have to work all weekend on this when we’ve already discussed with the client...certain people

were going to do stuff over the weekend and we were [to] check back Monday and pick it up from there. Then I got a call from (name), saying ‘Sorry, you’re on right now.’ We worked the entire weekend, then we get in Monday morning and it’s made no difference whatsoever because no one else was there. It’s the optics of management, they need to report up, right. They need to be seen to be on top of things. So, we get forced to work on things in certain ways or on certain timelines that don’t have a basis in reality. There’s no need for it. If people that need help aren’t going to be there until Monday, then what am I doing there all weekend.” (Focus Group 1B)

In another situation observed, during an incident the situation changed as the team gained information about the threat actor and how the compromised had progressed. Once the incident was escalated within SSC and discussed at higher governmental levels, the context in which the team was working changed as priorities were adjusted, different resources were applied, different internal and external teams were engaged and there was a commensurate increase in the pressure on the team due to the increased visibility of the incident at higher levels in the Government. In this example, one small change in the incident resulted in changes to the overall context in which the team was working; there was new knowledge about the threat actor gained, new teams to engage, new channels of communication to use and different pressures to perform. These influenced the team’s activities including what and how the team learned during that incident.

These examples demonstrate the influence of management expectations and also how power is sometimes used to influence the team’s learning and work to arrive at an outcome that would have normally not been required. Indeed, another member simply noted that they have to handle some cases differently “due to all of the politics around [them]” (Focus Group 1A).

There are also drivers that are ever present during the team’s work that seemed to be part of the team traits or character. There are three that were prevalent in my view: the spirit of continuous improvement, the team’s collaborative nature, and the need to protect the team’s reputation. Continuous improvement, in general terms, was evident in all three work contexts, but was particularly noteworthy in the JIRA and SOP revision examples already discussed.

The collaborative nature of the team was also evident. As one member stated “...in the context of cases, we seem to be able to divide the work, share findings and share expertise” (Interview N). Another echoed these sentiments stating:

That [big incidents of 2014] raised a lot of challenges where you needed to share information amongst all the people and you needed to be on the same page in terms of process in order to identify an item to be completed or provide the status. (Interview E) The other was an implicit driver that was evident across the team – their professional reputation. It was clear from the statements of the individuals that have been previously captured, particularly in the last section, that their sense of professional identity and their reputation was important. I believe that one of the members summarized the feelings about the challenges well:

“I think the key word is struggle. Whenever you’re on a case, you struggle on something, and you don’t want to struggle on the next case. So, you try to take what you learn from that case and, regardless what’s the source, whether it’s a colleague, new technology...”(Focus Group 1A).

These types of drivers were overarching and, while not necessarily situationally dependent, supported team activities when they were immersed in situations.

Summary. Overall, there were many triggers and drivers identified for collective learning. Only some of them have been presented here. These provide important context for understanding the team informal learning that occurred and as can be seen while there were many triggers to learning, there were also drivers that also obliged or compelled the team to learn.

Team change and transformative learning

The third sub-question in this research was “How does Mezirow’s theory of individual transformative learning contribute to understanding collective transformative learning processes that may occur in this authentic work team?” Before responding to this question, it is necessary to identify whether or not transformative learning occurred. To help distinguish between the different types of learning that contribute to team change, the following will distinguish between significant team changes which were the result of adaptive and/or generative learning and those which appear to support that the team *transformative* learning in terms as defined by Mezirow (2012). To remind the reader, to support the claim for transformative learning, I used the reframed process where transformative learning occurred as the team: encounters a disorienting dilemma; conducts an internal examination of the shared experience; critically reflects and assesses their shared assumptions; recognizes their discontent and the process of transformation is shared; explores options for new roles, relationships and actions; discusses and plans for a

course of action; determines the new capabilities to implement the plan; trials the plan; renegotiates relationships and negotiates new relationships; builds competence and confidence in new roles and relationships; and reintegrates into the organization on the basis of conditions dictated by the new shared perspective. Further, the transformative learning must have resulted in a significant, enduring change in the team.

In this case, there are documentation, member statements and researcher observations that support potential collective transformative learning of the IT SIRT. More specifically, the team appears to have undergone a learning process where the collective perspective on their identity as a team has significantly changed relative to how they viewed themselves before the major *disorienting dilemmas* associated with the incidents of 2014.

Figure 12 helps the reader to visualize the situation of how and under what circumstances the team has potentially transformed. This diagram is intended to help illustrate the overall phenomenon that was identified in the findings. However, the graphical limitations of the medium result in a linear representation though none is intended and may appear to suggest causality where none exists. In the diagram, the small grey boxes in the figure represent team members and their unique frames of reference (FoR) based largely on the interviews; there is not a box for each member, these are merely representative. The larger boxes represent the team's FoR which were supported by all sources.

It appears that after the events in the summer of 2014, there was considerable collective reflection on their performance and subsequent changes to the team's perspective. As the team reflected on their performance and who they were, they appear to have undergone a transformation in that the team's identity that has crystallized in the minds of a majority of the team members. The individual and team FoRs became more aligned within a common perspective and they collectively came to see themselves as an advanced forensics analysis team.

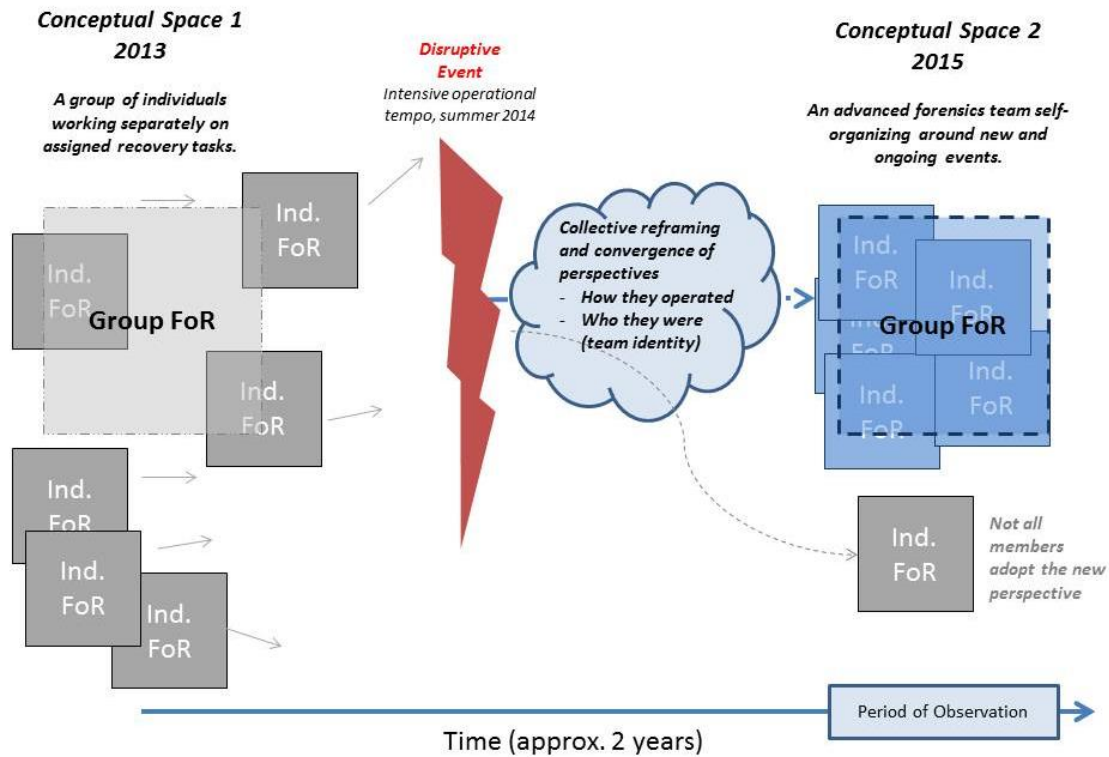


Figure 12. Representation of team transformation

‘Conceptual space 1’ preceded the incidents of 2014 and highlights team characteristics at that time based on the data. As synthesized from the documentation, interviews and focus group data, at this point in their history the team was characterised a group of individuals working separately on assigned recovery tasks. They were further described as a group of individuals working independently rather than as a team all using their own tools and techniques. There appeared to be no ‘team trajectory’ to speak of, but rather several distinct, individual trajectories. There was also significant emphasis on compliance and drafting SOPs for many of the team’s internal procedures. Finally, there seemed to be no common approach or values articulated within the team other than those associated with the larger community (e.g. security mindset, public service, etc.)

‘Conceptual space 2’ represents a qualitatively different team that existed at the end of the period of observation. This conceptual space was created from the findings which were based on team activities, artefacts and interactions. First, the team demonstrated a significant change in how they operated. As opposed to being procedure bound, the team adopted a much more adaptive work posture freely self-organizing around new and ongoing events. More relevant SOPs were developed and the team approach, including the use of sub-teams, was solidified to

better support client department activities during team investigations. Second, there was a definite change in team trajectory and evidence of collective identity transformation as the team emphasized their identity as an advanced forensics team. This was also accompanied by greater congruence in team's values as they appeared to be working from a common perspective. The changes to how the team operated may have in fact been antecedent to the identity transformation.

These two conceptual spaces as described above do not fully reflect that the team was situated in a dynamic environment that included space, time, material and socio-cultural influences throughout the period. Further, though the incidents of 2014 were disruptive, they were not necessarily causal to all of the changes that occurred on the team that resulted in the team arriving in 'conceptual space 2.' There was a host of factors that contributed to or influenced the outcomes including management decisions, implementation of a new Government policy and plan for incident response, team decisions on approach and processes, departure of two team members and arrival of others, and multiple changes to the technology and systems. The degree to which a multitude of factors contributed to what occurred over time is too complex to determine with certainty. That said, the statements of the participants, the observations and the documentation indicate that the major incidents of 2014 were disruptive to the team, who they were, what they did and how they did their job. The two major changes are discussed and differentiated in more detail below.

Significant changes in how the team operated. In the broader sense, there seems to have been a significant change in the team that was triggered by two major incidents in the summer of 2014. The change was reflected in how the team works. Before the two major incidents, cases were assigned to individuals based on their expertise and there appeared to be little team work. According to participant statements, they: "used to work independently a lot" (Focus Group 2B), "everybody was just doing their own thing in terms of tool set, in terms of process...it was depending on who was doing the work" (Focus Group 1A); "back in the day, it was just a constant fight..." (Focus Group 1B); and "There was a lot of in fighting within this group" (Focus Group 1B). Another reported that "we didn't really work like a team initially, it was him and whoever he decided was going to work on the case. There was very little collaboration" (Interview N). As well, there was considerable confusion on responsibilities between the SOC teams as expressed by one member "In the beginning it seemed like there was

a lot of duplication of efforts between the teams, like FIPC ‘we’re doing forensics’, and ‘we’re doing forensics’ [meaning IT SIRT], who’s actually supposed to do this? First come first served? Whoever gets the case first, gets to do the forensics” (Focus Group 1B). Supporting this, another stated, “. . .when you deal with some of the other teams in the SOC, they don’t necessarily have that same approach. And it would make our lives a lot easier if everyone had a standardized way of doing things” (Focus Group 1B).

Since the two incidents, the team has started to restructure itself to better support the complex cases similar to those that they encountered. The members acknowledged that the two incidents stimulated change and has allowed them “to develop a more focused approach and be better prepared” (Focus Group 2B). Subsequent to the two incidents, there were several efforts initiated from within the team and supported by the team to change how they operated. As already noted, these include the implementation of JIRA, revision of SOPs and introduction of team meetings. There was also a new approach that includes the use of sub-teams vice independent work. This was not only a structural change, but changed how collective knowledge was leveraged within the team. As stated in by one member, “(w)e are more of a team now and we also now employ micro teams. We used to work independently a lot, but now in the team and the new micro teams we are bouncing things off each other more” (Focus Group 2B). Another was more specific in terms of the redistribution of knowledge:

When we originally started out, it was a per incident kind of thing. For some incidents, everyone jumped in, but for the one offs where you were doing all of the forensics, the acquisition, the intake, the triage, the reconnaissance, and then you would have to write a report. Now we have the team concept where we have two qualified guys, CS 03s, in each of the teams. The knowledge and the expertise in those groups were distributed well.” (Interview N)

There are also member statements that discuss how the team has “[t]he team has matured a lot” (Focus Group 1B) and how they “manage the stress as a team better” (Focus Group 1B). One member summarized his thoughts stating that “There’s a difference between saying we are a team and actually being one. Now we are” (Focus Group 2B).

There were several team member statements and indicators in team documentation that also show that there was a significant change in how the team operated and agreement that group has transformed to become a “different team” (Focus Group 2B). While various terms were used

within focus groups and interviews, each of the team members agreed that the team changed since they joined. This was reinforced by the one member who recently rejoined the team after a year-long assignment who stated that he saw a “huge difference” (Interview G). Further, in the interviews and focus groups, all members appeared to agree that the changes have been positive in that the team appeared to be more organized, processes were more formalized and the capability had grown. As supported in one member’s statement, “Over the last year we’ve taken more courses, we’ve talked about incidents, and had meetings over how we can better improve our processes” (Focus Group 1B).

Of note, there is no evidence to suggest that the changes to how the team worked was driven by managerial decisions. Rather, the changes seem to have evolved with the team experience and management has supported the changes. Moreover, based on the interviews, document analysis and review of the specific cases, there does not appear to have been any single decision or any collective discussion that resulted in the changes. Instead, it seems that the requirement to change has been discussed often amongst team members and there was a tacitly understood goal to improve even though there did not appear to be a particular end-state in mind. As one member noted, “(w)e are a high ability or high professional team so we will figure something out and do our best” (Focus Group 2A). Another now noted, that “I think our group is based around difficult situations. We adapt really well, because we expect every incident to be different” (Interview C).

The preceding findings suggest that there has been a significant change in the team’s approach to their work or how they operate due to concerns regarding the team’s performance on two successive incidents in 2014. They engaged in ongoing critical reflection on their performance and in doing so they realized that they could no longer operate in the fashion they had been. While there appeared to be no overall collective plan or strategy for change, the team made conscious efforts across several work areas aimed at improving how the team worked as already noted in the examples. This changed the roles within the team and how the team operated as a whole. In my observations and as noted in my reflections, based on my own extended relationship with the team I agree that there has been a distinct change in how the team operates since the incidents of 2014. While the changes have been significant, the learning associated with this type of change was adaptive and, at times, generative as the team grappled with an evolving work dynamic while attempting to improve how they operated.

Identity transformation. There was another significant change in the team noted that has taken a longer period of time and has been far less visible. Since the inception of the team there has been a subtle, but meaningful shift in emphasis from broader incident response and recovery activities to a more intensive emphasis on advanced forensics analysis role. For the reader, there is a distinct difference where incident response and recovery are primarily about incident mitigation and continuity of IT services, whereas forensics analysis is primarily about investigating the causes, identifying and securing evidence support legal or administrative action, and finding ways to eliminate those potential causes. The former is primarily about ‘fixing’ the problem where the latter is primarily about ‘attributing’ to a specific threat actor or event in such a way as to support legal proceedings.

Several statements indicate a distinct shift in team’s perspective on its role and identity. In addition to the previous statements on how the team was previously operating, one member recalled his earlier impressions of the team as an entity “There were more one offs and there was not really any identity” (Interview B). A number of other statements support that the team now identifies closely with a forensics analysis role rather than the broader incident handling and recovery activities. For example, one member noted that “[b]efore it was more of a gathering thing and we were handing a lot of things off to CSE, now we’re doing the forensics” (Interview O). Another asserted that “I think we are more of an Advanced Analysis Team rather than a recovery team” (Focus Group 2B). Yet another stated, “I would say we concentrate more on a lot of the forensics stuff” (Interview P).

Beyond the mere statement of what they did, there was also evidence that suggested that the team members particularly identified with their role as ‘specialists.’ Given the GC’s dependence on their role, one member expressed his view stating “It’s nice that we can kind of be out there a bit. We should be a black box and you won’t know what we do until we stop doing it then you’ll panic and then come back to us” (Focus Group 1B). Another emphasized the uniqueness of the team’s role relative to other IT security teams, “Coming from that line of thought, you have people from different departments in SSC that think they are the forensics team...then they realize that we actually have a team [the IT SIRT] that is trained to deal with these incidents” (Focus Group 1A). One member discussed how the team change has resulted in an increase in the teams prestige and authority indicating “before, we were taking anything, now that we better understand our role, we now are able to turn down work if we don’t think it fits

within our mandate” (Focus Group 2B). Yet another expressed a more global sentiment stating that “we have a better idea of our own identity.” (Interview B)

While perhaps only a subtle change to the reader, in my understanding the IT security community, the distinction between being part of the larger incident handling and recovery process to being considered the subject matter experts in forensics analysis is a considerable shift in focus and identity. Indeed, it is a shift in *raison d’être* of the team. This subtle but important change was even reflected in SSC documentation. In the original charter, the IT SIRT was:

“tasked in the recovery of complex and/or widespread IT security incidents leveraging and ensure rapid restoration of services *within the 43 departments and agencies of SSC. By definition, the IT SIRT team will perform incident handling activities. This entails analyzing and resolving events and incidents* that are reported by end users or are observed and escalated through the proactive network and system monitoring of the FIPC.” (Shared Services Canada, 2013, p. 3 – author’s emphasis)

Within this definition, this had the team involved in a full-suite of incident handling activities with an emphasis on recovery operations as their team name reflects. Even before the incidents of 2014, there was a pattern noted within the training documentation, team reports, and other team records that the team seemed to be narrowing their focus of work towards specializing in forensics analysis including a shift in the SOPs, task changes and increasing requests from team members for forensics training.

As a significant disrupting event, the incidents of 2014 seemed to have a galvanizing effect on the team as they realized the significant dependence that departments and the GC had on the IT SIRT forensics abilities. As one participant noted, “We sort of went in, did what we needed to do, did our investigations, made our recommendations and that’s kind of where it ended” (Interview H). In fact, according to other team records on the cases, another branch of SSC assumed the lead for the actual technical recovery in both of the effected departments; the IT SIRT was not engaged to do the recovery operations work. It appears that despite what was written in their mandate, even the organization had realized the effort and effect that the IT SIRT could have by focusing on forensics activities.

This shift in professional, specialist focus is also evident within their community engagement. Based on observation, while they were certainly a part of the broader incident handling community, the team members have all been engaging more specifically with the

digital forensics community and forming close professional bonds with other GC digital forensics professionals in partner lead security agencies including “CSE, RCMP and Public Safety” (Focus Group 1A). As noted by one member, “we have seen really good improvement... to leverage the experience and skill set of our partners” (Interview E). Another emphasized the growing relationship and the benefits for the team from such relationships “events at CSE that I was lucky enough to attend, was a really good experience and really good information to bring back and better understanding of the organization. It influences the way that you’re responding to that organization because you know the way they work” (Focus Group 1A). This also lends credence to the team being recognized as forensics specialists since the event discussed in this statement was exclusively limited to forensics specialists from lead security agencies.

Interestingly, the management of the organization continued to espouse the IT SIRT’s broader mandate, but comparing the previous excerpt to the more recent one below there were subtle changes to the team descriptions that suggest a shift in the management’s perspective:

“This specialized team is tasked in the recovery from complex and/or widespread IT security incidents to ensure the rapid restoration of services government wide...IT SIRT can *provide in depth analysis* and direct on-site incident response supporting repair and recovery operations. The unit has the delegated responsibility to *provide and/or oversee any forensic evidence collection and all phases of artifact handling* in incident response activities.” (Shared Services Canada, 2015, author’s emphasis)

The references to “in-depth analysis” and “forensic evidence collection and all phases of artifact handling” reinforce the team’s forensics role. Note that, according to the team’s documentation and based on the previously mentioned member statements, this description was drafted well after the team had already commenced a shift away from the previous emphasis on technical recovery operations towards more forensics analysis. Again, as with the previously discussed change in how the team operates, it appears that management was not directly involved in effecting this change. Rather, they seemed to play an enabling role that retrospectively supported the team’s shift in professional, specialist focus which has now started to be reflected in the organizational documentation.

In further analysis of team records and considering many of the previously mentioned team member statements, it is evident that the team has evolved from a broad suite of responsibilities across the spectrum of incident handling to become a specialist team of digital

forensics analysts. The two incidents of 2014 appear to have solidified the team's role and identity as forensics specialists. However, the incidents themselves cannot be identified as a singular trigger to this change. It appears that there may not have been any specific trigger other than the team's tacit and collective desire to be identified as GC digital forensics specialists as borne out in their actions as seen in focused training, focused activity, or references in their language as discussed above.

Notably, not all team members have acknowledged this shift. As per the focus group discussions, one individual agrees that the emphasis is on forensics activities, but continued asserting that "...we are engaged in recovery, not necessarily rebuild, which is a different process." (Focus Group 2B) In this situation, there is likely a semantic discussion around the terms recovery versus rebuild that did not occur to help clarify what was meant. Based on observation, team documentation and history, the individual had been with the team since inception, had been acting manager on numerous occasions, had a significant influence on the initial team direction and support of the recovery functions, and was the initial drafter of the team charter and concept of operations. He acknowledged that the team was different and indeed had transformed, but did not agree with the team identity as an advanced forensics analysis team. That said, it is understandable that there were different perspectives. The participants had different experiences before and during their time with the team, they had a different appreciation of the degree of change in the team and, depending on their perspective, they may not have seen the shift as significant.

Importantly, there is no evidence of a single trigger for this collective learning and change. Rather, this change appears to have been created out of the larger GC need to have deep analysis of certain incidents and the team's desire to fit within this specialist niche. Finally, there was also no evidence of a conscious collective decision or verbal consensus of the team to become this; the team seems to have, over time, adopted a particular view or professional identity of who they are and sculpted the team's character and capabilities to fit that view. Suffice to say that this narrowing into a specialist niche over the course of two years is an example of an incremental, yet significant qualitative change to the team over time.

In observing the team and reflecting back on their early days, there has been a significant shift in how the team sees themselves and this has affected how the team interrelates with others. My reflections also note a sense of eliteness within the team. Revisiting one quote emphasizes

this: “We should be a black box and you won’t know what we do until we stop doing it then you’ll panic and then come back to us” (Focus Group 1B). The team had become a different team in their own eyes and in the eyes of others. Accordingly, the activities related to their shift in identity, this shift in how they saw themselves within the larger community, and the formulation of their professional identity as an advanced forensics analysis team has potential to be identified as a transformative learning.

Alignment with the reframed transformative learning process. Based on the data, the team had participated, consciously or unconsciously, in several steps associated with the transformative learning process that was reframed for the collective in my conceptual framework. Table 6 provides a summary of steps of the proposed reframed process that were evident in the findings. My comments provides additional explanatory information drawn from team history and team member statements and confirmed to exist by observation. In viewing the evidence in this transformative process, there is also further support to the assertion that how the team operates may have been antecedent to the identity transformation. For example, many of the issues that stimulated team introspection pertained to the overall team performance which incrementally changed over time and likely contributed to their more confident perception of themselves as an advanced forensics analysis team.

Team activity	Present	Researcher’s Synthesis of Evidence
A disorienting dilemma encountered by the team	Yes	As noted in the focus group and interview comments, the incidents of 2014 gave rise to the team questioning its ability to perform well, where it should focus its energies, and how they were viewed as a team.
An internal examination of the shared experience	Yes	According to all sources, the team had numerous discussions regarding the incidents of 2014 and how the team operated before and during those incidents. In particular, there were questions that pertained to who they were and what they were supposed to do as a team.
A critical reflection & assessment of shared assumptions	Yes	For the incidents of 2014, there were team lessons learned developed which intentionally precipitated critical reflection. Moreover, there were other points of evidence in focus groups and interviews that suggested that the team had engaged in this level of discourse.
Recognition that the team’s discontent and the process of transformation are shared	Yes	As noted in the examples and discussion, the team was aware of their situation and acknowledged that the team needed to change.
Team exploration of options for new roles,	Yes	The commencement of various initiatives including the case management system, changes to SOPs; adoption of

Team activity	Present	Researcher's Synthesis of Evidence
relationships, and actions		sub-teams, support this step. At the same time, a look at the training record supports greater focus on forensics specialization.
Collective discussions and planning for a course of action	No	Even though there appear to have been numerous interactions concerning the potential team changes there is no evidence of a shared plan, strategy or vision for the team. Nor was there any evidence that the team formally discussed how they were going to proceed as a team in other than task specific activities.
Determination of new capabilities to implement the plan	No	Similarly, there was evidence of discussions on specific activities such as the implementation of the case management system and sub-teams. However, there was no evidence of a shared plan or consideration of team-wide capabilities nor how they should reshape themselves as a team.
Trialing the plan	No	Trials were conducted for specific activities that contributed to team tasks, but there was no team-wide plan to support transformation.
Renegotiating relationships and negotiating new relationships	Yes	This occurred as a natural consequence of the team engaging in new activities, processes and approaches. As discussed, the team participated in negotiation of roles and arrived at consensus in new roles within incident handling with a particular focus on advanced forensics. However, there was limited formality to this process.
Building of team competence and confidence in new roles and relationships	Yes	This occurred as a natural consequence of the team engaging in new activities, processes and approaches. However, there was limited formality to this process.
Reintegration into the organization on the basis of conditions dictated by the new shared perspective	Yes	The adoption of the case management system, the formation of sub-teams, the changes to team approach, changes to SOPs to reflected the change in the team and emphasized the forensics analysis focus.

Table 6. Noted team participation in reframed perspective transformation process

As shown in Table 6, the team participated in 8 of the 11 process steps. While this was a much more naturalistic setting and the team was not consciously following a transformative process, there appears to be a significant degree of alignment between the process and the team activities while undergoing transformation. However, there is a proviso. While there were no occasions where it could be reliably stated that all steps in the process had occurred, the absence of one step of the process does not mean that it did not occur, only that I did not find evidence of

it through my research. However, in this case, it appears that the team had undergone transformative learning as they had experienced significant, qualitative change in who they were as a team; their professional identity. Further, they generally followed the reframed process.

Summary. This section specifically attended to the third sub-question in this research was “How does Mezirow’s theory of individual transformative learning contribute to understanding collective transformative learning processes that may occur in this authentic work team?” First, I reported the significant change in the way the team operates and determined this to be largely adaptive and generative learning. Then I presented the significant change in the team’s identity. Finally, I identified the degree to which the reframed transformative learning process was evident in the two aforementioned changes. In this case, there was evidence of disorienting dilemmas, critical reflection and action as described in the reframed transformative learning process which suggests that Mezirow’s theory may have some applicability to groups. There was also evidence that the team was experiencing transformative learning as defined in the literature. Interestingly, the significant change in how the team operates may very well have been antecedent or integrated with the transformative learning.

Findings Summary

Using data and examples from the three work contexts, the findings show that collective learning is enacted in various ways, but primarily it occurs through a web of interaction processes and activities within and across team boundaries. These interaction processes and activities resulted in changes to the collective knowledge of the team and application of the knowledge which became manifest in verbal, textual, graphical/symbolic, and behavioural activities of the team. These, in turn, were reflected in team products, processes, relationships and overall work environment. The findings also highlighted the triggers and drivers which stimulated and influenced team learning. In one situation, it appears that there has been a significant change in how the team views themselves and has developed a unique identity which has the earmarks of a transformative learning experience more or less aligned with the reframed transformative learning process. The next chapter will discuss the relevance of the findings relative to the research questions.

Chapter Five - Towards an Expanded View of Team Learning and Transformation

Introduction

The preceding chapter presented the study findings and demonstrated how collective informal learning was enacted in this authentic work team. It also identified common triggers and drivers for the collective learning of the team and highlighted at least one instance where transformative learning seems to have occurred. The findings support that team informal learning is enacted in various ways, occurring through a web of interaction processes within and across team boundaries. These interaction processes change the collective cognition of the team which then becomes manifest in verbal, textual, graphical/symbolic, and behavioural outcomes of the team.

This chapter will discuss the relevance of the findings to the main research question “In what ways is collective informal learning enacted within this authentic work team?” and three sub-questions: how can this collective learning be understood and articulated; what were the triggers/drivers for this type of learning; and how can Mezirow’s theory of individual transformative learning contribute to our understanding of how learning may occur in this authentic work team? In addressing the main question and the first two sub-questions, I will synthesize the findings identifying the ways in which team informal learning was enacted and briefly discuss triggers and drivers for collective learning.

In addressing the third question, I will discuss the situation in which the team potentially experienced transformative learning relative to the reframed process identified within the conceptual framework. Referring to the literature reviewed and given the plurality of possible uses of the term ‘transformation’ relative to change, the discussion will include criteria of claims to determine the degree to which this situation can be confirmed as transformative learning. Leveraging the findings and the new understanding of how collective informal learning is enacted, I will then provide an expanded view of team learning that incorporates these new understandings.

To reconfirm the scope of the reporting and discussion, the reader should appreciate that not all team interactions and activities necessarily involve learning. For example, team activities that involve routine work or interactions with other teams where there is no change in the collective cognition does not constitute learning. Further, not all learning is work-relevant. For

example, new collective knowledge that arises from and relates to social activities is not work-relevant and is therefore not included in the discussion.

Team Informal Learning is Enacted in Various Ways

As presented in Chapter Two of this thesis, team learning as an enactment necessarily involves learning processes and outcomes. Accordingly, the definition introduced continues to support the findings. To remind the reader, team informal learning is defined as contingently formed patterns of understandings and interactions within practical and situated activities where learning is discovered and generated together. This learning results in changes to the collective cognition which becomes evident through team activities, artefacts and other outcomes including changes in how the team communicates or how they approach situations encountered. Returning to the earlier discussion of distributed leadership, there were some examples of this occurring particularly during incident response and recovery activities. Those team members that assumed leadership roles engaged in informal learning as an individual. However, this was not seen as enacted team learning.

The individuals within the team were almost continuously interacting with each other within and across team boundaries. It is when these interactions transcended individual experience that collective learning was evident. These interactions occurred face-to-face, through open dialogue, and over electronic means such as the telephone, mobile devices and IT/workstation applications. As observed and shown through previous examples, not all of the interactions were clear exchanges of information. Along with explicit communications, members also interacted through other means including presence, posture, gestures, physical artefacts or body language. As well, the absence of any verbal or physical interaction also has meaning, though this meaning often remains tacit and not necessarily understood by all individuals within the collective in the same way.

The Information Technology Security Incident Recovery Team's (IT SIRT) collective learning occurred in various ways and reinforces and expands on McMurtry, Rohse and Kilgour's (2016) proposed framework for enacted collective learning. The findings of this research provide evidence of how collective informal learning is enacted within this work team through verbal, textual, graphical/symbolic and behavioural activities or representations. While presented separately, these enactments were part of the complex, dynamic work environment of the IT SIRT and as such they were simultaneously occurring and interwoven with team work

performance. For each of the enactments, it appears that there were contributing processes within a cycle of activity that reflects how the team informal learning occurred. Supported by examples, each of the detailed enactments of team informal learning below discusses the contributing processes.

Establishment and maintenance of interrelations with other teams. The most obvious enactment of collective informal learning was the team activity of establishing and maintaining interrelationships with other teams or groups. As previously discussed, the Y meetings and other engagements with the Federal Information Protection Centre (FIPC) and Government of Canada Cybersecurity Incident Response Team (GC CIRT) supported collective learning and connected the team to new information and different perspectives. As well, the IT SIRT partnered with other teams from the security and intelligence community and engaged other departments during their work. As shown through the examples provided, learning, often reciprocal in nature, was ongoing. This included boundary crossing in which learning was often a primary endeavour of the team. While the activity was largely deliberate, there were also implicit and reactive learning occurring during these interactions.

An effective example from the findings is the interrelations during incident case management activities with other departments. As reinforced by the statement of one of the team members, there is the overarching requirement to know “how to deal with other groups and outside people in a different way because generally we’re going into someone else’s environment and they’re uncomfortable with that” (Interview O). As identified, this often resulted in a reciprocal informal learning relationship between the IT SIRT and client. However, from the team perspective, nearly all of these relationships provided learning opportunities that built upon the IT SIRT’s knowledge of the client’s technical situation, technical expertise, and other aspects of the client’s work environment such as mandate, priorities, culture, and structure.

The interactions with other lead security agency teams such as the Royal Canadian Mounted Police (RCMP) Technical Crime Unit or the Communications Security Establishment (CSE) Cyber Threat Evaluation Centre (CTEC) also supported various IT SIRT activities, but learning was particularly evident during incidents. These organizations have at their disposal certain tools, processes and information that is typically not known to IT SIRT at the onset of an incident. However, as an incident progressed, the IT SIRT would often contact these organizations for information and assistance. These exchanges provided the team new

knowledge about the incident as well as offering additional insight into the work, capabilities, interests and concerns of these organizations relative to the incident being investigated. These changes to the collective understanding of the other GC teams were subsequently reflected in changes to what the IT SIRT did and how they interacted with those other teams.

Though the team was regularly engaged with a wide variety of other groups or teams, the underlying cycle of activity was most visible during incident response and recovery operations. During such operations, the team often established, maintained and dissolved multiple relationships throughout the course of an incident. In each of the examples cited in the findings, collective learning was triggered by a team need that could be addressed in a new relationship or through an existing relationship. For example, the relationship with CTEC was an ongoing one that, as inferred from the statements, has grown since the team's inception and will continue to develop, change and mature. However, given the nature of the IT SIRT's work and the complementary CTEC mandate, it is unlikely that this relationship will lapse. Alternatively, the IT SIRT's relationship with a specific client department during an incident was temporary. The relationship may go through the entire lifecycle in a very short period depending on the extent of the incident. In some situations, this can be less than a few days. Once an incident was over and the post-analysis activities completed, the relationship either lapsed or was formally terminated. Depending on the situation, another relationship may have been established because of the initial relationship. In the example of the remote client, the team first needed to establish a relationship with the Departmental IT authority, then discovered the requirement to establish another one with the local team at the remote site. While the formal relationship at the remote site was no longer needed after the incident, there was an ongoing relationship established with the Departmental IT authority that has sustained as a consultative and collegial one within the larger IT security community.

In the examples presented, the contributing processes in support of the outcomes were often explicit given the team's interactions during incident handling operations. The processes were situationally specific; this means that there was no single way that the team established and maintained the interrelations with other teams. Rather, the activities of the team depended on how the relationship emerged during the incident, what members of the team pursued the relationship and why, and what mechanisms were used to initiate and maintain the relationship.

Based on team member statements and observation of team interactions with both new and existing groups, contributing processes appear to have been: identifying a team requirement to connect with another group or team; searching for or encountering the other team or group; conceptualization of the relationship; analyzing potential value based on the team's interactions, reconciling any differences or rationalizing the relationship; deciding to engage; generating/developing the connections; engaging the new team or group; and maintaining the relationship. In maintaining an ongoing relationship there may also have been reflection and evaluation of the relationship; modification of the relationship if it changed; and re-generation of the relationship if required. Finally, if the relationship was no longer warranted, as was also seen in the last example, the team would allow the relationship to naturally lapse or they would terminate the relationship.

Formulation of team approaches. Team informal learning was also enacted in situations where the team was required to arrive at a collective understanding and formulate a team perspective or approach triggered by an issue or event. This was evident in all three work contexts; there were several examples that demonstrated how collective informal learning was enacted through team formulation of approaches to work. Normally sharing, dialogue, negotiation and conceptualization coalesced into a team approach that would not likely arise in another context, in a different situation or with a different team. In situations such as developing a new procedure, adopting a new tool, or addressing a threat actor, team learning was often emergent as the situation was new or had characteristics deserving a unique approach. This type of activity was regularly observed during issue-based discussions and problem-solving activities. One of the examples presented was the change in the team approach to the role of the Duty Analyst (DA):

[The DA] can't be the busiest guy on the team and take on the busiest assignments. So, we've kind of decided as a group, yes the initial DA gets everything going, the contacts, all that kind of stuff, then you assign an incident manager for that case and then he will step up and be the main contact after that. (Focus Group 1 A)

However, the most visible examples were during incident response and recovery activities where the team encountered complex problems that could not be solved by a lone individual. As well, any time the team developed a new approach, it was often communicated outside the team to the other Security Operations Centre (SOC) teams or to other expert teams to garner feedback. This

feedback provided the team with different perspectives and insights which, if warranted, were considered in the formulation of the team's approach.

In the examples provided, team informal learning was enacted through the collective formulation of a team approach to address an issue or resolve a problem. Again, these activities were often deliberate and explicit. The change in collective cognition was evident in the team learning and communicative processes that resulted in a team approach that was situationally unique, included the team members present, and resulted in some form of team supported action. Contributing processes appear to have been: searching for an opportunity or encountering a problem; conceptualization of a potential solution; analyzing the solution against the opportunity or problem, reconciling any differences or rationalizing any issues in implementing the solution; deciding to address the situation with a team approach; generating/developing the approach; and implementing the approach. If post implementation actions were required, the cycle included reflecting on and evaluating the approach or solution; modifying or revising the approach to meet the team goal; and revisiting or retiring the approach or solution when no longer required. In such cases, particularly in developing approaches to specific incidents, this process was highly condensed and often fragmented depending on how well the approach addressed the situation at hand.

Generation of team artefacts. Team informal learning was also evident at the team and sub-team level through generation and the subsequent maintenance of team artefacts such as: Standard Operating Procedures (SOPs); the case status board; and collaboratively drafted reports. These were not simply the result of aggregative individual effort. Rather, there was an ongoing interaction between members and across the team as these artefacts were generated and maintained.

A good example was the development of SOPs. As was presented, initially the development of SOPs was driven by anticipated activities in which the team would be involved. As the team became engaged in a higher volume of incidents, the development of the SOPs was triggered by a particular team need to arrive at and document a common standard of practice. In the development of SOPs, a majority of the team had not necessarily been involved with the related formalized processes before, as was noted in development and revision of the SOP for "First Responder Memory and Custom Live Acquisition using FTK Imager" (Focus Group 1B). There was clearly individual learning for those tasked to investigate the procedures, but also

collective informal learning as the team: identified/reconciled reliable sources of information; challenged internal and external processes; experimented with format and tone; responded to feedback within and from outside the team; and revised the artefact to arrive at a synergistic product that reflected the team's collective understanding. This occurred through various verbal and electronic interactions, including negotiative dialogue when there was disagreement. It is very likely that the outcome would have been considerably different if the process had only included one individual drafting and reviewing the artefacts.

Based on team member statements and documentation, the collaborative development and review of SOPs resulted in a more rigorous product that appreciated a variety of perspectives that simply would not have been able to be produced by any one member of the team. The subsequent use of the SOPs for both new team members and to refresh procedural knowledge of more experienced members demonstrates the value of these artefacts. Moreover, the fact that the team also shared the SOPs with other groups and teams provided evidence of extending their knowledge to others who also learned. This provided another opportunity for learning during boundary crossing, as feedback from these other groups and teams helped refine the SOPs and, as such, contributed to the team's collective knowledge.

The development of other team artefacts was triggered or driven by changes in team perspective or process, a lack of collective understanding, or new way to do business. The change in collective cognition was evident in the artefact itself relative to past team practice or past artefacts as shown in the findings. The collective action was embedded in the development of the artefact and its subsequent use. Using the example of SOP development again, contributing processes appear to have been: searching for or encountering a need to solidify a team practice into an SOP; analyzing the requirement; conceptualizing the SOP's purpose and intent; reconciling any differences or changes required within the team to develop and implement the SOP; deciding on the SOP design and structure; generating/developing the SOP; and posting or implementing the SOP in the team's repository. There was also evidence that after implementation, there was reflection on and evaluation of SOPs from time to time which included any commensurate modifications or revisions. If no longer required, the artifact was retired and maintained as a matter of record, as was noted by the various versions in the team's SOP archive.

Adoption and alterations in technology use. Team informal learning was also enacted in how the team reflected on and changed its use of technology. Technology includes machinery and devices used to support human activity (Oxford University Press, 2016). In this case, the predominant technologies used were computers, networks, systems, applications, mobile devices and storage devices. While several specific examples were provided in the findings such as log-to-timeline and X-Ways applications, two examples stand out: adoption of the case management system; and the general refinement of the team tool set.

In the adoption of a case management system several team members identified that a key driver for this was that the old paper-based technology was simply not working well during incident handling and case management (Focus Group 2B). As a member in a focus group stated:

Last year we were using Excel for a major incident and it was one person...was doing all of the updating. So, he had to be aware of any tippers, any IOCs. Everyone had to go to him. If he wasn't there to update it or if he had it open on his computer, but wasn't there, it was locked so no one else could update it. It was constant issues like that. This one program has made us infinitely better in working and delegating tasks to each other.

(Focus Group 1B)

The genesis and adoption of the system involved a collective learning process. Embedded in the design and subsequent implementation of this system were a collective understanding of team history, lessons learned from past case management experiences, awareness of unique team processes and functions, understanding of how the team worked and team priorities. Though difficult to establish through the research as the system was developed prior to the observation period, there was evidence in the member statements and documentation that the collective understanding of the need significantly aided integration and use of this system as there appeared to be fewer challenges, less negotiation, more rapid adoption, and greater satisfaction with the system than would normally have been the case with a newly implemented system.

As observed and noted by the members, the ongoing maintenance of the system, including individual inputs, interactions and reporting, resulted in a collective product that supported sharing, exchange, reflection and process change. As one member indicated:

JIRA has evolved a lot since we had a major incident. This is where we leveraged the tool to capture the information about a specific case, but also to distribute all the tasks within

an incident. And there's more collaboration and sharing of information amongst [the team] for information/intel. (Focus Group 1A)

In conjunction with the collective motivation to improve their case management process, there was also a sense that their identity contributed to the type of system they wanted, as it was unique within that team and could only be accessed by the team. Overall, the findings suggest that not only had the team's use of JIRA evolved, the team processes, collective understanding and overall sense of control over their work also evolved.

Regarding the example of the refinement of their tool set, initially the team did not have a 'toolbox' and everyone was just doing things their own way, using their own tools (Focus Group 1A, Focus Group 1B). The consequences of which were: variable results; limited between-tool communications; increased cost; and increased administration. As per the findings, the tool set has dramatically changed and the team acknowledged that there are fewer tools, a better definition of what is required, better understanding of the standards the team wants to achieve (Focus Group 1B) and better results (Focus Group 1A). Triggered by the inefficiencies and driven by a goal of improved performance, the team collected, generated, refined and arrived at a common tool set through their shared learning and experience.

As discussed, there are also inferences that can be made that the case management system and some of the unique tools they developed, such as "Bane", their stand-alone forensics analysis system, contributed to and reinforced the team's sense identity. This stands to reason if one thinks, for example, about the relationship that some mechanics have with their tools; the quality and condition of their tools often speaks volumes about the professional image they hold of themselves. The same appears to apply to the collective identity of the IT SIRT.

In both examples presented, the adoption or alteration of tool use is another way that team informal learning was enacted. These changes were triggered by the team's desire to make their job easier, create efficiencies, and improve their collective performance. The change in collective cognition was evidence in the change in the attitude towards the status quo and the negotiation and development of a new technology or tool that would support team goals. The adoption of the case management system and the changes to the team's tool set were supported by collective processes in which learning was ongoing and also appeared to support their collective identity.

The contributing processes for these examples were: searching for a technological solution or encountering a need to obtain or change the current technology; analyzing the requirement; conceptualizing the tool or solution and identifying the specifications; reconciling the degree to which the technological solution or tool will fulfill the requirement; deciding on acquiring or designing the technological solution or tool; acquiring/generating/developing the solution or tool; and implementing the solution or tool. In the observed cases, technological solutions or tools that were to be used by the team were always the subject of team critique and evaluation, whether formal or informal. Consequently, there were modifications to the solution or tool as discussed with the JIRA example. As with any technology, any tool or solution employed has a determinate life-span and will be subject to replacement, update or destruction. In this case, there were several examples where older forensics analysis tools were no longer being used as they were superseded by newer tools (e.g. X-ways).

Establishment and refinement of team norms and practices. Within all three work contexts, team norms were evident. Unlike the SOPs which were documented, the team norms reported in this case were informal, undocumented behaviours which were visible at the team or sub-team level. These norms often reflected the team's perspective or values. This was most evident where new team members were indoctrinated into the team and their subsequent adoption of team norms and practices became solidified within their behaviours.

Examples of this enacted learning included team decisions on types of tools used for certain functions, common activities and team practices such as log-to-timeline (Focus Group 1A, Interview H). Another practice that emerged from team experience was the use of micro-teams (a.k.a. sub-teams) which resulted in them "bouncing things off each other more" (Focus Group 2b). Open communications across the room was another informal norm that was very apparent. As previously alluded to, this speaks to the character of the team as well; when I worked in the proximity of the FIPC and GC CIRT teams, loud, verbal interactions were not common. In contrast, the IT SIRT operated quite differently:

Often when we're working on a case, or someone just needs help, they'll just shout out. Or they know someone is specialized in a certain program they'll just ask for help. And everyone will over hear it and either they'll pick up something from that conversation or someone will have input to improve on the evidence that they're trying to find or the program they're trying to work with. (Interview C)

This team dynamic was regularly observed and, as noted, went beyond a mere one-on-one exchange. Such interactions often stimulated team-based discussions and contributed to the broader team knowledge of: the status of ongoing cases; sources and levels of knowledge within the team relative to the issue discussed; knowledge of common experiences, challenges or problems faced; and tips, techniques, procedures or tools used.

Examples provided of team informal learning enacted in the establishment and refinement of team norms were triggered by a range of potential work-related situations that often became immediately apparent in the discourse and behaviour within the team. As well, the physical environment within which the team worked, the character of the team and the implicit and explicit team goals seemed to drive the generation and adoption of certain norms and practices. The contributing processes for this enacted learning were almost all tacit, highly situational and fluid. Note that not all members adopted all team norms. However, based on the statements and observations, the contributing processes included: encountering similarities or patterns within the team; assessing the value of the practice or behavior as an individual or sub-team; reconciling the value with the change in behaviour that would be required; adopting the behavior or norm; evaluating the effectiveness of the new practice or behavior relative to the effort; and modifying or ceasing the behavior based on feedback or team changes.

Formation of team identity. During the discussions, interviews, focus groups and observations, there was a common theme concerning the team's professional identity. A much more nuanced learning activity, the interactions within the team, at team boundaries, and external to the team, reinforced how the team perceived itself and how the team was perceived by others. The GC and Shared Services Canada (SSC) policies and other organizational documents support that the IT SIRT had a different role than other teams. As shown through the interviews, there was a clear sense from each of the members that the IT SIRT was distinct from other teams. As observed and reinforced during the focus groups, this sense of uniqueness permeated the entire team. This identity did not originate from the documentation, but was generated from within the team and readily adopted and reinforced by new members. The findings identified that the team had gained knowledge of themselves, their abilities and their place within the community and this contributed to their sense of collective identity.

Referring back to specific examples, one member stated that "you have people from different departments in SSC that think they are the forensics team... then they realize that we

actually have a team that is trained to deal with these incidents” (Focus Group 1A). It was evident that they took pride in their work and their level of specialization describing themselves as a “SWAT team” (Interview O) or a “black box, and you won’t know what we do until we stop doing it then you’ll panic and then come back to us” (Focus Group 1B). The team members often compared their work to the other SOC teams indicating that they were one of the better teams in outlining processes, having everything in place and having a set of standards (Focus Group 1A).

The team clearly saw themselves as unique with a higher degree of specialization than other teams. Through the focus groups, interviews and observation, I noted a sense of pride, uniqueness and, as well, a sense of licence and privilege that was not enjoyed by other teams. Based on the documentation reviewed, the changes to their formal mandate over time and development of a special training program, this view of the team was apparently shared and reinforced by other teams both within and outside their department. As presented in the findings, however, there was one individual on the team who had not fully accepted the team’s identity as an advanced forensics analysis team, though he acknowledged the team’s unique role and the team’s significant changes over time. This may have been a function of the label used rather than denying that a change in the team’s identity had occurred.

As discussed, the team’s formation of identity was a subtler enactment that was triggered by the team attempting to find a sense of who they were and their purpose within an evolving organizational and GC context. The change in collective cognition was gradual and appeared to be cumulative. It required the team to reflect on themselves and their role relative to other teams and the remainder of the community. Further, as discussed in the interviews, when new team members arrived, rather than challenging the identity, they readily adopted it. By the time I had arrived to observe the team, they had already assumed their new identity as an advanced forensics analysis team.

Formulation of identity is a common occurrence within teams, but in this case, the identity formulated was not completely congruent with organizational expectations. Instead, what appears to be the case is that the team’s subtle campaign to redefine themselves as an advanced forensics analysis team has gotten traction and the organizational expectations and related documentation have slowly evolved along with the team’s identity.

As will be discussed in more detail, the team’s journey to arrive at their new identity generally followed the steps in the reframed transformative learning process which also aligns to

the cycle of activity discussed in the other enactments above. However, what I captured during my observation was an ongoing, unstructured, largely tacit set of activities that contributed to sculpting, refining and reinforcing the team's identity.

Team Transformation. Not unlike Mezirow's conceptualization of transformative learning as part of adult life, there is the life of a work team that can be similarly transformed. The formulation of the team's identity discussed above serves as an example of potential collective transformative learning. Rather than a separate aspect of the team's learning, transformative learning processes and outcomes should be discussed as another way in which team informal learning can be enacted as it too involves a collective learning process and outcome.

As noted in Mezirow's perspective transformation process, transformative learning is triggered by a disorienting dilemma. It is enacted in an enduring cognitive change in the collective perspective of the team. This, in turn, becomes visible in the team's behaviours in ways that are congruent with the change in the team's perspective. The transformative learning process and related outcomes are another way in which collective learning is enacted. This is similar to how learning is viewed in Sessa et al.'s (2011) typology where transformative learning is another form of learning in contrast to against adaptive and generative learning. As the investigation into collective transformative learning relates to a sub-question of my research, this form of enacted learning will be discussed in more detail in a later section.

Summary. As shown in the findings, team informal learning was enacted in various ways. Seven specific enactments were identified that explicitly showed the team learning processes and the resulting outcomes in the form of team artefacts or activities expressed in verbal, textual, graphical/symbolic and behavioural form. While presented separately, these 'enactments' were often simultaneously occurring and interwoven as the team performed their tasks.

As discussed, for each of the enactments, it appeared that there were contributing processes within a cycle of activity that also help to reflect how the team informal learning occurred. This cycle of activity as well as collective transformative learning will be discussed in more detail later in this section.

Triggers and Drivers for Collective Learning

The following expands on the findings to more fully answer the question, “What are the triggers/drivers for this collective learning?” To review the definitions provided at the beginning of this thesis, triggers stimulate collective learning in the moment and often relate to problems, issues, or changes that influence team activity. In contrast, drivers are bound within the context in which the team works. As opposed to arising from the work or specific situation, they background the work and drive the team to learn. These may be explicit or implicit and can emerge from team traits or attributes, team motivations, collective goals, mandated activities, cultural norms or anticipated activities.

Triggers and drivers were identified in several examples in the findings and were also reflected in the discussion of the enactments above. In general, the major triggers included: a lack of collective knowledge; overcoming resource challenges; the need to adapt to existing or changing work conditions; encountering new or novel situations; entry into new environments such as unfamiliar departments or systems; poor or unsatisfactory team performance; new directions/tasks; or changes to other teams or their systems.

A number of drivers were also evident that obliged or compelled the team to learn. These included: team mandate, organizational requirements, socio-cultural environment, expectational forces and team traits. The triggers and drivers can also be discussed in more general terms that considers a wider range of organizational contexts. Accordingly, I have brought them together in major categories that may find more universal appeal within the workplace learning discourse:

Mandate or mission. These triggers or drivers explicitly derive from the team’s mandate or mission. As a trigger, the mandate provides context for some team learning within certain situations. The mandate or mission also demands certain team actions. In this case, there was extensive coverage of potential triggers to learning that were discussed within the team’s reactive mandate in incident response and recovery; obvious examples were the host of reactive, implicit and deliberate learning ‘in the moment’ triggered by unpredictable threat activity while addressing their reactive mandate.

The mandate or mission can also drive deliberate learning of the team. In this case, the team was very aware of their mandate and in anticipation of various situations the mandate drove deliberate learning in advance of having to perform their role. Perhaps the clearest driver for much of the team learning was based on the requirement for team to “provide highly specialized

response and recovery of complex and/or wide-spread IT security incidents.” (Shared Services Canada, 2015a). The mandate-specific knowledge extended across a spectrum of activities that related to their reactive, proactive and consultative mandate. This included knowledge of the diverse client base and foundational understanding of common threat actors and their techniques. While formal training was provided to support some of this requirement. The team was also engaged in informal learning activities to be ready for the various activities in which they would be engaged. The extensive amount of knowledge required to be at hand exceeded the capacity of any single individual; knowing where other knowledge resided and what networks were required to obtain it was critical to the team. In conjunction, there were numerous other references to the team’s capability requirements such as proactively providing technical advice, conducting vulnerability assessments, and consulting that drove team learning in each of these topic areas.

Organizational requirements & expectations. With all work teams, there are organizational requirements and expectations which can trigger or drive team learning. In this case, these often triggered learning within the team. Establishing and refining relationships with other teams triggered deliberate collective learning to attain knowledge of the others including their capabilities, interests, approaches, and perspectives. In doing so, other implicit learning occurred as well. One example was the situation where the team was required to respond to the compromise of a remote server. In connecting to the department, they needed to learn a considerable amount about that department’s IT operations and the capabilities of the remote team. Additionally, there appeared to be a considerable amount of implicit learning concerning the culture and structure of the client department that challenged some of their assumptions. Moreover, during the actual incident, in attempting to track the incident across other servers, they connected with other teams and individuals in remote locations and other regions that provided different information and they worked in different ways which solicited reactive and adaptive learning on the part of the IT SIRT team.

There were also formal and informal organizational requirements and expectations which drove the team’s collective learning. The team was often required to learn about internal processes, connect with other teams or organizational groups, address various sub-cultures, work within the organizational power structures, and produce required deliverables in the prescribed format, tone and style. These requirements posed many challenges particularly for this mission-focused, largely technical team in that they have typically not been well prepared for these tasks

nor were they necessarily prepared to work in the socio-cultural environment beyond their team boundary. For example, the team's capability to properly draft executive-level reports was an example where a formal requirement and organizational expectations drove team learning (Focus Group 1B, Interview N).

As discussed, there were also expectational forces that the team adapt to different nuanced socio-cultural environments within the organization and across the GC. These included the expectation to work closely with other teams where they were often exposed to new formal and informal structures, new people and new knowledge. They were also expected to work effectively and efficiently in all roles despite evident challenges with facilities, resources, processes and senior management pressures. These drove the team to learn about and generate different approaches to their work.

Conflict. Conflict or tensions within a team or conflict that occurs outside a team and between teams can also trigger learning. In this case, the team's challenges with the procurement process as well as other situations in which they found themselves triggered a range of deliberate, implicit and, at times, reactive, team learning activities related to team role changes, changes to how tools and resources were acquired within the team and changes in how the team managed the situations. There was also discussion of internal conflict between individuals and sub-teams where team actively engaged in learning about others and managing conflict within the team.

Conflict may also be a driver to learning, though there were no conflicts observed or recorded that resulted in driving the team to a collective learning outcome. As a hypothetical example, there is potential that organizational or inter-organizational conflict on the impending changes to the GC incident handling process may result in the team engaging in anticipatory, deliberate collective learning that supports the team's favoured strategy or perspective.

The new or novel. New or novel situations, processes, equipment, etc. can also trigger or drive team learning. In this case, as the team was relatively new and they were working in a dynamic cyber security environment, there was a range of opportunities to encounter the new or novel. Introduction of the unfamiliar was always an opportunity for learning, particularly if the team was required to address it. The most evident examples were those situations in which the team found themselves on new ground working with an unknown adversary and employing their tools and techniques with no certainty as to the effectiveness of the tool/technique or how the

adversary would respond. Of course, leading up to the event, there was deliberate learning to attain knowledge of the threat actor tradecraft. However, during the incident there was often reactive and adaptive learning triggered from specific situations encountered. As noted in these situations, an incident often triggered other deliberate team activities such as planning, development of courses of action and application of mitigations. The team learned the effectiveness of their work based on its impact on the adversary.

While there were no new or novel situations that arose during the study that could be considered drivers, a new or novel policy or practice that does not immediately impact team operations may sufficiently influence the context in which the team works to drive them towards deliberate collective learning in anticipation of potential impacts of the new policy or practice.

Change. While admittedly a broad category that can apply to any of the categories discussed above, this is specifically related to intentional or situational changes within or around a team that can trigger collective learning. For the IT SIRT, one change that triggered collective learning was the adoption of the case management system. As presented in team member statements, going from a paper-based record system to a structured, searchable digital system was a significant improvement in how the team operated. More than this, it was an opportunity for learning as the team was required to reflect on and revise how they worked in response to the new system. Largely deliberate, there were also several instances where implicit learning occurred in the discussions and negotiations that related to how the team used and maintained certain components of the system.

As well, the team often found itself in various situations during incident handling which had little to do with the actual incident. Depending on how the team handled the situation, there may have been managerial or executive level engagement that prompted particular actions. For example, when an incident was escalated within SSC and discussed at higher levels of Government, the situation in which the team was immersed changed, priorities were adjusted, different resources were required, different teams and work environments became involved and there was a commensurate increase in the pressure on the team to adapt and perform. Consequently, the change in the situation did not arise directly from the incident, but came from outside the incident and stimulated team learning, some of which were deliberate, others were reactive.

Changes that drove collective learning were those where the team encountered contextual or situational issues and reacted to these encounters by adapting to what they have learned. Throughout the team's history and even during the observation period there were changes to management structure, other teams' roles, software and tools, and many other areas that influenced team activity and learning. For example, the team interviews and focus groups discussed a change in the team management that directly influenced team activities and drove the team to find out more about how the new manager was different from his predecessor and to figure out what they needed to do to foster the new relationship. Changes like these cannot be ignored and, while there may not be any immediate requirement to address the change, the team seemed obligated to learn and adapt to the change.

Gaps in team knowledge or capability. This category could perhaps be included within each of the other categories discussed as well, but it merits a distinct place in discussion of learning given that it relates to explicit knowledge requirements and is important for dynamic teams. In this case, the team's collective knowledge and capabilities were continuously being challenged as they were exposed to different situations, tools or techniques, or approaches that contributed to their effectiveness as a team. There was always the opportunity for them to learn when they discovered a gap in the team's knowledge or capability. As an example, the procurement issues resulted in tool licenses expiring in the middle of a case. This triggered both deliberate and implicit learning to adapt and address a gap in the team's capability that resulted in them researching, creating, adapting and learning about other tools that would provide the same or similar outcomes.

In the longer term, gaps in team knowledge or capability were also drivers to learning. Though not specifically observed, the team had discussed engaging the expertise of other partner teams when they became aware of a new persistent threat actor they had yet to encounter. They were aware of a gap in their knowledge. This drove them to try and learn more about the threat actor's techniques in preparation for potential attacks.

Problems. Again, interrelated with other categories, defining this category was intentional as teams are often created to address problems, but additionally, there are often problems that arise that may not be associated to the formal problem solving. The introduction of a problem that could not be solved by one member alone also triggered team learning. For example, as previously described there were several members who noted that they had a problem

with the consistency of work and the related results because everyone was using their own tools. This problem was resolved through collective reflection on the issue, research into the various tools used by the team and dialogue on which tools best met the team's needs. This involved deliberate and often implicit learning throughout. In resolving the problem in this situation, there was the added trigger of the new technology or tool that required the team to learn and integrate the new tools into their existing processes.

If broadly based and not urgent, problems may also be a driver for collective team learning. For example, the most evident example where a problem was a driver was the ongoing efforts of the team to improve their performance that stimulated team learning and experimentation on different ways of working together that lead to their adoption of a sub-team approach. The driver was the team's recognition of and intent to reduce problematic processes related to communication and continuity within the team stemming from the previous approach where single individuals were assigned to address all aspects of a case.

Collective motivations or goals. Closely tied to a team's professional identity, are the collective motivations and goals. These can trigger as well as drive collective learning. The most evident example of collective motivations and goals triggering learning from this case is the team's 'can-do' attitude, collaborative nature and teamwork in the face of specific challenges when the team came together to work through and issue. Also, reflected in the findings was the team's spirit of continuous improvement which drove the team to learn, to stay on the leading edge of their discipline and out-perform management expectations.

Collective motivations and goals may not, however, always be seen as positive from others' perspectives. There were statements during both focus groups and interviews which emphasized retaining the status quo in some situations and this may have limited team learning. Though no specific instances were identified in the findings, there was also the potential for confirmation bias as an important determinant of thought and behaviour. Whether explicit or implicit, such a bias may create a collective disposition towards learning that emphasizes their embedded beliefs (Nickerson, 1998).

Summary. The above summarized the types of triggers and drivers from the findings. While not exhaustive, this provided a better explanation of the triggers and drivers to support a more coherent response to the related sub-question. In doing so, there were clear categories that

were formed based on the findings that may find universal appeal within workplace learning discourse.

Team Informal Learning: A Cycle of Activity

As previously mentioned, for each of the enactments above, I found that there was a common cycle of activity and contributing processes underlying the key enactments. These were evident in team artefacts, activities and interactions. After identifying common elements that appeared to suggest a cycle of activity in support of team informal learning, I reviewed my findings relative to Engestrom's (1999) "expansive learning cycle" (p. 384) shown in Figure 13. While his original interest was on large-scale expansive cycle of organizational transformation, he acknowledges that such large-scale cycles "always consists of small-scale cycles of innovative learning" (p. 385). Therefore, the cycle is applicable to smaller collectives such as groups or team. He notes, however, that the appearance of small-scale cycles do not "guarantee that expansive cycle is going on" (p.385).

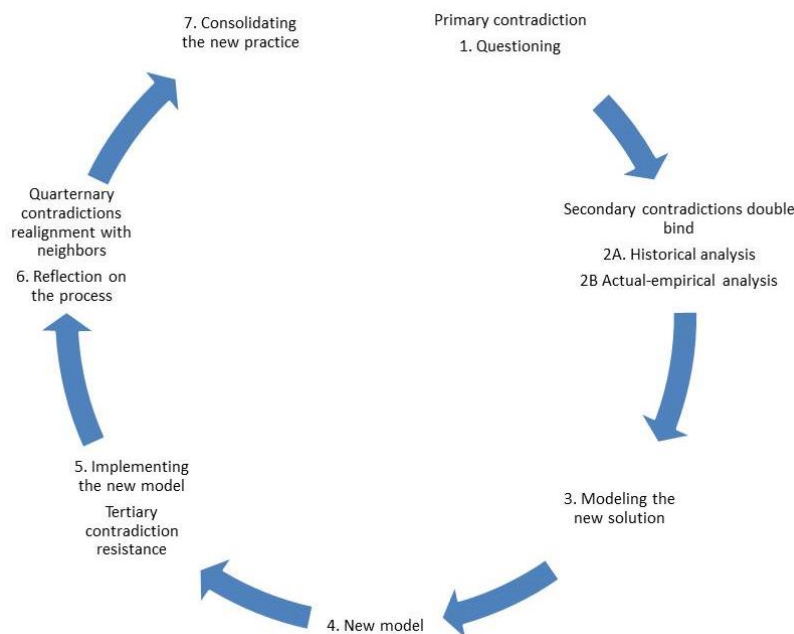


Figure 13. Engestrom's expansive learning cycle.

As applied to teams, Engestrom's research focused on observation of two problem-solving teams. The process his research uncovered was explicit problem solving as "both meetings...started with *formulating/debating a problem*, and both ended with constructing operational knowledge" (p.390). His cycle supports strategic learning and conscious problem solving. It accounts for construction and resolution of successively evolving tensions or

contradictions in a complex system that includes the object or objects, the mediating artifacts, and the perspectives of the participants that support changes in activity systems (p. 385).

With this 'expansive' learning, implicit is the spiral of knowledge generation within the team as the team uncovers issues and attempts to resolve tensions in solving the problem. While providing a more concrete explanation of how a team may learn in a complex organizational problem-solving context, the focus is on generative knowledge building activities and there is an assumption that the (expansive) learning is resulting in knowledge growth to support organizational goals. The more naturalistic team learning that occurs in other work contexts such as during daily activities, and the potential for 'non-productive learning' does not appear to be addressed. Indeed, teams are engaged in a variety of learning activities some of which may not reflect positive knowledge growth in the eyes of the organization.

Referring back to the findings and the discussion of enactments, a cycle of team informal learning activity appeared to emerge that is different in many ways from Engestrom's expansive learning cycle. First, Engestrom's (1999) examples present a deliberate learning context. My findings included a breadth of informal learning activities that reflected reactive, implicit and deliberate learning which occurred in and through work to address a variety of outcomes which were often emergent. Second, there was no assumption that the learning necessarily supported organizational outcomes. Rather the cycle was a pattern of team activity noted across a range of learning situations that arose within the three work contexts that supported adaptive, generative and transformative learning outcomes. Third, while there may have been problems and associated tensions and contradictions the IT SIRT faced, these were not the only triggers or drivers to learning. As presented above, there were various triggers and drivers to learning that cannot all be stemming from a problem. Finally, while there was evidence of modelling in some cases, it was not as explicit or consistently evident within the IT SIRT learning activities. Rather than moving from the abstract to an explicit model, the team was often operating with loosely defined collectively generated, practical concepts of work that were contextually or situationally driven. In some instances, the pressures under which the team worked precluded any form of model development. This may very well have been a function of the dynamic context within which the team worked. However, my findings suggest that a different understanding of the approaches used by collectives in constructing their responses was required to address the range of learning that occurred.

In broad terms, the notional cycle of team informal learning in dynamic work settings in Figure 14 starts with the team encountering an issue or discovering something of value that will contribute to the intended outcome. This feeds into the next activity where the team situates the new encounter or discovery through adhoc analysis, conceptualization and reconciliation of new encounter or discovery within their current setting. Once they have decided, explicitly or tacitly, on a course of action, they generate or develop the related artefacts, processes, tools or concepts. Upon implementation or application, evaluation may commence immediately or be consciously or unconsciously deferred. Evaluating the utility of the artefacts, processes, tools or concepts, may result in maintaining the status quo, re-generating them or disposing or retiring them. Importantly, team informal learning is ongoing through the various team interactions to support the processes and the cycle and this learning was evident in the team's activities, artefacts and interactions.

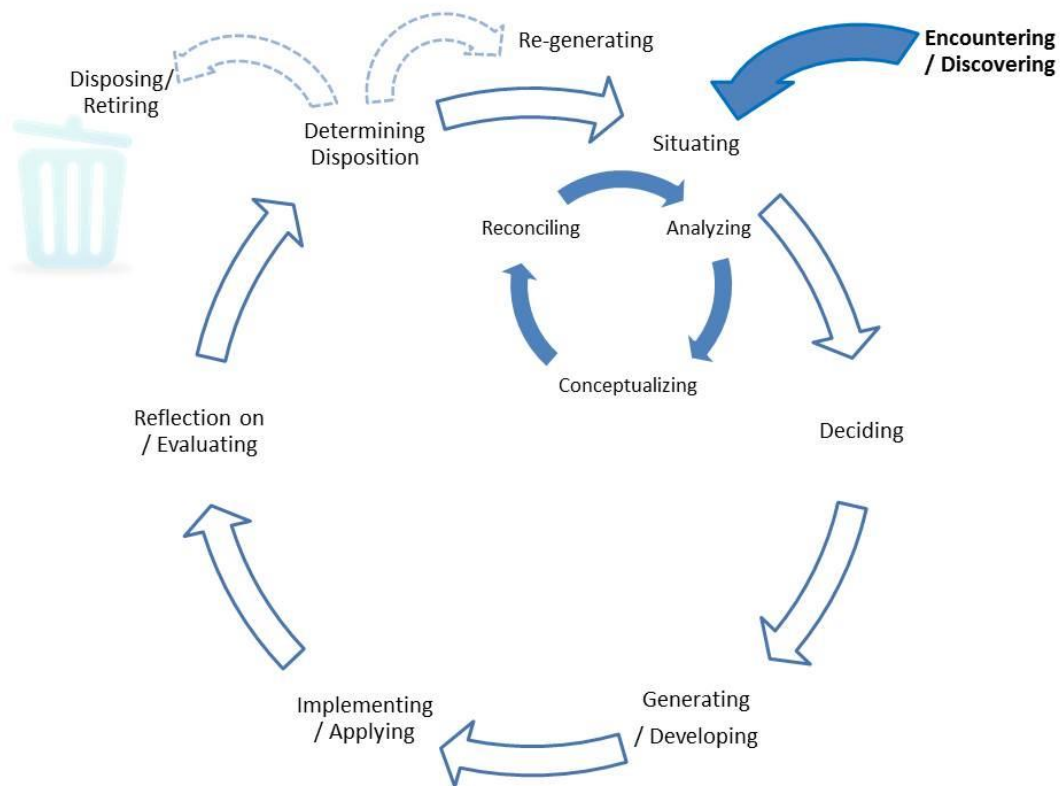


Figure 14. Notional cycle of team informal learning in dynamic work settings

There are elements of this cycle, particularly when there is deliberate team informal learning that may closely align to Knowledge Building (Scardamalia & Bereiter, 2006) that is common within educational practice. Knowledge Building is the intentional provision of

activities and mechanisms to support creation or modification of knowledge that is available to be worked on and used by other people practice (Scardamalia & Bereiter, 2006). In team informal learning, the learning can be reactive, implicit or deliberate during and through work. When there is deliberate team informal learning activity that becomes distinct from their work, this can be seen as Knowledge Building.

To discuss the cycle in practical terms, I will refer to the example during an incident handling operation. As the reader will note, this example includes several enactments already discussed. Further, as some of the details are classified, the incident will be discussed in general terms only.

The cycle started with the team encountering or discovering something. In this situation, the Duty Analyst (DA) *encountered* information on a suspected intrusion from a GC CIRT report that was triggered by information from a partner agency. The DA initially *situated* the incident within his own terms, conducting initial *analysis* during his triage, *conceiving* it as a complex intrusion and *reconciled* it against what he knew realizing that it was not within his capacity to address alone. At this point, the DA engaged the senior forensics analyst who also *encountered* the information for the first time. Through a discussion with the DA and after his own analysis, the senior forensics analyst learned more about the compromise and expanded on the DA's *conception* of the incident understanding that it was a new sophisticated threat actor that required special attention. In their discussion, they *reconciled* this information against what they already knew including the existing talent and current workload of the team. They called an adhoc team meeting to discuss the incident and how to proceed. During this meeting, the team collectively *encountered* information on the new intrusion and formed an initial common *conceptual* understanding of the situation through discussion of what was occurring, who the client was, and what systems were affected. This dialogue included *analysis* of various initial options which were *reconciled* against their capability and current priorities.

During the discussion, the team *decided* on an approach. More specifically, the team agreed that they needed capture the memory from the infected work station to obtain more information; agreement was evident in the acknowledgements and gestures of the team members. One of the members volunteered to go to the remote site. As this was their first time a team member would be required to visit a remote site, there was no standard operating procedure for this activity. Consequently, the team returned to *situating* the requirement, *encountered*

unfamiliar procedures for travel through discussions with another group and *conceived* of the processes and tools required to support the task. They *decided* on an approach and *developed* the plan for the travel and *decided* on and *generated* the tools and documents needed. The plan was *implemented* and the volunteer travelled to the remote site and performed the memory capture regularly connecting back to the team to discuss nuanced requirements and communicating new information about the client and the situation at the site.

Upon return to the team, the volunteer provided the memory captured and it was analyzed by another team member where new signatures were *encountered* which triggered additional dialogue with a security partner team where more detailed *analyses* was conducted and there was collaboration on the various *conceptions* of how to mitigate the threat. Throughout the incident, there were numerous other exchanges that resulted in the team *encountering* new information that stimulated additional learning cycles of a similar nature. In each set of circumstances that the team encountered, there was *reflection* on the team's performance. For example, concerning the remote memory capture, this triggered another learning event as the entire encounter with this incident resulted in a *decision* to *generate* an SOP for remote memory capture. Ultimately, the threat was mitigated and *disposition* of the historically relevant information was determined. The formal incident handling relationship with the client department was also terminated, though there was now a sustained relationship with the IT team at that department.

This brief example provided insight to the notional cycle of team informal learning and related contributing processes. While the cycle does not necessarily capture underlying collective learning processes across all potential team activities, it provides a reasonable structure from which to further explore collective learning and emergence which includes reactive, implicit and deliberate learning not predicated on specific outcomes.

Expanding on Conceptualizations of Team Informal Learning

As Bell, Kozlowski, and Blawath (2012) exclaim, this area of study remains “broad and it is also messy and fraught with conceptual confusion” (p. 1). In investigating team informal learning, a persistent challenge for educational researchers seems to be capturing when actual team learning has occurred. The observations, with the other supporting data, were particularly valuable in capturing the collective learning as it occurred, rather than attempting to establish this through retrospective analysis and participant statements. This, in part, addresses Kozlowski et al.'s (2013) concerns about limited direct experience regarding team learning research. From

the findings and discussion on how collective informal learning is enacted, it provides context to applicability of the predominant conceptualizations of team learning and allows us to expand on our understanding of team informal learning.

Within this instrumental case study, the IT SIRT, as an authentic work team, provided a unique opportunity to investigate a relatively autonomous, highly specialised team that worked in a dynamic threat environment responding to unpredictable events. Moreover, there were other influences on their work and learning that were factors of the specific context in that they were a relatively nascent team whose processes and collective identity were still forming.

As presented, the IT SIRT was working under relatively restrictive work conditions in terms of space and access to tools and resources. As a social entity, the team was nested within the larger organization of SSC and the GC. The team's learning was influenced by a wide range of triggers and drivers such as their mandate, organizational requirements, change, and the dynamic IT security work environment. Consequently, this instrumental case study revealed enacted team informal learning and associated processes and outcomes which have not been captured in other research.

The following will discuss how this research expands on our understanding of team informal learning at the collective level of analysis and reinforces predominant conceptualizations of team learning while contributing to the understanding of teams as complex learning systems. It also supports collective learning as emergent, provides a dialogue on typologies, and highlights the relationship between collective transformative learning and emergence.

An expanded understanding of team informal learning. At the onset of this thesis, team learning was characterised as a form of collective learning. Acknowledging that I was viewing team learning from a social constructivist perspective, I defined team informal learning as: *contingently formed patterns of understandings and interactions within practical and situated activities where learning is discovered and generated together. This learning results in changes to the collective cognition evident in team activities, artefacts and other outcomes.* Keeping in mind that the focus of this research was on informal learning in the work place, in practical terms, team learning was considered to have occurred if there were changes in how the team interacts or works.

Situating teams as complex learning systems. At the start of this thesis, I asserted that team learning is primarily conceptualized in four ways (Bell, Kozlowski & Blawath, 2012; Decuyper et al., 2010; Garavan & Carberry, 2012; London & Sessa; 2006):

- as an aggregate of individual learning as individuals generate, acquire and share unique knowledge and information;
- as participative activity when a collective engages exploratory or reflective behaviour such as asking questions, seeking feedback, discussing options or errors;
- as an open system; and
- as a complex learning system.

Each of these conceptualizations provides some level of insight to ways in which collective learning occurs within a team and they all can contribute to the definition provided above. The first three predominate the literature and, as shown in the findings, are also evident within this case study. For example in incident response, the team initiated initial courses of action to mitigate a compromise featuring an unknown sophisticated threat actor. In this situation, the aggregative perspective was evident when the team applied their collective individual procedural knowledge and expertise to the initial response task. Further, in the application of this knowledge, the team was learning about the situation together while attempting to mitigate the incident. In coming to agreement on courses of action in ill-defined situations, they were involved in dialogue and negotiation often indicative of participative processes. The team could also be seen as working and learning as an open system given the myriad of mediating influences on their work and their reliance on a variety of inputs and feedback to help determine future action.

While the three predominant conceptualizations were evident, none fully captures all of the learning that was happening at the team level of analysis. I found that team informal learning was more fluid and was often simultaneously occurring during work and this did not fit with the first three conceptualizations. The fourth way that appears to capture these latter learning characteristics is where the team is situated as a complex learning system. As noted by McMurtry (2008), a team or group can be understood as a collective learner that emerges from the interactions of the people who compose it. This picture of the team as a complex learning system aligns with Fenwick, Edwards, and Sawchuk's (2011) discussion of complexity theory and learning:

Complexity theory posits that these complex open systems emerge in unpredictable patterns that often defy attempts to control and direct. Some claim that a complex system is inherently a learning collective. Most agree that a complex system is disordered while balancing particular orders. It is ceaselessly dynamic, and does not exist in stasis or it would die. It constantly adapts to what surrounds it and what is nested within it, which is constantly changing. (p.19)

Beyond theoretical generalizations, this latter view of team learning has yet to be meted out in any detail within the literature nor explored through research of dynamic teams. In conceptualizing teams as complex learning systems, the learning is not based upon single attributes, but rather is constituted in emergent learning processes and outcomes which are enacted in and through team work.

At the collective level of analysis within this case study, team learning was often situational and emergent; it was not linear and there was no clear sense of input, process, and output. Learning was enacted through team interactions that were triggered or driven by contextual or situational events, or needs encountered by the team. Once triggered, the team became involved in collective activity that simultaneously included learning and work; learning was enmeshed with work as they self-organized around routine work, non-routine events and incident response and recovery operations. The team and its work emerged together as described in the incident handling examples provided or as noted in the collaborative development and implementation of the case management system.

A primary tenant of complexity theory holds that a complex system is irreducible (Cilliers, 1998). Kozlowski et al (2013) note the challenge of distinguishing between micro-level (individual) interactions and the multiple interactions that reflect the team's meso-level experience. In this case, the team was never autonomous; they were connected within a larger web of interactions influencing and influenced by the individual team members, the organization and other groups or individuals. The team was comprised of ten individuals at the micro-level. These individuals contributed to the meso-level team and the team influenced the contributions of the individuals. The team was nested at the meso-level within the larger macro-level organization and contributed to the organizational outcomes both as an entity and through other groups and teams.

Viewing teams as complex learning systems supports appreciation of the interactions between and among systems within a nested systems view (Davis & Sumara, 2008). While I drew examples from the larger team experience to help describe the team as a complex learning system, this was not intended to reduce the meso to the micro. Rather, as Kozlowski and Klein (2000) express, this instrumental case study was a means to “both understand the whole and keep an eye on the parts” (p. 54). For the purposes of this study, identifying sub-system or individual interactions was necessary as the micro interactions were implicated and contributed to the meso-level interactions. This is not to suggest that the numerous micro interactions were additive. Rather, as shown in the examples, team informal learning was emergent as were at least some of the outcomes. In several situations, the outcomes could not be simply reduced to the contributions from the individual team members. Even within the notional cycle of team informal learning presented, contributing processes could be identified, but there were many micro-interactions that were not captured. It nonetheless helped me to better understand how team informal learning occurred, what contributed to the collective effort and the process of emergence simultaneously across multiple levels (Kozlowski et al. 2013, p. 583).

Though not investigated, there were also likely larger unseen outcomes in cyber space as they mitigated threat actor activities and supported other departments’ and GC outcomes. On occasion, these were reflected back on their team in various forms of feedback either through the success of their mitigation or the defence of the networks they were assigned to protect. This multi-level perspective provided an opportunity to investigate the team as a complex system and its interactions from within and across the team boundaries to better appreciate the changes and the potential impacts to other systems.

There were also several indicators that the team activities and learning were emergent and not bound by this structure. Returning to the Karpiak’s (2000) reference, as I have seen in this case, the team has emerged as an entity that is “always becoming”, always a “work in progress”, destined to change and grow (p. 33). This was visible in both the learning processes and outcomes discussed in the findings including the dynamic relationships, evolving artefacts, and transforming identity.

As shown, some additional insights into team informal learning are provided if we view teams as complex learning systems. While this study was conducted with the social constructivist lens, the rhetoric of complexity and systems theory helps to explicate what was observed and

supports a more comprehensive understanding of collective learning within dynamic work environments. This conceptualization is therefore intriguing and worthy of expansion.

Given the findings and discussion, the IT SIRT can be situated as a complex learning system. This does not discount the other conceptualizations as they were also evident. They are part of the patterns of learning that can occur within a complex learning system. While the view of teams as complex learning systems fits this case, there may be other contexts where the work is far less dynamic, the processes more discrete or collectives may be uniquely autonomous from other systems. Further, there may be organizational settings that are far more stable, where this view of the team and collective learning may not be evident. For example, a team tasked with specific designed-in functions working within given tolerances and standards such as we see in manufacturing settings may not necessarily demonstrate attributes of a complex learning system. This does not detract from the fact that they could be.

Collective learning as emergent. Integral to the conceptualization of teams as complex learning systems is the phenomena of emergence; the idea that in complex adaptive systems, phenomena, events and actors are mutually dependent, mutually constitutive, and emerge together in dynamic structures (Fenwick et al., 2011, p. 21). The past decade has seen increasing interest in learning as an emergent process. It is recognized that “[k]nowledge is understood...to “emerge” as we participate in the world” (Osberg & Biesta, 2007, p. 2) and that collective learning may give rise to emergence in teams (Kozlowski et al., 2013; Sessa & London, 2008). Emergent phenomena are holistic, greater than the sum of the parts, and irreducible at a higher level.

In this case, there were many situations where team informal learning was emergent. First, the team was unique within the Government and the Canadian IT security community. As discussed, they were working at the edges of their discipline and the IT SIRT was emerging as a team. As noted in the findings regarding the team’s formulation of identity and transformative learning, they were in the process of becoming a different team, though this was not necessarily a well-defined predictable outcome. As already suggested, they are still in the process of becoming, so how the team will learn and act as they continue to form and reinforce their identity is uncertain.

Being a new team, numerous team-level encounters were novel and required collaborative and exploratory processes such as experimentation, questioning, researching, and

investigating to creatively and effectively address the range of team needs. Furthermore, their learning within work was fundamentally an emergent process. For example, with each incident, the team practice was to develop courses of action that would support a planned approach to incident mitigation. As with many plans in a complex environment, they are only good until they encounter something that had not been planned. Courses of action were often disrupted by unpredictable threat actor activities or impeded by other unforeseen circumstances. Consequently, the team was required to move through incident response in an open, experimental way, actively engaging within and across team boundaries, processing, sharing information and generating options in attempt to mitigate the compromise. Without knowing the threat/threat actor intentions and motivations, the team was working with the unknown and the outcomes of each course of action were uncertain.

In these types of work circumstances, the team collectively generated situation-specific knowledge, created options, and explored opportunities to arrive at a common understanding of and developed what they believed to be an appropriate response. The learning process was emergent and, at times, solutions were revealed suddenly as was the case when the team was attempting to mitigate sophisticated threat actor activities or when particular tools or techniques used had greater or lesser effect than the expected. In other situations, the solutions unfolded gradually such as when the team used more systematic processes and worked with other parts of the organization to find a way to engage a remote client and obtain, secure, and transport a system memory from the remote location back to the SOC to facilitate forensics analysis.

Of course, not all learning was emergent. There were several routine activities, well defined processes and procedures, and established tools and techniques for some of the team's work. There were also situations where there was conscious adaptive and generative learning. For example, there was adaptive learning where the team had to adjust to a different understanding of the team organization during holiday periods. In these situations, there was not a lot of new knowledge, but rather restructuring existing knowledge and mapping of different capabilities to other team members who were involved in different team tasks. There was also conscious, generative learning when the team engaged in cross boundary activities with other expert teams. In such cases, they sought expert knowledge on new threats then had to situate this knowledge within the team and build a new understanding of how it would impact team

procedures and practices. This process would be explicit and communicated throughout the team and, once completed, could be seen as part of the aggregative cognition of the team.

In further support of collective learning in dynamic work settings as emergent, Fenwick, et al. (2011) state “Some would call learning the very dynamic of emergence in complex systems...Cognition occurs in the new possibilities that are always opening for unpredictable shared action” (p.29). The IT SIRT, perhaps more than other teams within the GC environment, has demonstrated this. The team collectively waded into the unknown, learned about the situation and engaged in a diversity of activities that supported a general goal where there may not have been well-defined courses of action. Throughout there was a component of discovery, reflexivity and evaluation as the team responded to changes in the actors, the situation, and the local and global cyber security environment. This was particularly evident within initial incident response and recovery activities, but also in other aspects of work like research and development on tools and techniques. Rather than their work being segmented within a definable process, it often involved multiple, simultaneous interactions, large and small. In these often fluid interactions, existing knowledge was exchanged, but also new knowledge could emerge within the team and in the team’s interactions with others. The team learned and produced outcomes that would not have been created had even one aspect of the work or one team member had been different. Not only was their collective learning emergent, the team itself was emergent. One of the ways in which the team was emergent was in their ongoing transformation that will be discussed in more detail in the next section.

Typologies of team learning. Beyond the three previously discussed conceptualizations of collective learning, I have drawn similar conclusions to Sessa et al.’s (2011) typology which characterises group learning as interaction processes that result in different group outcomes: adaptive, generative and transformative learning. To review, adaptive learning is a process where the team reacts to stimuli from their organizational surroundings. It is largely viewed to be incremental. Generative learning builds on prior perspectives, but is pro-actively and intentionally applying new skills, knowledge, behaviors, and interaction patterns to improve the team’s performance. Transformative learning requires experiencing disorientation and then reorientation for an entirely new direction for growth. This reorientation produces a new team structure, strategy, goals, and identity. For the latter, I believe that Hoggan (2016) refines the language around transformative learning that can equally apply to the collective. To extend his

definition to the collective, I suggest that collective transformative learning requires depth, breadth and relative stability in the change resulting from transformative learning and that this must be visible to others.

As previously discussed, Sessa et al. (2011) indicate that all three learning processes can occur at different times within the same group and that some behaviours and interactions may have elements of each process (p. 150). As per the findings, all three types of learning could be seen within this case. This stands to reason and is particularly applicable to a complex work environment where there are multiple, ongoing activities by the team and sub-teams as shown in this case.

This was evident during incident handling. The team was engaged in adaptive learning in the outset of the incident as they went through their initial intake procedure. Generative learning occurred once they realized that this was a sophisticated threat actor and new knowledge was being created as they encountered the adversarial techniques. Finally, as has already been suggested, all the while the team was leveraging their collective knowledge, skills and abilities, working through their understanding of who they were as a team and reinforcing their reputation as an advanced forensics analysis team. This latter activity, though occurring in the background, was indicative of transformative learning.

Beyond Sessa et al.'s (2011) discussion of the potential simultaneity of the team engaging in interaction processes that may support any of the three outcomes, my findings also show that interaction processes that occur are situationally and contextually driven. This avoids the problematic issues associated with certain processes being aligned to specific team or organizationally defined outcomes which are not necessarily evident in emergent learning contexts. The team learning, particularly as seen within this dynamic work context, should be appreciated as complex; it is irreducible. However, it should also be appreciated that for every major team learning outcome there were multiple individual and collective interaction processes with several less prominent outcomes throughout. There is not necessarily a one on one relationship between processes and outcomes.

For example, as discussed in the findings, the learning and subsequent generation of a team artifact such as the SOPs was not conducted as a singular collaborative activity. Rather, there were often smaller sub-teams who, when faced with a situation where the team did not have a standard approach, took initiative to research the issue, investigate possible options,

identify key points that the SOP needed to address and draft the SOP which was subsequently reviewed and refined within the team. As discussed when presenting the notional cycle of team informal learning, there were also many other micro interactions and learning that occurred throughout the process that contributed to the larger outcome that were not specifically captured during the SOP development process.

With the benefit of the research and findings within this case study, some potential criticisms of Sessa et al.'s (2011) typology emerge. First, all three types of learning are intentional and explicit providing no account of reactive or implicit learning that I found during my study. Second, the language used is instrumental such as 'to improve the team's performance.' This suggests a specific intention and positive orientation and a trajectory that was not exhibited in all forms of learning that occurred within this study. In this case, there were learning outcomes that while work related had nothing to do with the explicit goals of the organization or improving the team's performance. As examples, both the procurement issue and the learning associated with the team's identity transformation represent outcomes that were not necessarily predicated on team improvement.

Third, there is no reference to temporality that was evident. In his typology of informal learning, Eraut (2004) does not tie the learning processes to outcomes as is the case in Sessa et al. (2011). However, he notes that the context of learning is always in the present and he includes a time of focus that provides the "possible temporal relationships between a learning episode and the experiences that gave rise to it" (p. 251). For example, reactive learning, whether considered adaptive or generative, often provides limited opportunity for collaborative deliberation, whereas deliberative learning requires time for the team to interact, deliberate, decide and act as required.

Sessa et al.'s (2011) typology focuses on the outcomes where the processes are included within their descriptions and therefore remains more attractive to help explain collective learning within work team. The challenge, however, is resolving the issues discussed concerning implicit learning and temporality. Eraut's (2004) typology is useful to frame a more comprehensive and refined typology of collective informal learning. Borrowing from both scholarly works, the typology should consist of adaptive, generative and transformative, learning where learning can come about through any combination of implicit, reactive or deliberative learning activities with similar temporal boundaries as expressed by Eraut. However, this is not simply adding another

column to either construct. Additional research focusing on the types of learning and temporality is needed.

Collective transformative learning and emergence. Following Sessa et al.'s (2011) typology and as identified in the findings, team learning can be adaptive and generative; it can also be transformative. As identified in this case, transformative learning can be seen as a collective learning process enacted through team interactions and activities that result in transformative outcomes. As opposed to discussing transformative learning as being completely distinct, this case and the findings support that transformative learning can be considered another form of learning within a complex learning system where transformative outcome emerge.

It has been suggested that all complex systems are learning systems (Arrow et al, 2000; Davis & Sumara, 2006; Fenwick, 2012). Viewing teams as complex learning systems borrows from evolutionary sciences, systems theory and complexity theory. Each of these perspectives support potential transformation of complex systems as a naturally occurring event where, "learning is defined as transformation that expands the system's potential range of action" (Fenwick, et al., 2011, p.29). In particular, complexity theory incorporates the concepts of non-linearity of process, unpredictability, uncertainty, and emergence (Alhadeff-Jones, 2012) that have been highlighted within the findings of this study. These concepts help support contextual, temporal appreciations of phenomena and how they are implicated in the team's activities and interactions as well as across multiple levels. Importantly, complexity theory does not suggest a positive or negative subjective value associated with team change. Complexity theory simply acknowledges that learning may result in a change to the team's trajectory or the team itself. Viewed in pragmatic, value-neutral terms, this conceptualization allows the researcher to identify what may have triggered the transformation, see the processes in absence of any value judgement, help identify the related dynamics and determine the type and degree of transformative outcomes in concrete terms. Once this has been completed, then the researcher's epistemological lens can be applied to analyse and interpret what the researcher has found.

Though from a different paradigm, I believe this is aligned with Mezirow's intentions that support transformative learning resulting in the individual's or group's perspective becoming more open, permeable, and better validated (Mezirow, 1991, 2000). Beyond the narrow definition of a 'disorienting dilemma' supported in Mezirow's perspective transformation, complexity theory accounts for the notion of disequilibrium, disruption or

perturbations. This suggests that even a small or subtle trigger can propel the system out of its current structure and support new possibilities where events, individuals and their environment emerge together in dynamic structures (Davis & Sumara, 2008; Gersick, 1988; Karpiak, 2000; Osberg & Biesta, 2008). Understanding this allows us to acknowledge that large or small occurrences can create crises and chaos that can lead to transformation and to a new view of ourselves and the world around us (Karpiak, 2000, p. 32). Indeed any disruption from the norm may create a disorienting dilemma that causes critical reflection and subsequent action.

In this case, the disrupting event of two sequential, significant incidents of 2014 appears to have triggered/drove the transformative activities of the team. Rather than being predicted and intentional, the learning process was emergent resulting in transformative outcomes evident in the team behaviours and attitudes about themselves and their work. Based on this, transformation can be considered one of many potential outcomes of an emergent learning process within a complex learning system such as the IT SIRT.

Expanding the Understanding of Collective Transformative Learning

To address the third sub-question of my research requires further discussion of the findings presented. This will be followed with revisiting key points from the literature to support the criteria of claims for collective transformative learning. Finally, I will provide my insights as to the utility of Mezirow's transformative learning theory and the reframed process in contributing to our understanding of collective learning.

In this case, there are documentation, member statements and researcher observations that support potential collective transformative learning of the IT SIRT. More specifically, the team appears to have undergone a learning process where the collective perspective on their identity as a team significantly changed over time. It appears that after the 'disorienting' events in the summer of 2014, there was considerable collective reflection on their performance and subsequent changes to the team's perspective which resulted in them being a qualitatively different team at the end of the period of observation. As the team reflected on their performance and who they were, they appear to have undergone a transformation in that a different team identity appears to have crystallized in the minds of a majority of the team members. As previously presented, many members emphasized the team's role in digital forensics and the high degree of specialization. They expressed some desire to be considered an 'advanced forensics analysis team' (Focus Group 2B).

Importantly, there was no formal ‘vision’ articulated by the team of where they ended up and no formal plan associated with the larger changes within the team. The transformative learning related to the formulation of the team’s identity seems to have occurred in absence of any specific plan; rather this was emergent and the result of numerous subtle and gradual changes that were evident in the artefacts, activities and interactions within the team.

The transformative learning that occurred within the team resulted in the change that was far more than Kegan’s (2000) ‘informative learning’ and it would not be correct to label the overall outcomes as per Sessa et al.’s (2011) typology as either ‘adaptive’ or ‘generative.’ While it is agreed that some of the changes in how they worked were supported by adaptive and generative learning, the critical reflection and the gradual change in how the team viewed themselves and their identity within the community was far more than ‘adapting.’ It appears that the team had undergone significant, qualitative change (Clark, 1993; Illeris, 2013; Segers & de Greef, 2012; Taylor & Cranton, 2013) that was apparent to the team and visible to others.

It was also clear from the findings that the team had participated, consciously or unconsciously, in 8 of 11 steps associated with the transformative learning process that was reframed for the collective in my conceptual framework (see Table 6). This is significant, but as was noted in the findings, there were no occasions where it could be reliably stated that all steps in the process had occurred, the absence of one step of the process does not mean that it did not occur, only that I did not find evidence of it through my research.

Based on the findings, one could consider that the team had undergone transformative learning as they had experienced significant, qualitative change in who they were as a team and their professional identity. Further, they generally followed the reframed transformative learning process. Notwithstanding, is this sufficient to justify call this transformative change? Considering the hyperbole around transformation within popular and academic literature, a closer exploration of the criteria of claims for transformative learning is warranted.

Assessing claims of collective transformative learning. At the beginning of my research, I believe I fell into a rhetorical trap leveraging a generic and broad definition of transformative learning as *learning that contributes to significant, qualitative change* (Taylor & Cranton, 2013; Clark, 1993; Segers & de Greef, 2012; Illeris, 2013). Following Mezirow’s transformative learning process, the team seemed to have experienced a disorienting dilemma and critical reflection that provided a new perspective which guided future action (Mezirow,

1994/2012). Other vaguely stated outcomes suggest that transformative learning “results in people acting differently in the world” (Cranton & Roy, 2003, p. 88) or that they are different afterward “in ways that both they and others can recognize” (Clark, 1993, p. 47). Within the broad range of statements that appeared to characterise transformative outcomes coupled with the reframed process, I believed I had sufficient criteria to identify whether the IT SIRT had undergone transformative learning. However, in analyzing my understanding of the team’s experience and attempting to pull together evidence to legitimize my claim, I realized that my previous criteria was not sufficient to declare that the team had truly experienced transformative learning as conceptualized by Mezirow and other leading scholars.

In attempting to understand the criteria for collective transformative learning, I reviewed existing literature and research. Similar to the Taylor’s (1997/2007) earlier findings, I noted that the majority claims for transformative learning were primarily based on individual, subjective, and retrospective accounts of transformative phenomena. In the few reports on collective transformation, I saw similar accounts (Choy, 2009; Kasl & Elias, 2000; Scribner & Donaldson, 2001; Yorks & Kasl, 2002). This is not to say that the individuals or groups did not experience transformation; there were retrospective accounts where individuals declared that their perspective had changed. Indeed, a group of individuals may have all experienced some form of personal transformation. If this is the case, this supports the aggregation conceptualization of collective learning which suggests that if each member of the group in some way believed they underwent transformation, then it was considered that the group had transformed. This does not, however, support transformation at the team level of analysis. Moreover, in my case study, I did not believe that all of the individuals had ‘transformed.’ In fact, there are statements supporting this. Accordingly, I suspected that the criteria used to make claims of collective transformation, at the team level of analysis were limited or not well defined. In my view, not one of the studies in the literature reviewed provided sufficient indication that the collective as a complex social entity experienced transformative learning.

Similar to the definitional issues of transformative learning noted by other scholars (Hoggan, 2016; Taylor, 2007), collective transformative learning must be appropriately defined so that there is no confusion on what constitutes collective transformation. Central to this is that individual transformation is not necessarily antecedent to collective transformation. The collective can emerge and transform as an entity; the individuals themselves may not transform

at all. Rather, as part of a complex entity they contribute to and participate in the trajectory of the collective and the members themselves may not undergo full transformation. With this in mind, there is a need to further elaborate on the criteria for claims for collective transformative learning.

It appears that the hyperbole around the term transformation and transformative learning has potentially diluted Mezirow's original intentions. In his recent paper on a typology for individual transformative learning, Hoggan (2016) discusses that a defining issue relates to Mezirow's theory which focused on perspective transformation and the broader domain in which there may be various types of learning that can contribute to transformation. Hoggan (2016) states that:

[f]or the sake of clarity and consistency, we should return to using the term perspective transformation to refer to Mezirow's theory, and use transformative learning to refer to the broader range of similar phenomena. Used this way, transformative learning would operate explicitly as a metatheory. (p. 63)

As he notes, this allows for other transformative outcomes in: worldview, self, epistemology, ontology, behavior, and capacity. While each of these may require further investigation, in a general sense, Hoggan's (2016) typology is helpful and captures what I believe was Mezirow's (2012) intent that suggests that through critical reflection we may challenge assumptions that are epistemological, logical, ethical, psychological, ideological, social, cultural, economic, political, ecological, scientific or spiritual or they may pertain to other aspects of experience (p.85).

In this case, Hoggan's (2016) category of 'self' may apply to the collective as an entity. He breaks down self to include: self-in relation, empowerment-responsibility, identity-view of self, self-knowledge, personal narratives, meaning-purpose, and personality change (p. 66). While he did not include the potential for collective transformation within his article, this typology and transformation of 'self' can potentially be applied to any complex social entity. Extending this to the team, it could include: collective experiencing; collective-in relation, collective knowledge of itself; collective identity; and collective meaning-purpose. In this case, the IT SIRT experienced a significant change in how they see themselves and consequently, there is alignment to Hoggan's description of transformation of 'self' and the collective identity transformation the team seems to have experienced.

More importantly, Hoggan (2016) provides a more precise definition of transformative learning as a “process that results in significant and *irreversible* changes in the way a person experiences, conceptualizes and interacts with the world” (author’s emphasis, p. 71). He stresses that the terms ‘experiences’, ‘conceptualizes’ and ‘interacts’ reflect a range of potential outcomes. Importantly, these terms are neutral and not imbued with a positive orientation. He further suggests that there are three aspects of a learning outcome that should be considered before determining whether or not the learning has been transformative: depth, breadth and relative stability.

These terms lend precision to claims of transformation. Depth refers to the impact or degree of significance of the change. The first criterion is complementary to Lange’s (2004) assertion in that transformative change is not only epistemological; “it is also an ontological process where participants experience a change in their being in the world including their forms of relatedness” (p. 137). Breadth refers to the number of contexts in which the change is manifest. In other words, the transformation must have an influence on more than one aspect of an entity’s existence. Relative stability refers to the relative permanence of the change. This means that a temporary change is inadequate to be considered transformative. This is aligned with Mezirow’s (1978) distinction where transformation means “[m]oving to a new perspective and *sustaining the actions which it requires*” (author’s emphasis, p. 105). Accordingly, the learning must result in enduring change. Hoggan (2016) cautions that this does not mean that old ways are necessarily forgotten or that over the course of time additional changes, even transformative ones, may not occur. In all, these criteria go beyond ‘significant, qualitative change’ previously discussed and better align with the intention of transformative learning scholars such as Mezirow, Dirkx, Lange, and Cranton. Transformative learning must result in a deep, sustained change that influences multiple aspects of an entity’s life. Additionally, supporting Mezirow’s (1978) point that transformation involves “[m]oving to a new perspective and sustaining is dependent upon an association with others who share the new perspective” (p. 105). In this association, the presumption is that not only the team but others see the transformative outcomes. Linking these criteria together can form a more rigorous description of transformative learning that can reduce the hyperbole and provide greater specificity that can then be extended to collective phenomenon.

Accepting that the same criteria apply to collective experience, it is worthwhile reviewing how these criteria for transformative learning apply in this case. Team member statements, document analysis and observation identified that there has been a significant change in the team's identity and how the team views themselves. There was a clear team trajectory towards a specialist focus and emphasis on them being an advanced forensics analysis team. Several steps of the reframed collective transformative learning process were identified which included the disorienting dilemma, the team's reflection on who they were and a change in the team's work focus and their professional identity. This is therefore reflective of collective experiencing, collective knowledge of itself, collective identity, and collective meaning-purpose.

First, the depth of the change is therefore seen as supporting transformation. Second, the breadth of the change was felt across their entire scope of work and therefore supports transformation. Third, concerning relative stability, the team's new sense of identity, the sense of practice and community, the ongoing emphasis on specialisation as noted in the language of the team and the text in the documentation suggest that this is a trajectory that is unlikely to be changed over the longer term. As it pertains to who they are as a team, it is likely to be much more enduring. Finally, the change was visible within the organization and the community as is evident in the observation, member statements and documents. This also supports transformation as collective in-relation. Given the above, there appears to be sufficient justification that transformative learning has occurred.

However, while both the collective and I have a sense that they are engaged in some form of transformative change concerning their identity, the recognition that the learning has occurred and the team has *transformed* is only possible retrospectively. As the team has not fully realized this end and the team has not yet been explicitly recognized and resourced as an advanced forensics analysis team within their organization, it is premature to conclude that the team had transformed. Consequently, I am confident based on the data that the team has experienced transformative learning. However, I also believe that they are still in the process of transforming and only time will tell if this will endure and becomes a fully transformative experience for the team.

In summary, this review of the criteria for claims to transformative learning has been helpful and Hoggan's recent article has reinforced the support for more rigorous criteria. To justify a claim of transformative learning outcomes, collectives must undergo deep, meaningful

change that influences multiple aspects of their existence which is relatively enduring and stable over time. In addition, the transformation must be evident to both the entity that transforms and to others. Linking these criteria together forms a more rigorous description of collective transformative learning. As seen above, this suggests that the IT SIRT has, at the least, experienced transformative learning though whether or not there will be an enduring transformative outcome will only be determined in time.

Mezirow's theory and collective learning. As discussed above, the review of my findings, my reflections and discussion reinforce Mezirow's (1989/2012) transformative learning theory in the majority and, with refinement of the criteria based on Hoggan's (2016) work, can apply to collective settings. Within this research, Mezirow's transformative learning process was reframed and applied to collective learning settings. However, his original process was intended as a guide to adult educators to foster and facilitate perspective transformation in adult learners. Even in individual transformative phenomenon, its relevance may have been limited in more naturalistic learning settings such as workplaces as not all steps would necessarily occur.

In this case, the reframed process was applied to the IT SIRT's transformative learning experience. Referring back to Table 5, the team had 8 of the 11 steps in the process and not all of these could be concretely confirmed as contributing to the transformative experience. Despite the fact that the team had not experienced all steps of the reframed process, it appears to have some merit in helping to explain collective transformative learning within authentic work settings.

This finding is similar to other research in naturalistic transformative learning processes; it is rare that the learning occurs in lock-step fashion as described in Mezirow's (2012) process. Further, it must be kept in mind that Mezirow's theory was intended to inform adult educators of the transformative learning process; it was not intended to be a step-wise process upon which to assess transformative learning. Consequently, while it may have some merit in helping ferret out transformative learning, a more general process such as Henderson's (2002) synthesis might be more helpful where the process includes: some disruptive event; critical reflection; development of a new perspective; and integration of new perspective. The caveat is that evidence of transformative learning must be supported by strong criteria of claim as previously discussed. However, rather than attempting to reconcile team transformative learning against the reframed perspective transformation process, a tailored model that supports both conscious and more naturalistic collective transformative learning might be more useful.

Summary. The above has addressed the third sub-question of my research that asks “how can Mezirow’s theory of individual transformative learning contribute to our understanding of how learning may occur in this authentic work team?” Prior to specifically addressing the question there was a more detailed discussion of the findings relative to the initially proposed reframed transformative learning process. This discussion identified that the findings themselves based on the criteria initially chosen were not sufficient to confidently state that the team had experienced transformative learning. Following this, the criteria for claims were revisited. Leveraging Hoggan’s (2016) criteria and past scholarly work, I extended this to collective transformative learning and reinforced his assertion that true transformative change must reflect depth, breadth and relative stability. I also asserted that for collective transformation to have occurred it must be evident to both the entity that transforms and to others. Finally, I concluded that the IT SIRT had experienced collective transformative learning, but the degree to which this will be enduring remains a question. As well, I reviewed the relevance of Mezirow’s learning theory to contributing to our understanding of collective learning. Given all of the above, I believe that his theory can be applied to collectives, though rigid adherence to process and criteria for some aspects of the process should be cautiously used. Ideally, a tailored model would be preferred.

Discussion Summary

Within this chapter, I undertook discussion and explanation of the findings relative to what has been found in the literature. While some of the collective learning activities and outcomes could be explained using these more traditional conceptualizations, none of them seemed to provide a comprehensive and inclusive appreciation of all facets of team informal learning seen in this case. I believe my social constructivist world view supported my understanding of what occurred with respect to collective learning as I was already predisposed to social construction of knowledge and I appreciated the relevance of complex social interactions in learning. The rhetoric of complexity theory helped to explain some of the collective dynamics within the team as they learned, worked and emerged together as a team.

The situating teams as complex learning systems provides an account of the collective learning processes, dynamics and related outcomes. In particular, this conceptualization supports the processes of learning as emergence as observed in the case. As it relates to collective transformative learning, this conceptualization and the incorporation of concepts from

complexity theory provide a value-neutral basis from which to explore transformative learning and to provide a rich account of collective transformative learning in comparison to the earlier conceptual framework based on Mezirow's (2012) perspective transformation process..

Chapter Six – Conclusion

Introduction

As emphasized at the beginning of this thesis, the study of workplace teams has become important as they are now common place within organizations and are often the means with which organizations address complex problems. Having been involved with teams as a participant, manager, leader, learning advisor, and as an educational researcher, I wanted to know more about how teams work. I also wanted to contribute to the knowledge about how teams learn so that I may influence how organizations and the people within them conceive of, understand, develop, train and employ teams.

Within western society, one would have a difficult time finding someone who didn't have their own understanding of what teams are and most would have a pretty good idea of how teams are employed within work places. Notwithstanding, as Katzenbach and Smith (1993) originally stated "while most of us are familiar with teams and team work, we are imprecise in thinking about them" (p. 61). Almost two decades later, Kozlowski and Chao (2012) assert that the origins, processes and outcomes of team learning remain conceptually unclear. They also indicate that there is considerable diversity in the ways that researchers have represented and measured team knowledge and the processes by which it is acquired, emerges and manifests within the team.

I too am left with the impression that despite the efforts of many scholars, only some of whom are mentioned here, there is an ongoing struggle for understanding and practice. There are three predominant conceptualizations of team learning: learning as aggregation; learning as participative process; and learning as an open system. While discussed separately, these conceptions support a view of collective learning as a generally linear process supported by inputs, processes of acquisition, retrieval, and sharing and resulting in predictable outputs intended to support organizational outcomes. As presented in this thesis, these conceptions continue to have merit and are helpful in explaining some team learning phenomena. However, these conceptions did not appear to sufficiently capture all of the collective learning that occurred within my study of an authentic work team. Further, within these conceptions, team activity is only discussed in general themes and often interpreted as a learning event itself, though how team learning was enacted in work teams remained elusive.

As presented, teams have more recently been conceptualized as complex adaptive systems (Arrow, McGrath, & Berdahl, 2000; Kozlowski et al. 2013; Mathieu et al., 2008). Recent research appears to have emphasized team development, team interactions and emergence, and teams in complexity. Yet research into teams as complex learning systems at the meso-level of analysis appears to be very limited; Engstrom's (1999) expansive learning cycle is one such example that seems to capture this conception to some degree. Conceiving teams as complex learning systems is a far less linear and mechanistic conceptualization than the three predominant conceptions discussed. This view of teams has the potential to provide important insight into how dynamic work teams informally learn, interoperate and interrelate within an organizational context. Further, it has the potential to influence our conception of collective learning and transformation.

Summary of the Research

With the aforementioned in mind, the purpose of my research was to understand collective learning in an authentic work team and to identify the potential for collective transformative learning. To remind the reader, the main research question was "In what ways is collective informal learning enacted within this authentic work team?" Sub-questions that were also answered within the scope of the research were: how can this collective learning be understood and articulated; what were the triggers/drivers for this type of learning; and how can Mezirow's theory of individual transformative learning contribute to our understanding of how learning may occur in this authentic work team?

As a qualitative researcher with a social constructivist world view, I chose case study methodology. Moreover, as I was investigating a particular phenomenon and not the specifics of the case, the research was an instrumental case study of an authentic work team. To remind the reader, in terms of this research an authentic work team is one that is employed in their natural work setting and they are engaged in actual day-to-day work activities; there is no facilitated, simulated, laboratory or constructed environment often used in team research.

As a qualitative research project, the investigation into both team informal learning and collective transformative learning necessarily involved focus groups and interviews to capture the experiences and views of the individual team members as well as the collective. Document analysis provided insight into the team history, activities, interactions, and artefacts that helped create the rich picture of the team as an entity within the organization. Finally, it was also

necessary to be intimately familiar with and have the opportunity to observe the team's learning within their authentic work context. In short, the multiple methods used helped capture needed data and ensure the credibility and trustworthiness of the study.

As for the case itself, the Information Technology Security Incident Recovery Team (IT SIRT) was a work team where its members were engaged in various forms of learning including formal, non-formal and informal learning. However, the primary intent was to capture the collective informal learning that occurred in and through work at the team level of analysis. As a nascent, yet cohesive work team situated within an evolving organizational environment, the team was constantly working at the edges of their discipline, forming and re-forming past knowledge, and adapting to and generating new knowledge to respond to complex, high risk threats to Government of Canada (GC) information technology (IT) systems and networks. Secondly, I also wanted to understand how this learning, if at all, contributed to team transformation. The IT SIRT provided an excellent case to explore collective informal learning and team transformation at the team level of analysis within an authentic work context.

In my findings, I initially provided a general account of the team's organizational and work context. This was followed by the a more detailed description of the team and key attributes including gender, age, bilingualism, seniority on the team, and common level of skill and effort. This helped describe the character of the team and situate it as a unique entity within the organization. These attributes and team traits were also discussed in terms of their potential influence on collective learning which became evident in subsequent findings and discussion.

Following this account of the team and its general context, I provided a more detailed description of the case across three major work contexts: daily work routine; non-routine events; and incident response and recovery operations. To address the main research question and the first sub-question, I provided examples, team member statements, excerpts from documents and my observations to capture how collective informal learning was enacted.

To address the second sub-question, I used multiple sources to investigate triggers and drivers of which there were many. Using examples, team member statements, excerpts from documents and observations, I described how the triggers and drivers provide important context for understanding the genesis of and influences on collective learning activities. Finally, I addressed the third sub-question pertaining to the utility of Mezirow's (2012) individual transformative learning theory relative to collective learning. The findings suggested that the

team had experienced transformative learning based on the reframed process introduced in the conceptual framework, though I stopped short of declaring that the team had truly ‘transformed’.

After the findings were presented, the next chapter provided an in-depth discussion of the findings and my interpretation of those findings relative to the literature reviewed. The chapter was titled “Towards an expanded view of collective learning and transformation” as the intent of the discussion was to address the research questions, attempt to close some of the evident gaps in the current research and literature, and propose refinements to existing theoretical constructs. Importantly, the discussion provided valuable insight into team informal learning and collective transformative learning within an authentic work context. These will be discussed in terms of scholarly contributions in the next section.

Scholarly Contributions

The questions posed in support of this research were in themselves original and intended to investigate areas where I believe there are gaps in the research or a need to further expand or explicate our understanding of team informal learning. This project also exposed me to a fresh landscape of opportunity to explore the potential of collective transformative learning at the team level of analysis which was, based on my investigations of the literature, a first. In this section, I will provide a more detailed account of my key scholarly contributions: expanded notions of collective learning and confirmation of the phenomena of collective transformative learning.

Expanded notions of collective learning. Through instrumental case study, this research investigated collective informal learning of a work team, the IT SIRT, within the dynamic IT security environment. Accordingly, this study provides insights to multiple disciplines including broader collective learning, workplace learning, and IT security collective learning and development.

Within my literature review and in organizational practice, I have noted that the predominant view of team learning is largely built on the individual learning metaphor of acquisition and conceptualized as aggregation of knowledge within the individual team members. As I presented, other predominant conceptualizations of collective learning included learning as participation and teams as open systems. Each of these conceptualizations helps to explain some of the processes and outcomes of team learning. For example, the discussion of shared mental models, transactive memory, communities of practice and emergent states provides insight to team learning processes. However, having read the literature and compared it

to my personal experiences in working in dynamic teams and managing teams in various settings, I was aware these conceptualizations did not necessarily provide a comprehensive and integrated view of informal learning in dynamic work teams at the collective level of analysis.

Some of the contemporary literature in team studies positions teams as teams complex adaptive systems (Arrow, McGrath, & Berdahl, 2000; Kozlowski et al., 2013; Ilgen, Hollenbeck, Johnson, & Jundt, 2005; Rico, Sánchez-Manzanares, Gil, & Gibson, 2008). Research in team development and performance supports that teams can be complex adaptive systems. However, in conducting my literature review and looking into the educational research, I did not see any research that specifically investigated teams as complex learning systems at the meso-level of analysis. This was particularly relevant given my social constructivist world view and understanding teams as complex social entities working within a larger socio-cultural context.

As previously discussed, this research was not as much about the specific team as it was the phenomena of collective informal learning within an authentic work team. While I was certain my research would have practical applications within the local team setting, as an educational researcher I was even more interested in exploring collective informal learning of a work team at the meso-level of analysis as there was very limited research of this phenomenon within an authentic work context. Therefore, the key contribution is that my research provides unique insights on collective informal learning and contributes to our understanding of how teams learn in and through their work in very practical ways.

As presented in this thesis, ‘how collective informal learning is enacted’ entails both process and outcome. Of the various definitions posited in the literature, none incorporated the breadth of possibilities. Therefore, I chose to expand on Johnsson & Boud’s (2010) definition of collective learning. I extended it to the team and included both processes and outcomes: *Team informal learning is contingently formed patterns of understandings and interactions within practical and situated activities where learning is discovered and generated together. This learning results in changes to the collective cognition which becomes evident in team activities, artefacts and other outcomes.*

My research identified that the individuals within the team were almost continuously interacting as a team and across team boundaries. It is when these interactions transcended the single individual experience that collective learning was evident. As presented in my findings and subsequent discussion, there was evidence of frequent sub-team and team level interactions

where knowledge was accessed, shared, processed, generated, and applied not just at the individual level, but as a collective level whether as a sub-team or team. These interactions occurred face-to-face, through open dialogue, and over electronic means such as the telephone, mobile devices and workstation applications. As reported, not all of the interactions were clear exchanges of information; along with explicit means, members also interacted through presence, posture, gestures or body language. Even an absence of any form verbal or physical means may have had meaning for the team. As it pertains to a particular team activity, the totality of team-relevant process interactions and related outcomes often represented the changes in collective cognition, hence team learning.

In my study, I found that collective informal learning within this authentic work team was enacted through a variety of team interactions, processes, and activities which were then reflected in verbal, textual, symbolic/graphic, physical, or behavioural team outcomes. More specifically, I found team informal learning was enacted in various ways:

- Establishment and maintenance of interrelations with other teams;
- Formulation of team approaches;
- Generation of team artefacts;
- Adoption and alterations in technology use;
- Establishment and refinement of team norms and practices; and
- Formation of team identity.

As opposed to being looked at as the result of isolated learning activities in support of a specific team outcome, it should be appreciated that these 'enactments' were often embedded within the complex and dynamic work environment of the IT SIRT, simultaneously occurring and interwoven into the team's work.

Beyond the six previously identified enactments of team informal learning, I found that transformation of the team was an additional way in which collective learning was enacted. Much like all of the team learning and related outcomes, this enactment was intertwined within team activity.

For each of the enactments, whether contributing to adaptive, generative or transformative learning outcomes, there were contributing processes within a cycle of activity that also include new and ongoing team informal learning that was enacted through the team's work. This cycle was previously presented in my discussion and is included again for the reader

in Figure 15 below. This paints a somewhat different picture of team informal learning than previous linear or other cyclical models.

To review, the team informal learning cycle starts with the team encountering an issue or discovering something of interest or value to the team. The team then situates this encounter or discovery within their current setting through processes of analysis, conceptualization and reconciliation. They then decide on a collective course of action and generate or develop the related artefacts, processes, tools or concepts. Upon implementation or application, evaluation may commence immediately or be deferred. Evaluating the utility of the artefacts, processes, tools or concepts, may result in maintaining the status quo, re-generating them or disposing or retiring them. Importantly, collective informal learning is ongoing through the various team interactions to support the processes and the cycle and consists of innumerable micro interactions of individuals, the team and others that the team engages.

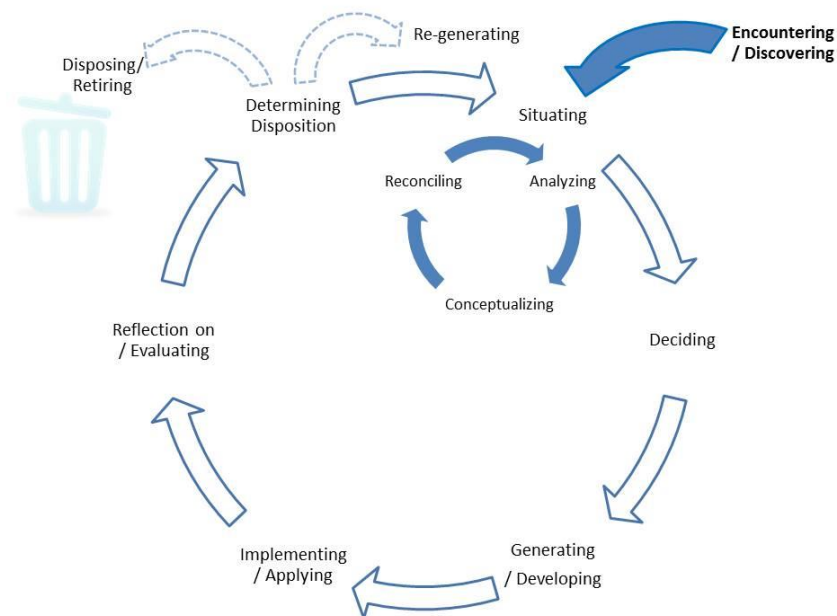


Figure 15. Notional cycle of team informal learning in dynamic work settings.

Though there are limitations in its use as previously discussed, it provides a non-linear representation of team informal learning that includes reactive, implicit and deliberate processes that can contribute to adaptive, generative or transformative learning outcomes within a dynamic work environment. It also appreciates that there are numerous underlying micro-processes that support team informal learning.

This understanding of the how learning is enacted and the underlying cycle of activity contributes to the field of collective learning and workplace learning in two distinct ways. First, it builds upon our understanding of teams as complex learning systems. It provides a non-linear representation of collective learning that may be particularly helpful in explicating team learning in dynamic settings. More specifically, there are accounts of the breadth of informal learning processes, outcomes and emergence. Second, my research places particular emphasis on the relationship between informal learning and work. In this case, the triggers and drivers for learning were bound to the work activities of the team. As presented in the discussion of my findings, the enactments and the corresponding cycle of team informal learning introduced suggest that the team's learning is inextricably implicated in their work and its outcomes. The learning could not be considered singularly causal to successful work performance as there were various other factors that contributed to successful work performance including individual motivation, team traits, team resources available, and authority of the team in performing their role. Accordingly, this research contributes to the understanding of team informal learning, including the commensurate processes and outcomes, as a natural consequence of work and inextricably tied to work outcomes.

Triggers and drivers to collective learning. While not as novel as they are already part of the educational community discourse, the research extended the discussion of triggers and drivers to learning in authentic work teams. As previously described in the findings, triggers stimulate collective learning in the moment and often relate to problems, issues, or changes that influence team activity. In contrast, drivers are bound within the context in which the team works. As opposed to arising from the work, they background the work and drive the team to learn.

While the detail is provided in the previous chapter, I provided a general categorization of triggers and drivers of collective learning based on the data. These included: mandate; organizational requirements and expectations; conflict; the new or novel; change; gaps in team knowledge or capability; problems and collective motivations or goals. Notably they all fall out of issues, problems, or opportunities that arose from the team's work. Some were internal to the team, others were external; some were explicit, others were implicit. Other team contexts may not have these types of triggers or drivers, but these nonetheless provide a better understanding of the various stimuli for team learning within this authentic work context.

Expanded understanding of collective transformative learning. This research contributed to the scholarly work of transformative learning research in several ways. The primary focus of this study was to identify in what ways team informal learning was enacted. As I have a keen interest in transformative learning, this research afforded me the opportunity to also explore collective transformative learning and thus answer the call for increased research to support a more comprehensive and inclusive theory of adult learning (Illeris, 2004; Mezirow, 1996; Taylor, 1998). Specifically, this part of my research was intended to address the question, “how can Mezirow’s theory of individual transformative learning contribute to our understanding of how learning may occur in this authentic work team?”

Given the primary focus of the study, the case team and the context, there was specific investigation of transformative learning in two areas that were under researched: applicability of transformative learning in groups; and transformative learning through work (Taylor, 1997/2007; Taylor & Cranton, 2013). This research was unique in that it attempted to capture collective transformative learning in an authentic work context. The previous research and literature reviewed appears to have been situated in a value-based context where there appears to be an inherently positive orientation, such as higher education settings where there is pre-disposition to support individual transformative processes. As this study was concerned with collective transformative learning in an authentic work context, there was no intention to facilitate or enable transformative learning. Rather, my intent was to capture team transformative learning, if it occurred, naturalistically through work.

The findings and discussions surrounding transformative learning were more involved than anticipated. However, the study provided me the opportunity to investigate transformative learning and, throughout the process, allowed me to reflect on my understanding of while exploring it in this unique context. Several points of import can be drawn from the study that contribute to an expanded understanding of collective transformative learning.

Within my research, I leveraged the reframed transformative learning process adapted from Mezirow (2012) and found that the team had undergone significant, qualitative changes (Clark, 1993; Illeris, 2013; Segers & de Greef, 2012; Taylor & Cranton, 2013). However, in discussing the findings, revisiting the literature on collective transformative phenomena, and reviewing the recently published work of Hoggan (2016), I saw the need to refine the criteria for claims of transformative learning.

Returning to the work of Mezirow (1978), I found that two key criteria applied to the collective level of analysis were not fully addressed – evidence of a visible shift to a new perspective and the need for enduring change. Hoggan’s (2016) recent article was timely in that it reinforced the need for more rigorous criteria that includes depth, breadth, and relative stability of the change. Merging Mezirow’s (1978) and Hoggan’s (2016) work, I arrived at the conclusion that to justify a claim of collective transformation, collectives must undergo deep, meaningful change that influences multiple aspects of their existence which is relatively enduring and stable over time that can be visible to others. With these new criteria, I was able to see a clear change in the team’s perspective of who they were as a team, their way of ‘being’ and their identity. However, as discussed, while I genuinely believe that the team had experienced transformative learning regarding their identity, it was probably premature to support that the team had completely transformed. Consequently, I am confident based on the data that the team is engaged in transformative learning, but only time will tell if this will endure and could be described as a fully transformative experience.

Having resolved that the team was undergoing transformative learning, the third sub question, still needed to be addressed: “*How can Mezirow’s theory of individual transformative learning contribute to our understanding of how learning may occur in this authentic work team?*” In general, I found that Mezirow’s process could be reframed to support collective transformative learning. As identified in the discussion in the previous chapter, it appears that the team either consciously or unconsciously participated in 8 of the 11 process steps. While this was a much more naturalistic setting and the team was not consciously engaged or facilitated through a transformative process, there appears to be a significant degree of alignment between the process and the team activities while undergoing transformation. That said, there were no occasions where it could be reliably stated that all steps in the process had occurred nor does the absence of a particular part of the process mean that it did not occur, only that I did not capture it during my study.

This investigation into collective transformative learning solidified the importance of the criteria for claims. Scholars have identified this in the past (Mezirow, 2012; Taylor 1997/2007; Taylor & Cranton, 2013). However, as discussed, there has been considerable hyperbole around transformative learning that has perhaps diluted the essence of what Mezirow and his scholarly contemporaries such as Freire, Boyd, Kegan, Dirkx and Daloz meant when they wrote and spoke

about transformations. Accordingly, the reiteration and refinement of legitimate criteria for claims provides a unique perspective that will benefit the scholarly discourse.

Perhaps most of all, this part of the study provides a significant scholarly contribution as the first documented case of unfacilitated, collective transformation of a work team at the meso-level of analysis. While I am somewhat equivocal on the extent of the transformation, the evidence of their journey over the past two years, the significant and meaningful change to the team's identity and the emerging outcomes and recognition of others strongly supports the applicability of transformative learning to groups/collectives and adds a credible example to the literature on potential for transformative learning through work.

Practical Implications

This research has the potential to progress our understanding of collective learning and advance theoretical discussions of transformation learning theory, particularly as it applies to diverse contexts such as workplaces and its applicability to groups. For the broader workplace learning community, this research will contribute to the understanding of the nature of learning processes as they apply to collective learning as well as transformative learning through work. While there are potentially many implications, the main ones related to my experience are provided below.

Implications for collective learning and training. This case emphasized how collective learning was ongoing in team interactions and how it was enacted in team interactions, activities, artefacts. It also revealed underlying activity and process cycles that may be present. While the three predominant conceptualisations of collective learning can be useful, the research suggests that teams in dynamic work environments may be better conceptualized as complex learning systems. Taking this non-linear, complexivist view can have a significant influence on how we understand, organize, enable and create meaningful learning experiences for teams like these who work in dynamic, unpredictable environments. For example, beyond IT response teams, this conceptualization may be appropriate to investigate and understand team learning in first responder teams, rescue teams, flight teams in extremis, military, para-military or law enforcement tactical teams and the like. This understanding of teams as complex learning systems can provide managers, supervisors, trainers and learning and development professionals with insight into how to better identify the collective informal learning through collective enactments. These can then better inform individual and collective learning design decisions.

For example, understanding informal learning processes and outcomes can highlight natural learning processes in and through work. If it is found that a significant amount of context relevant learning occurs in and through work, learning strategies can account for this learning and potentially reduce training costs. The insights gained into collective learning through this research also identify the potential value in multi-level analysis that contributes to understanding the interplay between levels which is so important in organizational and workplace performance issues.

Implications for transformative learning theory. This study enhanced my understanding of transformative processes within an authentic work team. While Mezirow's (2012) perspective transformation process should be appreciated for its intent to serve as a framework for adult educators, it can also be reframed to provide sign posts for collective learning processes that contribute to transformative outcomes. By extension, understanding how collective transformative learning occurs can provide insight into the types of support needed to better facilitate or foster collective transformation within organizations. The first key step to this, however, is to better understand what 'transformation' means.

Consequently, another important implication from this research is the need to reinforce rigorous criteria for claims of transformative learning. This may help to reduce some of the hyperbole around transformation which confuses those learning about or exploring the phenomena. For example, there is a significant body of literature pertaining to organizational transformation, transformative leadership and individual transformation where these criteria may be applied. As well, if genuine occurrences can be identified, this will help enrich the repository of knowledge on transformative learning and under which circumstances it can happen. Again, these experiences may contribute to the knowledge of those hoping to facilitate, foster and identify transformative learning that occurs in their workplaces.

Implications for IT security policy and practice. This study provides insight to the Security Operations Centre (SOC) work environment, the complexity of their tasks, and the contextual influences on the teams and their collective learning. This study will contribute to local SOC and GC understanding of how IT security teams learn and develop. This case revealed an extensive amount of collective informal learning that took place within the IT SIRT which occurred as a natural consequence of the team's work. This understanding on what a team does and learns on the job, provides insights into team performance and what is needed or not needed

to support learning and performance. For example, in this case, the initial emphasis placed on SOP development at the early stages of the team's maturity and the subsequent lack of use of most the SOPs, may suggest that structured SOPs are not needed in this type of dynamic environment. Instead, the collective knowledge can be captured in a more practical, efficient, and less bureaucratic way that still meets the learning needs of the team.

Additionally, a better understanding of collective learning of these types of teams is beneficial in support of staffing and learning and development policies. Those charged with recruiting, managing, and training these types of teams appreciate the lengthy and costly process to develop this kind of expertise. Knowing how much actually gets learned on the job while doing the work may provide insights that can help refine recruiting and selection requirements, formal learning requirements, and perhaps reduce organizational training costs while improving team capability.

Moreover, read in detail, this study provides insights pertaining to IT SIRT and incident handling processes, interactions and requirements. These insights should inform team leaders and managers in the type of learning and work that occurs in incident handling contexts and how the team responds and learns from their own actions within their work processes. This knowledge can have an impact on what processes or tools are acquired and why, what individual and team competencies should be developed, and what type of team and sub-team strategies may suit their contexts.

Implications for learning policy and practice. Within the GC, 'collectives' as an entity that work and learn are acknowledged in general terms, but there is no explicit recognition of collective learning let alone collective transformative learning. Both topics are important for executives and managers as there are implications for how they lead and manage teams. As well as there are implications on employee and team development. These are important considering the GC's recruiting efforts and aspiration to be a preferred employer.

This research also sheds light on the importance of teams and collectives in the achievement of work-related outcomes within the GC. It provides insight to the value of understanding collective informal learning for reasons already stated. Accordingly, this knowledge should be considered within GC learning and development policies and reflected in the practices that support individual and collective learning activities. For example, the main findings should be communicated to the GC Heads of Learning Forum and the Canada School of

Public Service (CSPS) learning community network. As well, there is potential for greater knowledge mobilization on these issues through the GC Future of Learning Community of Practice.

As for transformative learning, there have been numerous organizational transformation initiatives and transformational leadership concepts espoused throughout the GC. Some of the core concepts are embedded into learning within the development pathways for managers and executives. However, there is limited understanding regarding transformative learning and there does not appear to be an appreciation of GC workplaces as potentially being transformative. While these pathways are focused on supporting knowledge and skill for concrete tasks, there are also recommended or optional learning opportunities to support specific career or functional interests where there is potential to create and have available modules on collective learning in work teams, transformative learning and collective transformative learning.

In addition to the more formal methods above, as a member of three different communities of practice within the GC that relate to learning and development, I can help expand the discussion and relate ways that will help the GC adopt more concrete understanding of collective learning, transformative learning and collective transformative learning in the workplace. The communities of practice where I see I have the most influence beyond my own local community are: the CSPS learning community forum; the Future of Learning community; and as a visiting advisor to Shared Services Canada Academy. Each of these has a role in shaping the landscape for various GC communities and can reach out to other GC departments through various media. I can also have a direct impact as a member of the GC learning professional's working group for professional development.

Study Strengths and Limitations

As with any study, this research has its strengths and limitations. As an instrumental case study, this original piece of research brings focus on team informal learning and transformative phenomena within authentic work teams. As McGrath (1986) notes, the study of teams is context sensitive. Therefore, the use of multiple methods gave needed insight to the team's work context in addition to supporting credibility and trustworthiness. The document analysis provided historicity and understanding of the team's evolution within their work and organizational context. The document analysis also included various team documents that provided insight to specific team activities such as incident response. The focus groups and interviews gave the

participants voice within the study and supported first person accounts of the team's learning and work. These methods also allowed me to capture both individual and team perspectives, attitudes and opinions on a range of issues relevant to the study and their work.

Observation as a data collection method was a critical component to the study, particularly researching from a social constructivist perspective, as it gave me the opportunity to be situated within the team's work space and gain first hand appreciation of their work and learning context. Further, over the 12-week period, I was able to capture incident response, case management, forensics activities and the associated learning in real time. This supported direct experience of learning which has been a noted criticism of most team learning research (Kozlowski et al, 2013). In all, the methods chosen and direct experience helped paint a rich picture of this instrumental case which allowed me to provide a more detailed, research-based account of team informal learning and transformation.

Notwithstanding the study's strengths, it also has some limitations. First, as an instrumental case study, the intent was to study the phenomena, not address an issue related to the IT SIRT. That said, the IT SIRT was working within a unique context and faced situations that most work teams do not face. While there may be similarities that would support some degree of generalization about collective learning, work teams in different contexts may learn in substantially different ways and under different conditions. That said, I have had experience in fire-fighting teams, military operations teams, peacekeeping observation teams, training teams and in policy development teams. I see how some aspects of this research are applicable to these fields and how I can potentially link my research to those areas of study. These contexts provide quite different learning environments and the learning is likely enacted in different ways based on a variety of factors. These include, but are not limited to, team goals, level of interdependence, task urgency, team risks, organizational commitment and available resources. So, while the research has contributed to the understanding of enacted team learning and collective transformative learning, the extent to which the findings are generalizable to other contexts or settings is not known. Further research is warranted in other areas where dynamic teams are employed such as those mentioned.

Second, the qualitative methods chosen support a rich picture of the team's context and work. However, regardless of the extent of researcher resources, we can never fully capture the complexity of the team and all of the team interactions, intentions, and meanings. Third, the

initially intended peer support for categorization of data never bore the expected fruit. The initial attempt made to use the peer to independently categorize the data proved to be of little utility in providing credibility. I often had to discuss and describe category headings and subsequent categorizations as the peer was from a different research paradigm and was not fully familiar with the underpinning concepts, work context and terms. The peer was helpful in that she helped me think through the categories themselves, but ultimately there were no substantive comments that pertained to the actual categorization of terms. Other ways in which credibility and trustworthiness have been achieved are identified in Appendix 1. For example, the triangulation between sources, the use of multiple sources and the richness of the data across all sources help to support credibility and trustworthiness. The situation with the peer support provided an important lesson in the criteria used in the recruiting and selection of such support for my future research.

There were also limitations based on the participant population. As discussed, this was an all-male team where half were bilingual Francophones and the other half were unilingual Anglophones and all but one member was in the 35-50 age group. Accordingly, given the constraints of the study, I could not sufficiently address potential linguistic, generational or gender issues that may arise in this type of work team. I was only able to observe the team for a period of 12 weeks. More time would have certainly provided a richer landscape from which to cull data. Further, as with most case studies, the research only captured a snapshot of the team's life over a short period of time. The IT SIRT environment and the organization in which they were nested were continuing to evolve. In fact, as of the writing of this report, the IT SIRT team had expanded by another ten members which will assuredly change the team dynamics and may have an influence on what I originally found. Accordingly, future research opportunities exist even within this specific team context.

As with any qualitative research, I had presuppositions and assumptions which framed my research. I was aware of my philosophical assumptions, but they nonetheless influenced the entire research process. As well, my previous understanding of the team's context, work and learning shaped what was drawn from the data and how it was analyzed. By the end of the report, it was also clear that reviewing this case through the social constructivist lens meant that I had missed some interactions within the team that went beyond the social interactions. While I reported on some of the team's development and use of tools and artefacts, there was limited

appreciation of the role these played in the team learning. I used various means noted in Appendix 1 to help assure quality research and I declared my biases. I understand, however, that other researchers would have contributed different perspectives to this study, interpreted the data differently and shaped a different story. Certainly, there would be significant value in conducting similar research using different lenses. For example, for this work team and context, a socio-technical or socio-material perspective would provide a different view that could contribute to the discussion of team informal learning.

Potential for Further Research

The scope of this research was focused on how team informal learning was enacted in an authentic work team and how this may have contributed to team transformation. Throughout however, there were areas noted that warrant further investigation. Some have already been alluded to in previous sections. However, the following identifies six areas that I believe warrant additional research. For each I have suggested research questions.

Socio-material understanding of teams. The team itself was more than just the individuals. Their work was both enabled and mediated by their interrelationships with various tools, facilities, equipment, artefacts, systems, and networks. For example, there were clear relationships that the team had with their tools and IT systems. The team depended heavily on tools and equipment to do their work and these also dictated team norms and practices such as the use of JIRA as the case management system. There was also ample discussion about the positive and negative influence the room had on the team's performance. Beyond what was explicit or visible, were the potential elements related to team identity. Just as part of the participants' professional identity was, in part, based on their declared expertise in certain systems, tools and techniques, the team's identity seemed closely tied to its capability in forensics and recovery activities which included unique tools and techniques distinguishing it from other teams within the SOC and GC. In fact, the team's ability to function as they did relied to a great extent on their tools.

While not the focus of this research, the team's relationship with the material including the tools, applications, systems, artifacts and physical spaces was undeniable and may have had a stronger influence on collective learning than suggested in this report. Therefore, there is potential to explore the socio-technical or socio-material aspects of team learning. More

specifically, such research might seek to understand how the technical/material was implicated in team learning and/or team identity.

Identity transformation in collective entities. Another topic that was threaded through the team informal learning and transformative learning discussion was the presence and enhancement of the team's collective identity as a professional, specialist team. There were multiple instances where identity was a key concern and may have been a driver to the collective learning and eventual transformation. There were references to collective identity and indicators that the teams' collective self-image was a relevant factor in their learning and trajectory. For example, as a specialist team, their identity seemed to flavour interactions with other teams and management representatives. The literature review did not capture this specific area nor were specific issues of collective identity formulation investigated other than as a way that learning was enacted. However, given the potential influence that professional identity has on team trajectory, it is worthy of future research. Research questions that might be considered are: how is team identity formed in dynamic work teams; or what is the relationship between identity formation and transformative phenomena in work teams?

IT security teams in physical versus virtual settings. There remain gaps in the research in IT work teams such as the IT SIRT. It seems that the assumption within the research community is that IT teams are generally 'connected' and are therefore a virtual team. There have been several studies of IT teams in virtual settings. I am not aware, however, of studies that investigate IT security teams that work primarily in the virtual community, but are bounded within a physical, common space. While the IT SIRT worked a considerable amount in cyberspace, most their collective learning occurred in the same physical space. Study of the interplay and influence on learning between the physical and the virtual worlds within teams such as the IT SIRT would be worthwhile. More specifically, comparing learning and work in both environments would expand our understanding of teams in cross-domain environments.

Diversity and learning in IT teams. As mentioned earlier, there were numerous aspects related to the team dynamics that were not specifically studied, but merit consideration within the IT setting. These include investigation of gender, generational and linguistic issues that relate to collective learning and transformation. Questions of interest might be: how does adding significant diversity in any one of these areas influence the team learning if at all; or how do

collective learning practices differ between male/female teams, English/French teams, or young/mature teams.

Collective learning within other IT domains. Another area which could contribute to addressing Canada's IT and IT security skills gap, is research into collective learning in other IT and IT security domains such as architecture and planning teams, network defense operations teams/information protection centre teams, network monitoring teams, security assessment teams or public/private liaison teams. Such research would expand our understanding of collective learning in cyber-centric work environments and potentially help to identify ways to help facilitate learning and development of expertise in these areas where there is a shortage.

Team informal learning & transformative learning in dynamic work teams. As previously mentioned, this research can have a significant influence on how we understand, organize, enable and create meaningful learning experiences for teams like these who work in dynamic, unpredictable environments. However, additional research is required. Accordingly, using similar questions as this research, there are opportunities to investigate informal and transformative learning in other dynamic work teams such as: first responder teams, rescue teams, flight teams in extremis, military, para-military or law enforcement tactical teams.

Understanding team learning – a Canadian perspective. In broader terms, I was not able to find a meta-study on the conceptions of team learning and organizational practices in Canada. Such research could reveal gaps or misunderstanding of team learning that could impact how team learning is understood and enabled. Accordingly, research questions could potentially investigate various organizational policies on team learning, how team learning is described, and how this information is provided to those that develop and facilitate adult and workplace learning.

In short, as often happens in research, in the process of answering certain questions, other questions arise. There may be others worthy of consideration, but the aforementioned were of particular interest to me and may help to guide future research.

Personal Reflections on the Research Process

To close, I wanted the opportunity to express some of my major reflections on the research process and this study. As a line of inquiry in educational research, this study occurred at the intersection of three sub-disciplinary study areas: workplace learning, collective learning, and transformative learning. As seen in my introduction, the original figure is reintroduced for

the reader's benefit in Figure 16. At the outset, I not only saw the potential contribution to team learning discourse, but I saw the potential for my knowledge to be expanded in these three areas. The following summarizes my personal academic interest in terms of my research questions.

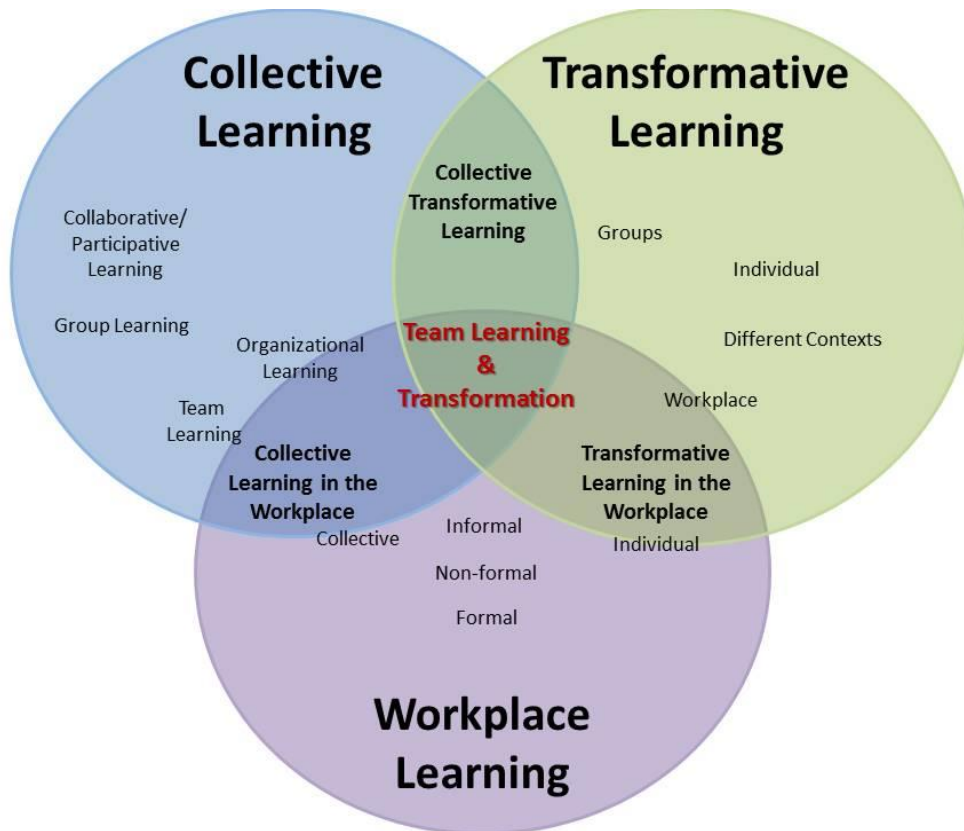


Figure 16. The research context at the convergence of three fields of study

Regarding collective learning, there is significant impetus to better understand how collective learning activities might be understood and enacted at the team level as directly experienced in the workplace (Chatalalsingh & Regehr, 2006; Kozlowski et al., 2013).

Distinguished as a form of collective learning, the focus was on how team learning was enacted in this authentic work team and how this learning could be articulated. More specifically, from a social constructivist perspective, I was intrigued by the conceptualization of a team as a complex learning system and the potential characteristics that support emergence and transformation as a team learns and works. Understanding how learning occurs within this far less linear and mechanistic conceptualization has the potential to provide important insight into how a team may learn, interoperate and interrelate within an organizational context. This contributes not only to

my body of knowledge, but this knowledge can also be applied within my current work and future work.

There was also the opportunity to better understand workplace learning and informal learning in work teams. There has been considerable effort into researching team performance and development. However, there has been limited research and scholarly literature on collective learning within authentic work contexts. More specifically, while there appears to be increasing interest in the role of informal learning in the workplace, the discussion of informal learning as it applies to work teams is almost non-existent. Perhaps this is because it is assumed that almost all team learning is informal, though this has not been explicit in the learning literature. As presented in this study, most of the learning that occurred within this work team was informal and occurred in and through their work. More specific to the context, specific influences on team learning were discussed in terms of triggers and drivers. These have long been a part of my learning and development lexicon, yet I had not done any specific research into them. Accordingly, they were included in my study. Finally, having experienced what I believe is a personal transformation over time, including influences by my PhD studies, I am fascinated by this phenomenon and wanted to better understand the potential processes and outcomes. In particular, I wanted to determine the utility of Mezirow's individual learning theory in collective learning. I uncovered more than anticipated and I am very satisfied that I integrated this into my research.

Now at the end of this thesis, I know I have a better understanding of all three areas of study and believe that I have contributed to the larger body of academic knowledge. Further, I am also able to help mobilize this knowledge to practice in very real ways. The following will discuss more specific reflections on my personal journey and what I discovered.

What I started out doing and how the research unfolded are vastly different. The language and framing of both collective learning within the team and the potential for teams to 'transform' were of primary issue. Important was the exploration of these phenomena in authentic, non-educational contexts where participants are likely to be less predisposed to both collectivity and transformative learning.

My exploration into collective learning was as complex as the case I was studying. There are myriad concepts and theories that connect to the issues I explored. The research process I

followed helped me to stay within scope and focus on answering the questions. In doing so, I could keep my attention on concepts and theories of specific relevance to my project.

Though I struggled somewhat with the multiple reviews of the data to find the statements, patterns, and meaning, it was worthwhile to conduct a manual analysis to ensure that I fully understood the what the participants views. However, leveraging NVivo 10/11 to support data management, categorization activities and conduct various queries and searches greatly aided my analyses and supported credibility of the processes.

As for the findings, I anticipated that my research would draw me towards complexity theory. This theory and the concepts appear to reconcile well with what I found within the case regarding collective learning. Moreover, the concept of teams as complex learning systems is highly attractive as it is value-neutral and provides a holistic, systems view that captures different learning forms, temporality, context, emergence and transformative phenomena. As this instrumental study was conducted in a very specific context, there are many opportunities for further exploration of collective learning and transformation in authentic contexts that may help to contribute to a more holistic theory of transformative learning. That said, I am already seeing the interrelationship between complexity theory and transformative phenomena that warrants further personal study.

Regarding transformative learning, I anticipated that Mezirow's perspective transformation had merit in helping me to better understand group transformative processes. To me, the research process revealed far more about the epistemological and ontological stance of those who have preceded him than expected. In reviewing some of the historical sociological literature, I was able to capture other language and thoughts that supported his ideas and enriched my own knowledge.

Finally, as an overall comment, while I started out this journey generally confident in my social constructivist world view, the insights gained through observations, discussions, and additional reading created a stronger understanding of complexity theory which I had pondered in the past and this aligned with what I was seeing during my research. In the drafting of this thesis, I had trouble remaining within the rhetoric of social constructivism. The language within this paradigm was limited relative to the paradigmatic journey experienced. From the view of social systems, the rhetoric of systems theory and complexity theory seem to better fit what I have seen and what I am discovering. I suspect that there are stronger linkages than I have

demonstrated in this case, which is a question that begs for more exploration and more research on my part.

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Appendix 1 – Assuring Qualitative Research Integrity

Criteria	Definition	Techniques Used to Attain Criteria
Credibility	The results of qualitative research are credible or believable, particularly in the eyes of the participants.	<ul style="list-style-type: none"> ● Thick, rich description including changes that occur and how these changes affected the research and approach. ● Appropriate audit trail: <ul style="list-style-type: none"> ▪ Accurate interview/focus group transcription. ▪ Accurate and specific observation notes which can be supported by other data sources such as work logs, reports, data entries ▪ Document analysis preceding focus groups and interviews. ▪ NVivo analysis results. ● Triangulation - analysis of across all data sources (documentation, focus groups, interviews, observation, reflection) to identify confirming or disconfirming evidence. ● Collaboration & participant perspective: <ul style="list-style-type: none"> ▪ Member checking of transcriptions. ▪ Prolonged period of observation (3 months). ▪ Researcher’s existing collegial relationship with the team. ● Researcher’s credentials within the cybersecurity domain ● Research journal to support ensure reflexivity describing researcher biases, assumptions and beliefs as well as provide a personal account of issues and decisions as the research progresses.

Criteria	Definition	Techniques Used to Attain Criteria
Transferability	The degree to which the results of qualitative research can be generalized or transferred to other contexts or settings.	<ul style="list-style-type: none"> ● Authentic workplace context. ● Thick, rich description including changes that occur and how these changes affected the research and approach. ● Research journal to support ensure reflexivity describing researcher biases, assumptions and beliefs as well as provide a personal account of issues and decisions as the research progresses.
Dependability	The need for the researcher to account for the ever-changing context within which research occurs.	<ul style="list-style-type: none"> ● Thick, rich description including changes that occur and how these changes affected the research and approach. ● Research journal to support ensure reflexivity describing researcher biases, assumptions and beliefs as well as provide a personal account of issues and decisions as the research progresses. ● Historicity established in document analysis. ● Prolonged period of daily observation (3 months)
Confirmability	The degree to which the results could be confirmed or corroborated by others.	<ul style="list-style-type: none"> ● Historicity established in document analysis. ● Member checking of transcriptions. ● Appropriate audit trail (accurate transcriptions/notes, NVivo results). ● Triangulation - comparative analysis of across all data sources to identify confirming or disconfirming evidence. ● Research journal to support reflexivity describing researcher biases, assumptions and beliefs as well as provide a personal account of issues and decisions as the research progresses.

Appendix 2 – Ethics Approval

File Number: 03-15-05

Date (mm/dd/yyyy): 05/07/2015



Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

Ethics Approval Notice Social Science and Humanities REB

Principal Investigator / Supervisor / Co-investigator(s) / Student(s)

<u>First Name</u>	<u>Last Name</u>	<u>Affiliation</u>	<u>Role</u>
Maurice	Taylor	Education / Education	Supervisor
Edward R.	Purse	Education / Education	Student Researcher

File Number: 03-15-05

Type of Project: PhD Thesis

Title: Team Learning and Transformation

<u>Approval Date (mm/dd/yyyy)</u>	<u>Expiry Date (mm/dd/yyyy)</u>	<u>Approval Type</u>
05/07/2015	05/06/2016	Ia

(Ia: Approval, Ib: Approval for initial stage only)

Special Conditions / Comments:

N/A

1

File Number: 03-15-05

Date (mm/dd/yyyy): 05/07/2015



Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

This is to confirm that the University of Ottawa Research Ethics Board identified above, which operates in accordance with the Tri-Council Policy Statement (2010) and other applicable laws and regulations in Ontario, has examined and approved the ethics application for the above named research project. Ethics approval is valid for the period indicated above and subject to the conditions listed in the section entitled "Special Conditions / Comments".

During the course of the project, the protocol may not be modified without prior written approval from the REB except when necessary to remove participants from immediate endangerment or when the modification(s) pertain to only administrative or logistical components of the project (e.g., change of telephone number). Investigators must also promptly alert the REB of any changes which increase the risk to participant(s), any changes which considerably affect the conduct of the project, all unanticipated and harmful events that occur, and new information that may negatively affect the conduct of the project and safety of the participant(s). Modifications to the project, including consent and recruitment documentation, should be submitted to the Ethics Office for approval using the "Modification to research project" form available at: <http://research.uottawa.ca/ethics/submissions-and-reviews>.

Please submit an annual report to the Ethics Office four weeks before the above-referenced expiry date to request a renewal of this ethics approval. To close the file, a final report must be submitted. These documents can be found at: <http://research.uottawa.ca/ethics/submissions-and-reviews>.

If you have any questions, please do not hesitate to contact the Ethics Office at extension 5387 or by e-mail at: ethics@uOttawa.ca.

Signature:

Kim Thompson
Protocol Officer for Ethics in Research
For Barbara Graves, Chair of the Social Sciences and Humanities REB

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550, rue Cumberland Ottawa (Ontario) K1N 6N5 Canada
613-562-5387 • Téléc./Fax: 613-562-5338
<http://www.research.uottawa.ca/ethics/index.html>
<http://www.recherche.uottawa.ca/deontologie/index.html>

Appendix 3 – Letter of Introduction

Manager IT Security Incident Recovery Team

Shared Services Canada

434 Queen Street, Ottawa, ON, K1G 4A8

Approval for Doctoral Level Research Project Involving the IT SIRT

As you are already aware, along with my other responsibilities at the IT Security Learning Centre (ITSLC) at the Communications Security Establishment (CSE), I have been working with the learning and development of the Information Technology Security Incident Recovery Team (IT SIRT) for over a year. Concurrently, I have been working on my PhD studies from the in the Faculty of Education at the University of Ottawa, under the supervision of Dr. Maurice Taylor. Through past work with teams and in working with the IT SIRT, I have gained interest in collective learning and how that learning influences the team.

I have submitted a proposal for research, to study collective learning and transformation. As the IT SIRT is a relatively nascent capability within the Government of Canada (GC) working within the complex and dynamic field of cybersecurity, I believe that the team presents a novel opportunity to study and better understand collective learning and potential transformative processes and outcomes.

By participating in this study, Shared Services Canada (SSC) and the GC will be contributing to the knowledge of these phenomena in organizational workplace settings that will contribute to the team, the organization and the field in which they work. The research will increase the understanding of explicit and tacit activities related to the IT SIRT that can be used to inform and refine team practices, mediate management expectations, target collective and individual learning opportunities, and refine formal learning needs. Additionally, the research will contribute to an emerging area in the larger IT security/cyber security community and some of the findings may transfer to teams in similar contexts such information protection centres, incident response teams, and security operations centres. However, it must be recognized at all

times that this research is being conducted independently and not as a part of any Government, Shared Services Canada, and Communications Security Establishment or IT SIRT requirement.

The scheduled period of the study is three months. During this period, I would like to be located at SSC, near or with the IT SIRT two to three days per week. I will conduct my research on a non-interference basis. My research will involve qualitative data collection using document analysis, two focus groups, and semi-structured, individual interviews as well as observation of the team during meetings, training events and operations.

IT SIRT member participation in the research must be voluntary. There is no obligation for them to participate and there can be no repercussions or consequences should someone choose not to do so. I will provide each member of the team a letter describing the research and emphasizing the voluntariness and asking them to contact me if they wish to participate. I will provide them the opportunity to participate. Once I have confirmed an individual's participation, I will ask them to individually read and sign the attached consent form prior to the commencement of the research re-emphasizing that their participation is completely voluntary. This will occur prior to the commencement of the research, and consent will also be confirmed before the interviews and the focus groups. If they request not to participate, then no data related to their role/position will be collected and I will not actively observe them as they work. They will also be reminded of the option to not participate prior to focus groups and the interviews. While the IT SIRT will be identified by name in the final documents or reports of this research, all of the team member information including quotes, responses, etc. obtained in the study will be treated as personal information protected and not disclosed unless authorized by the individual(s) concerned. As well, since the research results will be reviewed outside of the Government of Canada, they will be unclassified; any protected or classified information that may have been collected during the research will be properly handled and disposed of in accordance with your security policy.

The study will culminate in case report to support my doctoral dissertation that will be provided to my supervisor and thesis committee for review. Due to the size and format of this type of document, it is of limited benefit to the IT SIRT, SSC or other concerned parties. However,

upon committee approval of my thesis, I will provide you and the Manager of the IT SIRT with a summary of my research highlighting my findings.

I would appreciate your formal approval of the proposed research no later than (date). Thank you for considering this research initiative. Should you have any questions or concerns, please feel free to contact me at or my supervisor.

Sincerely,

Randy Purse
Doctoral Candidate
Faculty of Education
University of Ottawa

Appendix 4 – Management Letter of Approval

From: [Manager IT SIRT]

Sent: February-27-15 2:29 PM

To: Purse, Edward R.

Cc:

Subject: RE: Proposed PhD Research with IT SIRT

Hi Randy,

This is approved from my perspective.

There are some logistics that still needs to be looked at such as:

- Office space
- Parking
- Access to bldg and network, etc...

Let me know when you would like to start and what you require from our end.

Have a great weekend

Manager | Gestionnaire

IT Security Incident Recovery Team (IT-SIRT) | Équipe informatique de récupération d'incident de sécurité (EIISTI)

IT Security Operations | Opérations de sécurité de la TI

Shared Services Canada | Services partagés Canada

11 Laurier Street | 11 rue Laurier,

Gatineau QC, K1A 0S5

Government of Canada | Gouvernement du Canada\

Appendix 5 – Recruitment Text

(prospective participant’s name), I am conducting research to better understand collective learning, to include collective transformative learning, in authentic work teams such as the IT SIRT. The main research question is “In what ways and how is collective learning enacted in this authentic work team?” Under the supervision of Dr. Maurice Taylor from the Faculty of Education at the University of Ottawa, I will be conducting this research independently and not as a part of any Government, Shared Services Canada, Communications Security Establishment or IT SIRT requirement.

This correspondence is to ask if you are interested in being a participant in this research project. Your participation is completely voluntary. If you agree to participate, you will be asked to:

- Provide documentation related to the team’s operations, including team charter, organization charts, team directives, team incident and post-analysis reports, team training and learning documents, agenda and minutes, team performance measures, member self-assessments, and team artifacts (locally developed products and instructions).
- Allow observation of your activities in the workplace during various activities including team meetings and team operations. All observations will be on a non-interference basis, though I may ask questions about your ongoing work and activities.
- Participate in two focus groups of approximately 90 minutes duration with other team members. The focus groups will be about three months apart and I will be asked to respond to questions concerning the research topic and participate in group discussions. The focus groups will be digitally recorded and will be scheduled at a mutually agreeable time.

- Participate in one interview of no longer than 60 minutes during which I will provide answers to questions regarding the topic of research. This interview will be digitally recorded and will be scheduled at a mutually agreeable time.
- Read summaries of the focus group discussion and transcripts of my individual interview to ensure that the information is accurate. You will be asked to note any discrepancies and suggest any changes to make sure that the text reflects my meaning.

The information obtained from the above methods will only be used for the purposes of this study. While the IT SIRT will be identified by name in the final documents or reports of this research, the information you share will be protected. Names, identifying roles/positions, or other identifying personal information such as your personal record identifier (PRI) will be protected and will not be included in any publication without your written consent. I may use quotes or paraphrase statements in subsequent reports, publications or presentations. To ensure anonymity, a code or false name of your choice will be used in any written text resulting from the research including the case report, dissertation, publications and presentations. Only I will have access to the codes. While I will make every effort to protect your identity, given the collective nature and size of the team and the close working environment, protection of your identity from other team members or immediate management cannot be guaranteed as they have knowledge of specific team situations and events in which you have participated.

During the research period, text, digital recordings of interviews and other data collected will be kept in a secure manner. I will personally store the digital files on a password and firewall protected computer hard-drive only accessible to me. All paper transcripts will be stored in a secure location in my personal office space accessible only to me. Upon completion of the research, I will retain a copy of the digital and paper data, while the originals will be stored in a secure manner by Dr. Maurice Taylor at the University of Ottawa. Your superior(s), other government departments or agencies, or any university administrator will not have access to the data. The data will be kept for five years following completion of the project after which paper records will be shredded and electronic data and digital recordings will be permanently deleted.

All focus groups and interviews will be at mutually agreeable times during working hours and held in suitable locations that provide the required level of privacy. You can refuse to answer any questions or stop my participation in the interview or focus group if a question makes me uncomfortable. If you do not wish to be observed, you can inform me and I will ensure that there are no annotations pertaining to your work within my field notes or journal. If you decide to withdraw from the study, any information that you have provided will be destroyed and not used in the study. However, given that the focus group data are highly dependent on the overall group discussion, I may decide to use the data provided, but will nonetheless provide you with a rationale and discuss any potential concerns you may have. As your participation is voluntary, if you refuse to answer questions or withdraw from the study, there will be no penalty or judgement for doing so.

Your participation in this study is completely voluntary and that there is no pressure to participate and there will be no repercussions from either the researcher or management. However, I realize that there may be some social pressure associated with you participating or not participating in this study. If you have any concerns, I would be happy to discuss them with you.

The potential benefits of participating are that the result will increase the understanding of explicit and tacit activities related to the IT SIRT that can be used to inform and refine team practices, mediate management expectations, target collective and individual learning opportunities, and refine formal learning needs. Additionally, the research will contribute to an emerging area in the larger IT security/cyber security community and some of the findings may transfer to teams in similar contexts.

Ethical clearance for this research study was received from the University of Ottawa Research Ethics Board. Any questions about your rights as a research participant or the ethical conduct of the study may be addressed to Protocol Officer for Ethics in Research, 550 Cumberland Street, Room 154, Ottawa, Ontario, (613) 562-5387, ethics@uottawa.ca.

If you have any questions about your potential participation in this research project, you can contact me at my university email address or at my home phone number.

Thank you for considering your participation in this research project.

Appendix 6 - Consent Form

Title of Research Project:

Collective learning and Transformation: An Instrumental Case Study

Contact Information:

Principal Researcher - Randy Purse

Supervisor - Dr. Maurice Taylor

I, _____, am invited to participate in a doctoral thesis research project conducted by Randy Purse, the principal researcher, under the supervision of Dr. Maurice Taylor from the Faculty of Education at the University of Ottawa. The purpose of this instrumental case study is to understand collective learning, to include collective transformative learning, in authentic work teams such as the IT SIRT. The main research question is “In what ways and how is collective learning enacted in this authentic work team?”

I understand that this research is being conducted independently and not as a part of any Government, Shared Services Canada, Communications Security Establishment or IT SIRT requirement.

I understand that my participation is completely voluntary and the research activities will consist of:

- Documentation review wherein the principal researcher will read and collect data from team documents related to the research topic. Documents can include: team charter, organization charts, team directives, team incident and post-analysis reports, team training and learning documents, agenda and minutes, team performance measures, member self-assessments, and team artifacts (locally developed products and instructions).
- Observation of the team in the workplace during various activities including team meetings and team operations. All observations will be on a non-interference basis, though I understand that the principal researcher may have questions about my

ongoing work and activities. I have the option to answer such questions or may refuse to answer with no penalty for doing so. The principal researcher will also maintain field notes and a journal to record observations. I can request to see comments pertaining to me or my work at any time.

- Participating in two focus groups of approximately 90 minutes duration with other team members. The focus groups will be about three months apart and I will be asked to respond to questions concerning the research topic and participate in group discussions. The focus groups will be digitally recorded and have been scheduled for: _____ at _____ and _____ at _____.

- Participating in one interview of no longer than 60 minutes during which I will provide answers to questions regarding the topic of research. This interview will be digitally recorded and has been scheduled for: _____ at _____.

- Reading summaries of the focus group discussion and the transcript of my individual interview to ensure that the information is accurate. This will allow me to note any discrepancies and suggest any changes to make sure that the text reflects my meaning. The summaries and transcripts will be forwarded to me via secure, protected email at my workplace email address. I will have two weeks to review the documents forwarded and they can be sent back to the researcher at the email address indicated at the top of this form.

The information obtained from these activities will only be used for the purposes of this study. I understand that the IT SIRT will be identified by name in the final documents or reports of this research. However, I have received assurance from the researcher that the information I share will be protected. Names, identifying roles/positions, or other identifying personal information such as my personal record identifier (PRI) will be protected and will not be included in any publication without my written consent. The primary researcher may use quotes or paraphrase statements in subsequent reports, publications or presentations. To ensure anonymity, a code or

false name of my choice will be used in any written text resulting from the research including the case report, dissertation, publications and presentations. Only the researcher will have access to the codes. I realize, however, that while the principal researcher will make every effort to protect my identity, given the collective nature and size of the team and the close working environment, protection of my identity from other team members or immediate management cannot be guaranteed as they have knowledge of specific team situations and events in which I have participated.

During the research period, text, digital recordings of interviews and other data collected will be kept in a secure manner. The principal researcher will personally store the digital files on a password and firewall protected computer hard-drive only accessible to the principal researcher. All paper transcripts will be stored in a secure location in his personal office space accessible only to him. Upon completion of the research, the principal researcher will retain a copy of the digital and paper data, while the originals will be stored in a secure manner by the identified Supervisor at the University of Ottawa. My superior(s), other government departments or agencies, or any university administrator will not have access to the data. The data will be kept for five years following completion of the project after which paper records will be shredded and electronic data and digital recordings will be permanently deleted.

All focus groups and interviews will be at mutually agreeable times during working hours and held in suitable locations that provide the required level of privacy. I understand that I can refuse to answer any questions or stop my participation in the interview if a question makes me uncomfortable. If I do not wish to be observed, I will inform the principal researcher who will ensure that there are no annotations pertaining to my work within his field notes or journal. If I decide to withdraw from the study, any information that I have provided will be destroyed and not used in the study. However, given that the focus group data are highly dependent on the overall group discussion, the principal researcher may decide to use this data, but will nonetheless explain the rationale and discuss any potential concerns I may have. As my participation is voluntary, I understand that if I refuse to answer questions or withdraw from the study, there will be no penalty or judgement for doing so.

I understand that my participation in this study is completely voluntary and that there is no pressure to participate and there will be no repercussions from either the researcher or management.

The potential benefits of participating are that the result will increase the understanding of explicit and tacit activities related to the IT SIRT that can be used to inform and refine team practices, mediate management expectations, target collective and individual learning opportunities, and refine formal learning needs. Additionally, the research will contribute to an emerging area in the larger IT security/cyber security community and some of the findings may transfer to teams in similar contexts.

Ethical clearance for this research study was received from the University of Ottawa Research Ethics Board. Any questions about my rights as a research participant or the ethical conduct of the study may be addressed to Protocol Officer for Ethics in Research, 550 Cumberland Street, Room 154, Ottawa, Ontario, (613) 562-5387, ethics@uottawa.ca.

There are two copies of the consent form, one of which I may keep. If I have any questions about the conduct of the research project, I may contact either the principal researcher or Dr. Maurice Taylor.

Researcher's Signature

Date

Participant's Signature

Date

Would you like to receive information about the research when it is done? YES NO

Appendix 7 – Primary Document Sources

For the documents listed, they were either reviewed or analyzed. Reviewed means scanned or read to determine relevance. Analyzed documents were both read to identify any key information to the research questions and analyzed.

Review Summary

The review included all documents pertaining to team planning, strategy, structure, governance, learning and operations. Those documents that only underwent review were:

- references, training and user guides produced that did not have any SOC team involvement such as. vendor-based publications, training manuals, white papers, and technical reports.
- Client reports and detailed case information were not included in the analysis due to the sensitivity of the information and limited relevance to IT SIRT learning.
- Contact information due to the sensitivities related to contact name and position
- Email correspondence as it was too voluminous and risks were high relative to sensitivity of information and often disclosed personal identities/information.
- Team schedules were not seen as relevant to collective learning
- Inventory lists and publications with equipment details.
- Team forms without any relevant content such as checklists and sign-off sheets. Though these are considered team artefacts for the purposes of the study, they reveal modes of communication and exchange of information, but in themselves did not have any relevant information pertaining to collective learning.
- IT SIRT technical project documents (other than JIRA discussed in the case).
- SOPs were reviewed but not analyzed as they were issue specific.

Analysis Summary

The documents were manually analyzed and then analyzed with NVIVO 10. Analysis included the initial and subsequent categorization based on researcher developed categories. Text searches and queries were also carried out to identify frequencies and support cross-referencing.

The identified documents were analyzed. Using the original 10 categories, there were 218 observations/references related to IT SIRT activities. During coding there were some inconsistencies in categorization and coding of the documents due to the text and required interpretation.

General Findings

Numerous draft documents and changes to the organizational labels, titles, made it difficult to track. Ultimately all documents were ‘working documents’ in that there were no final approved documents. This demonstrates the evolution of the team from inception as well as the changes in how the team operates. In some cases there were multiple versions of with only minor refinements that did not have a bearing on the research questions and only the latest version was analyzed. For example, there were 6 versions of the IT Security Coordination Centre Service Catalogue created over the course of 8 months. There were cases such as the CONOP and service catalogues, where the version trail provides additional insight into the evolution of the IT SIRT and interrelationships. These were analyzed as a group and then as part of the larger team context. Many documents were reviewed, but only the documents below were analyzed. The only documents external to the SOC that were analyzed were those that directly relate to or communicate SOC/IT SIRT roles and responsibilities, interrelations or functions.

- Different perspectives identified in the versions.
- Names changes, differences in how the acronyms and functions are understood within the larger GC context depending on the author (IT SIRT responding to the 43 or the GC as a whole. Term use regarding skills of the team.)
- A majority of documents support expected team capability, work requirements, collaboration and interrelationships. Other than the distributed/shared nature of the documents themselves, there is limited evidence of collective learning contained within any single document. However, a view of the document intention and the evolution of the team over time is captured to some degree.

#	Name	Recorded Date	Status	Provenance	Relevance
	HR & Learning				
1.	ITSCC HR Strategy	February 22, 2013	Draft	IT SIRT on behalf of ITSCC/SOC	Identifies HR requirements, critical issues, requirements by role, certifications and learning and training.
2.	IT-SIRT_HR_Strategy	April 24, 2013	Draft	IT SIRT	Identifies HR requirements, critical issues, requirements by role, certifications and learning and training for the IT SIRT. Created after the ITSCC HR Strategy and aligned with the Service Catalogue.
3.	ITSCC_Skills_Inventory	February 12, 2013	Draft	ITSCC/SOC	Identify skills/team matrix within the SOC (similar to requirements by role in ITSCC HR strategy)
4.	ITSCC_Orientation	February 18, 2013	Draft	ITSCC/SOC	Partially completed document describing ITSCC indoctrination process for new members. Initial learning artefact which discusses training and highlights important tools/ connections/contacts. Also includes required reading.
5.	IT SIRT LNA Report_Nov12 (final)	January 30, 2013	Final	ITSLC	Identifies the formal learning needs of the IT SIRT at the time of inception.

#	Name	Recorded Date	Status	Provenance	Relevance
6.	IT SIRT Learning and Development Guide Ver 9 (Apr 14)	November 19, 2014	Final	ITSLC	Provides guidance to the IT SIRT manager and members on the implementation of the CSE created IT SIRT learning and development program.
	Service Catalogues				
7.	SOC Services v3	May 30, 2013	Draft	ITSCC/SOC	Partially completed table identifying SOC services and interrelationships with partners.
8.	SSC SOC Service Catalogue v1 2013-05-27	May 27, 2013,	Draft	ITSCC/SOC	Provides information on the services for partners/other government departments delivered by the SOC. Uses different categories than the IT SIRT service catalogue that represent SOC holistically. Supports support comparison of organizationally defined responsibilities relative to what services have actually been delivered.
9.	IT-SIRT_Service-Catalog	April 07, 2014	Draft	IT SIRT	Provides information on the IT Security services for partners/other government departments delivered by the IT SIRT based on categories to support reactive, proactive and quality management role. Supports support comparison of organizationally defined responsibilities relative to what services have actually been delivered.

#	Name	Recorded Date	Status	Provenance	Relevance
	Direction				
10.	functional_direction_en_v5	June 26, 2015	Final	SSC Business Transformation Committee	Organizational direction to SSC during transformation initiatives. Very general with no specific units identified. Provides context and high level organizational requirements for Cyber and IT security.
11.	SM-SM-TAD-INIv10-mlb	July 17, 2015	Draft	ITSCC/SOC	Technical Architecture Document in support of SOC and IT SIRT functions/systems
	CONOPS				
12.	Stakeholders	March 21, 2013	Draft	IT SIRT	Partial document describing, in general terms the ITSCC teams and very abbreviated responsibilities/relationships with partners/other government departments
13.	ITSCC_Strategy-March42013	March 04, 2013	Draft	ITSCC Working Group	Describe, in more general terms, ITSCC roles and responsibilities and team interoperability. Situates the ITSCC within the larger GC. Supports support comparison of organizationally defined responsibilities relative to what services have actually been delivered. Tone is particularly interesting when discussing the team interoperability.

#	Name	Recorded Date	Status	Provenance	Relevance
14.	SSC ITSCC_Roles and Responsibilities0206 2013	March 04, 2013	Draft	IT SIRT Mgr	Describe, in more general terms, ITSCC roles and responsibilities and team interoperability. Situates the ITSCC within the larger GC. Supports support comparison of organizationally defined responsibilities relative to what services have actually been delivered. Minor, subtle difference noted.
15.	SSC_SOC_ConOp_ 1 1	December 27, 2013	Draft	ITSCC/SOC	Describes SOC roles and responsibilities and team interoperability. Situates the SOC within SSC processes. The mark up demonstrates changes from previous versions and includes comments regarding IT SIRT role. Supports support comparison of organizationally defined responsibilities relative to what services have actually been delivered.
16.	IT_SIRT-FIPC_GC- CIRT_ConOp_1- DRAFT	November 22, 2013	Draft	ITSCC/SOC	Describes IT SIRT, FIPC and GC CIRT roles and responsibilities and team interoperability. Situates the them within SSC processes. The mark up demonstrates changes from previous versions and includes comments regarding IT SIRT role Supports support comparison of organizationally defined responsibilities relative to what services have actually been delivered.

#	Name	Recorded Date	Status	Provenance	Relevance
17.	ITSCC Technical Advisory Board	February 18, 2013	Draft	IT SIRT	An employee produced document that describes a peer-based technical advisory process provides a tangible method for technical resources to meet, have their ideas heard, advise management and contribute to ongoing issues. It also provides management a method to request technical advice that leverages the collective knowledge of the ITSCC. Not aware of any examples and no instances observed. Instead based on the range information, this appears to be more ad hoc now.
18.	SSC_IT_SIRT revised draft (Charter)	November 12, 2013	Draft	IT SIRT	Provides temporal description of IT SIRT roles and responsibilities including reactive, proactive and quality management services. Created before the service catalogue and before the introduction of the SOC concept (formerly ITSCC).
	Operational Plans				
19.	CommunicationsV2	February 15, 2013	Draft	ITSCC/SOC	Partially developed document. Describes SOC communications processes during incident response and various types of correspondence (RFIs, SITREPs). Tone and language appears to reflect SOC SOP. Limited relevance to IT SIRT in view of role in process.

#	Name	Recorded Date	Status	Provenance	Relevance
20.	ITSCC Security Incident Management Plan Draft ver 1a	March 21, 2013	Draft	ITSCC/SOC	Local ITSCC plan for incident coordination/response within the SSC ITSCC. Provides context at the time and high-level explanation of general process, but no IT SIRT specifics. Superseded by GC Cyber Security Event Management Plan.
	Projects				
21.	IT-SIRT_Project-Plan_2013_14	May 29, 2013	Draft	IT SIRT	An interim document identifying acquisition and development plan to for four technical capability environments to support reactive, proactive and quality management mandate of the IT SIRT capability. Aligned within the Service Catalogue.
22.	SITS_(JIRA)_PoCv3	June 04, 2014	Draft	IT SIRT	JIRA-Confluence Proof of Concept. Internally produced within the IT SIRT but intended as Security Incident Tracking System (SITS) for SOC. Identifies information sharing issues.
23.	SSC_Con_Ops_JIRA-Confl-Basic_V1.15	March 04, 2014	Draft	IT SIRT	Provides the context in which the GC CIRT, IT SIRT and FIPC will collaborate and coordinate work and workflow though JIRA/Confluence. Note that this was only implemented within the IT SIRT.

#	Name	Recorded Date	Status	Provenance	Relevance
	Team Meetings				
24.	Team Weekly Meeting Agenda	22 Jan – 20 May 2014	Final	IT SIRT	8 in total/largely exchange of case and technical information
25.	Team Weekly Meeting Records	22 Jan – 5 Feb 2014	Final	IT SIRT	5 in total largely exchange of case and technical information

Appendix 8 – Observation Guide

Within this research, observation is critical to providing evidence of undocumented collective learning and change. Understanding that the team will have been forming for over a year, the researcher will be primarily looking for indicators of collective learning and change and, potentially, transformative change that may be reflected in team behaviours. Three main categories of observation will be:

- Verbal behaviours and interactions within and across team boundaries to include:
 - Actors,
 - Context (environment, situation), and
 - Characteristics (type of interaction and distinguishing features).
- Physical interactions with others to include:
 - Actors,
 - Context (environment, situation), and
 - Characteristics (type of interaction and distinguishing features).
- Physical interactions with materials/technology to include:
 - Actors,
 - Material/technology involved,
 - Context (environment, situation), and
 - Characteristics (type of interaction and distinguishing features).

Observation Checklist:

- Arrange period of observation with the manager IT SIRT.
- Ensure the Manager IT SIRT has communicated the researcher's presence to the team and to others that work peripherally to the IT SIRT.
- Arrange for initial consultation with the team (e.g. at a team meeting) to discuss:
 - Research objectives
 - Details of the consent form
 - Establish consent
 - Solicit team ideas and considerations about observation (e.g. locations, times)
- Select the site(s), time(s) of day, and date(s), for observation.
- Observe team in various activities.
- Confirm remarkable team behaviours with team members or through other sources.

Observation Log:

The researcher's journal will be used to note observations throughout the observation period.

They will be transcribed to a formal observation log using the format below each evening.

Date/Time	Event/ Activity	Key Actor(s)	Interactions Observed	Characteristics of Interactions	Observed Outcome(s)	Observer comments
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Appendix 9 – Focus Group Guide

Before the Focus Group

- Select the group (key stakeholders, appropriate number 6-8).
- Identify any potential confidentiality/privacy issues related to the data.
- Prepare Agenda/Questions for distribution – refer to document analysis and observation log to identify areas requiring further exploration.
- Identify location, timings, and other essential logistics (e.g. refreshments).
- Confirm participant attendance at least one day before interview.
- Set up the room for optimum group interaction.

Initiating the Focus Group

- Provide an opportunity for introductions (opener) and establish rapport.
- Introduce the assisting colleague and his/her role, explaining that he/she has signed a confidentiality agreement.
- State the purpose and agenda. The main research question is “In what ways is collective learning enacted in this authentic work team?”
- Review the consent form details, remind them that participation is completely voluntary.
- Confirm their agreement to participate.
- Explain that responses will be recorded and how the data will be handled emphasizing confidentiality.
- Establish ground rules for the discussion (one person at a time, respectful behaviour, etc.)
- Be sure to paraphrase as required to ensure that you have captured the group’s impressions.

Focus Group Questions

Initial Focus Group: This session is to validate information from the initial document analysis and identify the work and learning context of the team.

1. What is the team’s work context?
 - Who does the team work with?
 - What constraints or limitations do you work under?
 - How is information shared within and outside the team?

- What external influences are there on the team and how do they influence the team?
- 2. Beyond the specifics of related to mandated activities, what guides the team's work?
 - During routine daily operations?
 - During recovery operations?
- 3. How is information shared within the team and external to the team?
- 4. What norms or practices within the team have evolved since inception?
- 5. What have been the key learning activities of the team:
 - Related to the work?
 - Related to working as a team?
 - Related to working within the organization?
- 6. What other points or comments regarding this subject would you like to address?

Final focus group: This session is intended to shed light on any observations of relevance and specifically address the main research question and sub-questions.

- 7. What difficult situations or dilemmas has the team faced since inception?
- 8. How did the team manage these difficult situations or dilemmas?
 - What triggered a team response?
 - What discussions or activities occurred?
 - Were there any new processes, products or procedures introduced as a result of this situation?
 - Was everyone engaged?
 - How was a decision arrived at?
- 9. What collective learning has occurred?
- 10. The team's meaning perspective or frame of reference can be described as a paradigm from which you view your work and through which you interpret your world. Has there been a change in the team's meaning perspective?
- 11. Has the team has 'transformed' in any way?
- 12. What other points or comments regarding this subject would you like to address?

Conclusion of Each Focus Group

- Summarize the main points from focus group.
- Confirm summary is accurate.
- Re-state what will happen with the focus group information.

- Re-emphasize the confidentiality of the group work.
- Provide contact information.
- Ask if there any final questions or concerns.
- Thank participants for their time and information

Appendix 10 – Interview Guide

Preparation

- Ensure the interview room is scheduled and available.
- Ensure that the interview guide is available.
- Ensure note-taking materials are ready and any recording equipment is operational.
- Ensure appropriate environment is established (comfort, sufficient privacy).

Conducting the Interview

- Introduce self and thank them for their participation.
- Explain purpose of interview relative to the focus groups, provide background, tell them what you will be doing with the data.
- Review their signed consent form or discuss any concerns regarding privacy/confidentiality.
- Remind them that participation is completely voluntary and confirm their agreement to participate.
- Indicate that the interview will be recorded and that notes will be taken throughout.
- Ask them if they have any questions or concerns prior to proceeding with the interview.

Note: all of the above should be established and provided when making initial arrangements for the interview.

Interview Questions

Main research question – “In what ways is collective learning enacted in this authentic work team?”

13. What are your general feelings about how the team works together?
 14. What have you personally learned that contributes to your role on the team?
 15. How does the team work differently from when you first arrived?
 16. What difficult situations or dilemmas did the team face?
 17. How did the team manage these difficult situations or dilemmas?
- What triggered a team response?
 - What discussions or activities occurred?

- Were there any new processes, products or procedures introduced as a result of this situation?
- Was everyone engaged?
- How was a decision arrived at?
- 18. What was your participation in these activities?
- 19. What collective learning do you think occurred?
- 20. Do you believe that the team has 'transformed' in any way? If so, how?
- 21. What other points or comments regarding this subject would you like to address?

Conclusion

- Summarize points from the interview.
- Confirm summary is accurate.
- Re-state what will happen with the interview information.
- Provide your contact information.
- Thank participant for their time and information.