How Shared Leadership Improves Team Performance:
Exploring the Role of Team Knowledge and Team Learning

by

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Abstract

How Shared Leadership improves Team Performance: Exploring the Role of Team Knowledge and Team Learning

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Team-structured work is prevalent in organizations and the effectiveness of teams greatly depends on the leadership enacted. Ample studies have supported the utility of a more fluid team structure where leadership is the property of the team and members lead one another to achieve goals. However, the mediating team processes and emergent states that make shared leadership effective are largely unknown. This study aims to answer questions regarding how shared leadership enhances team performance by taking a longitudinal approach to examine two interconnected mediators: team knowledge structure and team learning. Characteristics of the team such as size and member heterogeneity are also explored as moderating factors in this relationship. Results and practical implications are discussed.
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Introduction

Lori Goler, Facebook’s SVP of people, said the following during an interview when asked about her biggest lesson learned about leadership:

“One thing that we really believe in is leadership at all levels – that’s something that not every organization embraces. We have found that your leadership, your followership, is not necessarily defined just by the org chart. There are people in every different role around the world, at every different level, who have been able to provide leadership in so many ways at Facebook. That’s been really rewarding to see happen. (McGregor, 2015)”

This “leadership at all levels” she heartedly embraced signals a new approach in organizing and structuring team work, and has received increased attention in organizational practices as well as empirical research. Various labels have been given to describe this new form of leadership: collective leadership (Contractor, DeChurch, Carson, Carter & Keegan, 2012; Hiller, Day & Vance, 2006), distributive leadership (Brown & Gioia, 2002; Bolden, 2011), network leadership (Graen & Graen, 2006; Schreiber & Carley, 2008), and more commonly used, shared leadership (Pearce & Conger, 2003). Living up to its hype, empirical
research on shared leadership has supported its value in team functioning, and has demonstrated its unarguable connection to enhanced team outcomes such as team performance, commitment, job satisfaction, collective efficacy, and team cohesion (Nicolaides, LaPort, Chen, Tomassetti, Weis, Zaccaro & Cortina, 2014; Pearce & Sims, 2002; Wang, Waldman & Zhang, 2014).

Team-based organizational structure has largely replaced individual-based work structure since the mid-1980s in response to the rapid economic growth and need for agile adaptation to the changing market (Kozlowski & Bell, 2001; Lawler, Mohrman & Ledford, 1995). Based on the definition proposed by Katzenbach and Smith (1993), a team is consisted of a group of people who are interdependent and work together to reach agreed-upon goals. Over the years, teams have become the fundamental building blocks for most organizations to carry out critical tasks and functions. An organization’s ability to learn and adapt largely depends on the learning and adaptability of its teams (Edmondson, 2002; Senge, 2006), whereas the effectiveness of a team largely depends on the leadership enacted (Wang, Waldman & Zhang, 2014).

Shared leadership is a dynamic team process that enables the team to lead itself as members voluntarily take on leadership roles and responsibilities (Pearce & Conger, 2003). Recognizing shared leadership structure in teams is an exciting leap in the leadership arena since it shifts the focus from the individual leader (i.e.,
his/her traits, skills, behaviors) to the dynamic interaction processes within the team (Contractor et al., 2012). Leadership does not necessarily reside in one individual, instead, leadership roles could be fulfilled by the collective act of the team to accomplish goals (Heifetz, 1994). Traditional vertical leadership theories that focus solely on the individual "leader" are missing half of the picture when examining leadership issues. Therefore, to fully understand the leadership process, the social systems in which it is embedded in cannot be neglected (Dachler, 1984).

Ample studies have been conducted to understand the utility of shared leadership. Three recent meta-analysis studies nicely summarized these findings and generated sound evidence that shared leadership indeed brings added value to team performance (Wang, Waldman & Zhang, 2014, D’Innocenzo et al., 2014, Nicolaides et al., 2014). However, we are yet to understand the underlying mechanisms that enable shared leadership to enhance team effectiveness. Looking into the interplay of team processes and emergent states may point us to an answer.

Leaders greatly influence learning within the team (Edmondson, 1999; Hult, Hurley, Guinipero & Nichols, 2000; Lovelace, Shapiro & Weingart, 2001). Acting as a role model, leaders guide members in making sense of experiences, reframing knowledge, and applying new knowledge to achieve goals (Edmondson, 2003). As a result, team learning drives team performance, and this connection has been empirically supported in a variety of settings such as in product development teams.
(Sarin & McDermott, 2003), research and development teams (Bain, Mann & Pirola-Merlo, 2001), and multinational organizations (Zellmer-Bruhn & Gibson, 2006). The cognitive structures and mental representations embedded within a team act as a road map, guiding members in sense-making and way-finding. These team knowledge structures develop through member interaction (Kozlowski & Ilgen, 2006) and contribute to team performance (He, Butler & King, 2007). Moreover, team learning and the development of team knowledge structures are interconnected and positively affect one another (Guchait & Hamilton, 2013; Van, Gijselaers, Segers, Woltjer & Kirschner, 2011). Therefore, it is reasonable to propose that team learning and team knowledge structures are the more prominent mediating mechanisms linking shared leadership to team performance, and it is beneficial to study the two simultaneously in one model, which is the approach in the current study.

How shared leadership improves team performance is still largely a mystery. Without such knowledge, it is difficult to truly understand how shared leadership works in a team environment to bring out the optimum outcomes. This also proposes challenges in developing trainings or interventions to enhance team performance under such leadership structures. In an effort to explore this unanswered question, this current research takes a longitudinal approach and examines the interconnected roles of team learning and team knowledge structures.
in the relationship between shared leadership and team effectiveness. Characteristics of the team such as size and member heterogeneity also influence team dynamics and thus were explored as moderating factors in this relationship.
Literature Review

Shared Leadership

In the past century, vertical leadership theories have dominated the field (Bass & Stogdill, 1990; Lowe, Kroeck & Sivasubramaniam, 1996). These traditional forms of leadership theories are based on the assumption that authority and power reside in one individual, and that individual exerts leadership roles, power, and influence (Yuki, 1981). As a result, leadership was studied in a unidirectional relationship between the leader and the followers (Fiedler & Chemers, 1967). At the turn of the century, a new conceptualization of leadership began to emerge under the most common name of “shared leadership”. Different from traditional hierarchical forms of leadership, shared leadership proposes that responsibility and influence are voluntarily distributed within the team through dynamic interactions (Pearce & Conger, 2003; Nicolaides et al., 2014). Instead of following the lead of one central figure, members rely on each other for influence and guidance, and lead one another towards the accomplishment of collective goals (Wang et al., 2014). Leadership is a team-level process and it occurs in multiple directions such that members frequently engage in lateral or peer influence as well as bi-directional communication (Pearce & Conger, 2003). Any individual could
emerge as the leader given the appropriate time and situation, and perform leadership tasks and roles (Bligh, Pearce & Kohles, 2006; D’Innocenzo et al., 2014). When faced with change or challenges, the team takes a collaborative approach, and is able to react with greater flexible and adaptivity (Yukl, 2009). In studies comparing shared leadership to traditional hierarchical leadership, teams with a shared leadership structure exhibited superior performance, and this relationship held in both face-to-face teams and virtual settings (Hoch & Kozlowski, 2014). In addition, shared leadership structure is especially advantageous when the team engages in knowledge work, deals with complex or changing situations, and requires multiple team members’ expertise to solve problems (Bligh, Pearce & Kohles, 2006).

**Team Processes and Emergent States**

Teams allow individuals with different skills and expertise to work collaboratively and leverage on all members’ skillsets to accomplish tasks that would be too challenging or time-consuming for any individual alone. The interaction among members is crucial to the success of the team and it greatly affects how tasks are carried out. Team process describes how work is being done, and it leads to the achievement of collective goals and outcomes through the interaction among team members and tasks (Marks, Mathieu & Zacarro, 2001).
Another concept closely related to processes in team literature is emergent states. Emergent states are dynamic properties of a team that describe the teams’ “cognitive, motivational, and affective states” and it “varies as a function of team context, inputs, processes, and outcomes” (p.257) (Marks, Mathieu, & Zacarro, 2001). Different from team processes, emergent states do not describe team interaction but are instead the products of such interactions. For example, team cohesion is an emergent state while coordination is a team process due to its interactive nature. Emergent states are flexible and can change in a short period of time as they are dependent upon team processes and the environment.

In the traditional input-process-outcome (I-P-O) model, team processes have been extensively studied as the mediating mechanism connecting team characteristics to team outcomes (Marks, Mathieu, & Zacarro, 2001). To address the increased complexity and dynamic in teams, researchers have moved beyond the classic I-P-O model and proposed the IMOI (input-mediator-output-input) model. The new model broadens what goes into the middle linkage (Mediator) to include both team processes and emergent states (Ilgen, Hollenbeck, Johnson, & Jundt, 2005). In line with this model, one of the objectives of the current research is to uncover the black box (Mediators) connecting shared leadership (Input) and team effectiveness (Output) by specifically examining the process of team learning...
and the emergent state of team knowledge structure as parallel mediating mechanisms.

**Team Learning**

Team learning is a process through which members interact to share thoughts, reflect upon feedback, take actions, and create new knowledge that facilitates collective goal achievement (Argote, Gruenfeld, & Naquin, 1999; Argyris, & Schon, 1978; Edmondson, 1999; Edmondson, 2002). It is an iterative process of continuous reflection and modification of actions that occur in both the transition and action phases of team performance episodes (Edmondson, 2002; Marks et al., 2001). Gibson and Vermeulen (2003) defined team learning as “a cycle of experimentation, reflective communication, and codification” (p.48), through which teams identify areas of improvement, come up with mutually agreed-upon solutions, and take explicitly-stated actions to implement those solutions. Consistent with this conceptualization, Edmondson (2002) distinguished between behaviors that spark new insights (i.e., reflection) and behaviors that incorporate those insights to bring out changes or improvements (i.e., action). As a team process, a wide range of activities are encompassed under team learning. For instance, typical behaviors during reflection include sharing information and knowledge, seeking feedback, and discussing problems. Typical behavioral
markers during action include implementing changes or decisions, transferring new knowledge, and finalizing a plan. Both components, reflection and action, are equally important and should both be present for effective team learning to occur.

Like any team processes, another key component of team learning is member interaction (Crossan, Lane, & White, 1999; Kleinman, Siegel, & Eckstein, 2002). Reflection and action need to happen at the team level as a collective process for effective team learning to occur. A mutual understanding of the situation and actionable solutions can be reached through frequent interactions such as communication, constructive debates, reflective discussions, and collaboration. Once on the same page, new knowledge or processes of carrying out tasks can be created and shared across the team, and team performance can be improved through cycles of experimentation and reflection (Edmondson, 2002; Gibson & Vermeulen, 2003). Furthermore, team learning equips the team with an adaptive advantage by allowing the team to detect improvement opportunities, take actions, and quickly adapt to novel situations (Gibson & Vermeulen, 2003).

Team Cognition and Team Mental Models

Team cognition is commonly defined as team-level cognitive structures and activities (Cooke, Gorman, & Rowe, 2009). It encompasses the emergent cognitive states as well as the cognitive processes within the team (Cooke, Salas, Kiekel, &
Abundant research in this area has demonstrated team cognition’s positive effect on various team and organizational-level affective, behavioral and cognitive outcomes (Akgun et al., 2005; Chou, Wang, Wang, Huang, & Cheng, 2008; Huang 2009; Palazzolo, 2005). A related construct that falls under team cognition is team mental models. Mental models are networks of knowledge and association individuals form to understand and make sense of the situation (Langan-Fox, Code, & Langfield-Smith, 2000). Basically, mental models are cognitive heuristics to make our lives easier. When in a new situation, we learn about the environment and the people involved, figure out the rules and norms, and develop a repertoire of knowledge of the situation to guide our actions. When later placed in similar situations, the previous mental model automatically activates and immediately allows us to understand what’s going on and what to do next.

Team mental models are members’ shared mental representation of anything (e.g., people, situation, relationships, actions, etc.) related to team functioning (Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995; Cannon-Bowers & Salas, 2001; Klimoski & Mohammed, 1994; Mohammed, Klimoski, & Rentsch, 2000). These mental models are relatively stable emergent states developed through team processes and dynamic member interactions, and are products of merging and synthesizing people’s individual knowledge structures related to the team. Team
mental models are usually evaluated by two criteria: accuracy and similarity. A good team mental model meets both criteria: (1) the content of the mental model is highly accurate and (2) there is a high percentage of overlap between the mental models individual members hold (Marks et al., 2002). This enables members to effectively understand and anticipate others’ needs and actions, coordinate and synthesize work, and quickly adjust to VUCA (volatile, uncertain, complex, and ambiguous) environments (Cannon-Bowers et al., 1995; Cannon-Bowers & Salas, 1998; DeChurch & Mesmer-Magnus, 2010).

Ample empirical studies have consistently demonstrated that team mental models are fundamental to effective team functioning, such that highly effective teams usually establish a sound team mental model, whereas a lack of team mental model is often associated with failures or incidents (Mohammed, Ferzandi, & Hamilton, 2010). For instance, in a study using simulated flight mission games, Mathieu and colleagues (2000) found that mental model convergence predicted the quality of team processes and mission performance. Therefore, it is desirable for teams to create and maintain shared mental models, as they enable a common understanding that accelerates strategy development, implementation, coordination, and decision-making within the team (Baker, Prince, Shrestha, Oser, & Salas, 1993; Cannon-Bowers et al., 1993; Marks et al., 2000).
The field has widely accepted the multifaceted nature of team mental models. At any point in time, the team may share multiple mental models focusing on different aspects of the team (Klimoski & Mohammed, 1994; Levesque, Wilson, & Wholey, 2001). An earlier and most widely cited conceptualization by Cannon-Bowers and colleagues (1993) differentiated four types of mental models: technology, task, team interaction, and team. The technology mental model concerns knowledge of the equipment, operating systems, and technology. It is the most stable as technology tends not to change much. Task mental model involves shared understandings of the task components, procedures, goals, and strategies. It is especially important in times of uncertainty and change. Team interaction mental model provides information on members’ interaction patterns, communication, shared values, and interpersonal relationships. And lastly, team mental model contains team-specific knowledge of teammates, such as each members’ skills and expertise, preferences, behavioral tendencies, and attitudes. Later on, these four types evolved into two broad categories of mental models, one focusing on team-related aspects (including team interaction and team) and the other focusing on task-related aspects (including technology and task) (Mathieu et al., 2000). Through the evolvement in team cognition research, the conceptualization of team mental models further broadened into a variety of team knowledge structures.
Team Knowledge Structure

Team knowledge is a higher-level structure that represents knowledge within a team. This knowledge can be of members, facts, strategies, and procedurals -- the “who, what, when, where, how” related to the functioning of the team (Cooke, Salas, Cannon-Bowers, & Stout, 2000; Mohammed, Ferzandi, & Hamilton, 2010; Wildman, Thayer, Pavlas, Salas, Stewart, & Howse, 2012). These higher-level knowledge structures are developed through an interactive process of synthesizing individual cognitions and creating new knowledge shared among team members (Kozlowski & Ilgen, 2006). They are the team’s cognitive foundation that contribute to team performance (He, Butler, & King, 2007; Kozlowski & Ilgen, 2006).

As the knowledge representation of the team, like team mental models, team knowledge can be classified into different dimensions based on the area of knowledge it addresses. Wildman and colleagues (2012) conducted an extensive review on team knowledge studies and literature, and proposed a framework to provide a holistic view of this construct. Their framework identified four types of team knowledge content: task related knowledge, team related knowledge, process related knowledge, and goal related knowledge, which will be further elaborated in later sections.
Team cognition, team knowledge, and team mental models are three seemingly distinct but highly interrelated and similar constructs. Although slightly different in conceptualization, most studies have treated and measured team cognition identically with team knowledge; therefore, the current paper will treat the two terms interchangeably. The majority of studies on team mental models focus on two areas of team functioning: task-related and team-related (Mohammed, Ferzandi, & Hamilton, 2010). However, when viewed through a multidimensional lens, mental models can also be formed on other aspects of the team such as the goals, strategic vision, or external environment the team operates in. Therefore, team mental models and team knowledge can both be defined as the knowledge structure of some sort of areas related to the team. In fact, these two concepts are so interrelated that they are sometimes used to define each other. For instance, He, Butler and King (2007) defined team cognition as “the mental models collectively held by a group of individuals that enable them to accomplish tasks by acting as a coordinated unit. (p. 262)” Other scholars have also pointed out the conceptual similarity among these constructs, that they are all “team-level cognitive systems that encode, store, retrieve, and communicate knowledge (p. 278)” (Edmondson, Dillon, Roloff, 2008), and essentially they all “examine different ways to understand the distribution, structure, and interactive manipulation of knowledge within a team” (p. 278) (Wildman et al., 2014).
The conceptual distinction among team cognitive concepts is still vague in the field, and a clear definition of each is beyond the scope of the current study. In this study, the author will adapt the newer and broader conceptualization of team mental models such that team knowledge structures and team mental models will be considered identical. In particular, the team knowledge model from Wildman and colleagues (2012) that represents team knowledge structures in four areas: task-related, team-related, process-related, and goal-related (figure 1) is used as the guiding framework for team knowledge structures.

Task related

Task-related knowledge structures involve the team’s mutual understanding of the task itself, as well as the actions, procedures, resources, and strategies involved to successfully carry out the task. It enables efficient coordination and communication to complete taskwork. Developing a common understanding of the tasks is especially critical for projects that are complex, time sensitive, involve multiple people or units working together interdependently, or have barriers to communication (Mathieu et al., 2000).

Team related (TMS)

Team-related knowledge structures refer to the mental representation of each team member and the team as a whole (Wildman et al., 2012). To effectively
carry out tasks, members need to know who knows what, who can do what, and who has access to what resources. All of that knowledge needs to be organized in a way that is accessible to all team members. This has historically been captured as the construct of transactive memory systems (TMS).

A sound TMS can lead to better team performance (Liang, Moreland, & Argote, 1995; Stasser, Stewart, & Wittenbaum, 1995). Knowing exactly whom to turn to when specific expertise are in need, members can take swift actions and avoid process loss in case of consulting the wrong individual. This also facilitates team knowledge specialization in that individuals can devote time to improve own specialized skills, knowing that other skills and knowledge are covered by other teammates. In a lab study, Stasser and colleagues (1995) found that when members explicitly recognized each other’s’ skills and expertise through a group discussion, their task performance improved. The shared knowledge of what each team member can do also facilitated teams to more efficiently assemble transistor radios (Moreland & Myaskovsky, 2000). Due to the nature of the TMS, it may not add as much value to teams working on homogenous tasks, but is critical to teams that require a diverse area of skills and expertise from members.

Process related (teamwork)

Process-related knowledge structures encompass a broad range of interrelated behaviors (e.g. communication, cooperation, coordination) that are
based in interaction and facilitate task accomplishment (Dickinson & McIntyre, 1997). Shaped by one’s previous teamwork experience, people hold individual mental models on how members should work together within a team (Eby et al., 1999). At the team level, members develop a teamwork mental model that reflects their shared expectations, beliefs and perceptions on teamwork-related behaviors and norms, which subsequently affects team performance. For instance, Mathieu and colleagues (2000) found that teamwork mental model sharedness directly affected performance and higher levels of sharedness is more beneficial.

Goal related

Goal-related knowledge structures is defined as the team’s agreement and shared understanding on the team’s strategic goals, mission, and priorities (Wildman et al., 2012). It is most often studied in top management teams (TMT) and operationalized as strategic consensus, defined as the shared understanding of strategic priorities among managers at different levels of the organization (Kellermanns et al., 2005). Studies show that strategic consensus can be enhanced by frequent and open communication (Rapert, Velliquette, & Garretson, 2002). With the increase in work complexity, especially in the knowledge work sector, teams are moving towards self-management with much more autonomy and decision-making power. They function much like a tiny organization with an overarching team strategy or mission and each member working collaboratively
towards the shared goals. Therefore, although the concept of strategic consensus initiated in the TMT, its application and implications can be generalized to teams in general.

Having a strategic consensus allows members the flexibility and independence of individual work while at the same time ensures alignment towards the team’s shared goals (Amason, 1996). Since strategic consensus is largely studied in the business field, there is accumulated evidence supporting its link with various organizational bottom-line outcomes such as net operating income, gross revenues, and marketing performance (Rapert, Velliquette, & Garretson, 2002).

**Team Knowledge Structures**

- Task related
- Team related
- Process related
- Goal related

*Figure 1. Organizing Framework of Team Knowledge adapted from Wildman et al., (2012)*
Team Characteristics

A variety of team’s compositional attributes come into play and jointly shape the functioning and performance of the team (Campion, Papper, & Medsker, 1996). Some factors are easily noticeable at the surface level, such as size and gender composition of the team; while some are at the deeper level and less visible, such as value diversity and cultural orientations within the team (Sosik & Jung, 2002). Regardless, the interplay between team characteristics and team processes, emergent states, and outcomes is not always straightforward, and more often depends on the question at hand. Team size, for instance, could affect team outcomes in either direction based on the situation. Larger teams can be beneficial in that it holds more resources and capabilities (Eisenhardt & Schoonhoven, 1990), whereas smaller teams tend to be more cohesive and experience higher quality communications (Haleblian & Finkelstein, 1993). Diversity, another commonly studied team characteristic, also shows two sides. Studies indicating diversity is bad for teams argue that heterogeneity leads to conflicts and negatively affects team interaction and work relations (Elron, 1997; Pfeffer, 1985). On the other hand, team diversity has demonstrated positive effect on innovation and team creativity, greatly improving team performance (Hülsheger, Anderson, & Salgado, 2009). Watson and colleagues (1993) further suggested a curvilinear relationship between racial diversity and team interaction process over time. Their study found that
although racially homogenous teams outperformed racially diverse teams in the
tabital stages of team formation, this difference decreased over time and soon
became insignificant. Therefore, to fully understand team-level phenomenon, it is
recommended to take team characteristics into consideration.
Development of Hypotheses

Proposed Model

The goal of the current study is to unlock the black box that links shared leadership to effective team performance by answering the question “why and how does shared leadership enhance team effectiveness?” In particular, this study examines team knowledge and team learning as parallel mediating mechanisms in the relationship between shared leadership and team effectiveness, and also looks at team characteristics as moderating factors. At different points in time, teams undergo different stages and direct resources to different processes and activities (Kozlowski, Watola, Jensen, Kim, & Botero, 2009). Time plays a major role in team functioning. Using a longitudinal study design, this research enables a dynamic examination of how shared leadership, team learning, and team shared knowledge evolve and interact through different points in time, allowing a more realistic analysis of the relationship. See figure 2 for an illustration of the proposed model.
In addition to leadership, one critical factor that leads to high-performing teams is team learning (Huang, 2013). Leadership characteristics and behaviors greatly affect the amount and quality of team learning that take place (Edmondson, 1999; Edmondson, Dilon, & Roloff, 2008). In a study of fifty-two new product development teams, results show that a significant amount of variance in team learning can be attributed to the team leader (Sarin & McDermott, 2003). In particular, leaders who practice a participatory leadership style and engage members in decision-making processes promote a greater amount of learning and knowledge application within the team.

Traditionally, team learning has been studied in the context of hierarchical leadership. Researchers have realized the limitations and are calling for research that looks at how team learning emerges and evolves under the shared influence from multiple leaders (Yukl, 2009). When looking at shared leadership and team
learning together in a static model, empirical studies indicate a positive link between the two (Huang, 2013). As a dynamic interactive influence process, shared leadership sets up the perfect environment for team learning (Pearce & Conger, 2003). Quality interaction is fundamental for learning to occur at the team level, as studies show that information sharing and collective learning are enhanced by frequent interaction (Crossan, Lane, & White, 1999). In a study of accounting professionals, Kleinman and colleagues (2002) found that social interaction processes within the work team fostered learning at the individual, team, and organizational level.

Another key component that leads to team learning is the sharing of knowledge and thoughts (Edmondson, Dillon, & Roloff, 2008). The relationship between knowledge sharing and team learning has been established in multiple studies (Huang, 2013; Zellmer-Bruhn & Gibson, 2006). For instance, Adler (1990) demonstrated in manufacturing plants that team learning is facilitated by intensive knowledge sharing between the research and development team and engineering team, leading to significant cost reduction. Without establishing a mutual understanding, it would be difficult for the team to reflect on the same subject matter and reach agreement on any further actions. When leadership is the team’s shared property, members engage in mutual influence, and communication is channeled through multiple directions (i.e. upward, downward, and lateral) instead
of concentrated to one individual. This enables a quick spread of knowledge, prevents distortion of information, and allows members quick access to relevant information and ideas (Yukl, 2009).

Team learning behaviors can be undesirable to the individual at times. The act of disclosing potential issues, seeking feedback, and asking for help may imply one is incompetent at work (Brown, 1990). Therefore, team learning may be inhibited if members have concerns of openly voicing themselves. To encourage open discussion and reflection, a safe and supportive team environment needs to be in place to foster psychological safety. Psychological safety is a belief that one is safe to take interpersonal risks, and studies have found that when there is a low sense of psychological safety, members tend to withhold their thoughts and avoid changes (Schein 1993, Edmondson, 1999). Among the many factors that contribute to psychological safety, leadership plays a big role (Edmondson, 2003). Sarin and McDermott (2003) took an in-depth look at product development teams in technology companies and identified team leader behaviors that enhanced team learning. They observed that when leaders spread out the decision-making power within the team and allowed higher level autonomy, members displayed more learning behaviors, and in turn exhibited better team performance. Shared leadership fosters a sense of psychological safety within the group, and encourages open discussions and trust. A shared leadership environment will likely ease one’s
concern of others’ perception by lowering the interpersonal risk associated with open communication. As a result, learning can be stimulated when members in the team are open to expressing and understanding different viewpoints.

Empowerment is another factor that fosters team learning behaviors (Kirkman & Rosen, 1999). Providing members the autonomy to make decisions and take actions allows them the freedom to engage in learning-related activities such as exploring innovative solutions, testing alternatives, and taking time to reflect on past events. When members are empowered with more decision-making authorities, they tend to exhibit more learning behaviors (Gibson & Vermeulen, 2003). Shared leadership encourages autonomous team work. Since everyone has the potential to step up as the leader and influence others, the team as a whole will likely be more proactive in identifying areas of improvement and initiating changes. As responsibilities are distributed within the team, members are more likely motivated to acquire new knowledge and skills to enhance overall team performance.

The perception of power and hierarchy within a team also affects team learning behaviors. During an extensive period observing work teams within an organization, Edmondson (2002) found that teams with lower power distance whose leaders encouraged members’ input in decision-making exhibited more and higher quality behaviors related to reflection and action. A flat work structure
encourages individuals to challenge the status quo and openly share different opinions with members at different levels. When there is concern of power, individuals may withhold thoughts in fear of offending the authority figure, or may simply agree with the authority figure without speaking up truthfully. The team learning process could also be hindered when members engage in reflective discussion but do not follow through with actions. Shared leadership promotes a low hierarchical team structure and mitigates the power struggle, enhancing collective learning.

In conclusion, it is reasonable to argue that shared leadership enhances team learning by creating a psychologically safe and low-power environment that fosters member interaction, knowledge sharing, and autonomy. In addition, a few studies have indicated more direct evidence of the connection between shared leadership and team learning. For instance, Bligh, Pearce and Kohles (2006) demonstrated higher levels of shared leadership led to higher levels of knowledge creation. In a comprehensive review of team learning literature, Edmondson and colleagues (2008) identified shared manager or owner as a key factor to team learning outcomes. In a study of thirty-five work teams across fourteen companies, Huang (2013) found a significant and positive relationship between shared leadership and team learning. However, Huang’s (2013) research was cross-sectional, and measured shared leadership with a subjective survey by aggregating members’
perception of the team’s involvement in activities related to shared leadership, such as setting goals, making decisions, and solving questions. Inherently relational, shared leadership is best measured by the structure of the network linkages between members (Nicolaides et al., 2014). Moreover, since both shared leadership and team learning reflect dynamic interplays of relational processes, it makes the most sense to study them in a dynamic environment. Therefore, the current study further extends Huang’s (2013) research by measuring shared leadership with a social network approach in a longitudinal study design.

**Figure 3. Model Highlighting Hypotheses 1 and 2**

Overall, shared leadership provides the essential conditions that encourage, facilitate and sustain team learning. Taking into consideration the dynamic interplay between the two variables, it is hypothesized that (figure 3):

*Hypothesis 1.* Shared leadership at time 1 is positively related to team learning at time 2.
**Hypothesis 2.** Initial level of shared leadership is positively related to the speed of change (slope) in team learning, such that teams with higher levels of shared leadership at time 1 will experience a faster/steeper increase in team learning over time (slope of change between time 1 and time 2).

**Shared Leadership and Team Knowledge Structures**

Team cognition has long been used to explain the difference between high-performing and low-performing teams. For instance, a majority of studies have demonstrated a positive link between team effectiveness and the quality (i.e. similarity and accuracy) of team mental models (Cannon-Bowers & Salas, 2001; Mohammed, Ferzandi, & Hamilton, 2010). Teams with less overlap in mental models performed worse than teams with highly overlapping mental models (Mathieu et al., 2005). A well-developed team knowledge structure allows members to operate under the same set of assumptions and expectations, enhancing team coordination processes, and fostering high levels of team performance (Cannon-Bowers & Salas, 1990).

Team knowledge structures are created through an interactive process characterized by member interaction, knowledge sharing, and communication, all of which should be enhanced in shared leadership teams. When members engage in the dynamic process of sharing influence and leadership responsibilities, there will
be higher needs for more frequent and effective communications. To fulfill the need of coordinating leadership functions, members will need to explicitly discuss and agree upon a variety of issues such as the team’s goals, coordination mechanisms, and communication norms. To influence other members, one would engage in behaviors such as providing suggestions and feedback, reasoning, and negotiation. As leadership is the property of the team, all members are involved, and will need to develop similar team knowledge structures to enact the leadership behaviors appropriately. The enactment of shared leadership promotes a two-way communication that allows information to flow vertically and horizontally, also enhancing the sharing of knowledge. Interaction is also critical in forming team knowledge structures. When there is high role specification and each member focuses on independent tasks, the team mental model similarity decreases over time due to less team interaction (Levesque, Wilson, & Wholey, 2001). On the other hand, when there is regular interaction and interdependency within the team, mental model sharedness increases (Eby et al., 1999). The creation of shared mental models is the foundation for a smooth transition of leadership roles and responsibilities (Burke, Fiore, & Salas, 2003). Through the practice of sharing leadership functions, over time, members develop schemas and mental models with a shared expectation on who should assume which leadership role under what circumstances.
In a sense, team knowledge can be viewed as a product of the dynamic interactive process inherent in shared leadership (Pearce & Conger, 2003). As members become more involved in core team activities such as strategic planning and decision making, they gain exposure to a broader range of work within the team, allowing them to develop and share a more comprehensive repertoire of team knowledge. This knowledge base enables members to identify knowledge gaps, communicate across different functions, and share knowledge and best practices to enhance overall team performance. Although a relatively stable cognitive structure, team knowledge does evolve over time (Levesque et al. 2001; Mathieu et al., 2000). As members get to know each other better and become more familiar with the tasks, new knowledge emerges, increasing the accuracy and overlap of the team mental models. Therefore, it is reasonable to hypothesize that the enactment of shared leadership will influence and facilitate the growth in overlap in team knowledge structures (figure 4):

**Hypothesis 3.** Shared leadership at time 1 is positively related to team knowledge structure congruence at time 2.

**Hypothesis 4.** Initial level of shared leadership is positively related to speed of change (slope) in team knowledge congruence, such that teams with higher levels of shared leadership at time 1 will experience a faster/steeper
increase in team knowledge structure congruence over time (slope of change between time 1 and time 2).

![Figure 4. Model Highlighting Hypotheses 3 and 4](image_url)

**The Mediating Role of Team Learning**

The linkage between shared leadership and effective team performance has been well established in the field (D’Innocenzo et al., 2014; Nicolaides et al., 2014; Wang et al., 2014). However, less is known regarding the team processes or emergent states that could explain the linkage between the two. Moving beyond the classic Input-Process-Output (IPO) model to address the increased complexity and dynamic in teams, researchers now move towards the IMOI (input-mediator-output-input) model (Ilgen, Hollenbeck, Johnson, & Jundt, 2005). In line with this approach, another objective of the current research is to uncover the black box (Mediators) connecting shared leadership (Input) and team effectiveness (Output).
by specifically examining the process of team learning and the emergent state of team knowledge as parallel mediating mechanisms.

Both team learning and team knowledge structure have been extensively studied as mediators in team literature. They are also closely linked to shared leadership as illustrated in previous paragraphs. As they are dynamic emergent constructs that share a fair amount of antecedents (i.e., communication, interaction) and work together to collectively influence team performance, there is likely a mutual causal relationship between the two in the form of a positive feedback loop. However, a detailed discussion of their relationship is beyond the scope of the current research. This study focuses on their roles as co-evolving mediators between shared leadership and team effectiveness (figure 5):

**Hypothesis 5.** Shared leadership is positively related to team effectiveness.

**Hypothesis 6.** Team learning is positively related to team effectiveness.

**Hypothesis 7.** Team knowledge is positively related to team effectiveness.

**Hypothesis 8.** Team learning mediates the relationship between shared leadership and team effectiveness.

**Hypothesis 9.** Team knowledge mediates the relationship between shared leadership and team effectiveness.
Like all organizational phenomenon, teamwork does not occur in a vacuum, and it is important to consider the contextual factors that may act as boundary conditions on these relationships. Team characteristics affect team processes, emergent states, as well as team performance outcomes (Huang, 2013; Kleinman et al., 2002). Team size, for instance, has been shown to relate to communication frequency, and interpersonal relationships are more likely to develop in smaller teams (Perry et al., 1999). Huang (2013) showed that team heterogeneity moderated the relationship between shared leadership and team learning, such that this relationship was stronger in more diverse teams. Furthermore, his study found that team size moderated the relationship between shared leadership and team learning, such that this relationship is stronger in larger teams. However, Huang (2013) only examined shared leadership in a static one-point in time setting, and
less is known about how team characteristics moderate the relationship between shared leadership and other team processes or emergent states in a dynamic setting. The current study will fill this gap by studying the moderating effects of team characteristics in a longitudinal study design. In addition, the moderation effect will be examined on both team process (i.e., team learning) and emergent state (i.e., team knowledge structure) to provide a more holistic view on team dynamics.

Communication and interaction are essential for team learning, and teams with more members will need to exchange thoughts and information more frequently to ensure effective sharing of leadership. In addition, larger teams tend to encompass a larger repertoire of skills and capabilities and more heterogeneity within members, leading to a higher need and opportunity to engage in team learning processes to reconcile the differences and utilize the diverse skills. Therefore, this study hypothesizes that (figure 6):

**Hypothesis 10.** Team size moderates the relationship between shared leadership and team learning, such that this relationship is stronger in larger teams.

**Hypothesis 11.** Team heterogeneity moderates the relationship between shared leadership and team learning, such that this relationship is stronger in diverse teams.
Team size and team heterogeneity will likely influence the relationship between shared leadership and team knowledge structures in the same direction. Increase in team size and diversity simultaneously increase the complexity and amount of knowledge that could be shared among members. Therefore, teams will need to devote more time and effort in synthesizing individual knowledge and developing congruent knowledge structures. As a result, sharing of leadership becomes more essential in supporting the interaction needed to develop overlapping knowledge structures in larger and more diverse teams. Therefore, it is reasonable to hypothesize that (figure 6):

*Hypothesis 12.* Team size moderates the relationship between shared leadership and team knowledge structures, such that this relationship is stronger in larger teams.

*Hypothesis 13.* Team heterogeneity moderates the relationship between shared leadership and team knowledge structures, such that this relationship is stronger in diverse teams.
Figure 6. Model Highlighting Hypotheses 10 to 13

Studying shared leadership in a longitudinal design allows close examination of the change in variances across time. As can be seen in the hypotheses above, this study not only explores the mediating factors that link shared leadership to effective team performance, but also captures the dynamic nature of temporal intervals by examining how shared leadership affects the rate of change in the proposed team process (team learning) and emergent state (team knowledge). As the first study that specifically looks at how initial levels of shared leadership influences the emergence of team learning process and team knowledge over time, this research allows a more dynamic and realistic understanding of this relationship.
Method

Participants

Participants were recruited from project teams in senior-level undergraduate courses from the engineering and psychology department at a private university in the Southeast region of the United States. All teams engaged in at least one semester-long team projects as part of the requirement of the course. Data was collected during fall and summer semesters. Participation in this study was voluntary. A total of 52 teams participated in the study, and after ruling out teams with a low response rate (i.e., teams with less than 50% completion rate in any of the surveys), 30 teams with a total of 130 participants were retained in the analysis, among which, 16 teams were mixed-gender teams. Teams varied in size from 3 to 9 members. In particular, there were 10 three-person teams, 10 four-person teams, 1 five-person team, 2 seven-person teams, 4 eight-person teams, and 3 nine-person teams. Participants’ average age was 21.8. In terms of ethnic identity, 56.92% identified themselves as White or Causation, 13.08% Hispanic or Latino, 12.31% Asian, 9.23% African American, and 8.46% from other ethnical backgrounds.
Procedure

Teams were recruited via email invitations as well as verbal communications through professors and teaching assistants to the targeted classes in the engineering and psychology department. At set intervals of roughly two weeks throughout the semester, participants received email invitations to complete a series of surveys. The initial survey collected information on basic demographics as well individual differences, while the following two process surveys at Time 1 and Time 2 asked about teamwork processes and emergent states members perceived and engaged in. Data on shared leadership, team knowledge structures, and team learning were all collected at two separate points in time (i.e., Time 1 and Time 2), and only shared leadership measured at Time 1 was used in the analysis. Data on team effectiveness was collected in the second process survey (Time 2). The process and flow of the experiment is illustrated in Figure 7.

Figure 7. Experiment Flow with Measurements Used at Different Time Points
Measures

Demographics and Team Characteristics

Demographics information was collected in the initial survey, and participants were asked to provide information regarding their age, gender, ethnicity, major, class year, employment status, GPA, and English language proficiency level. Team size was measured by the number of people in each team. Team heterogeneity was measured by team racial composition.

Information on the team and team members was also collected in the initial survey. Participants were asked to provide information on the name of their team, their formal team leader, their familiarity with each team member, and previous experience working with each member.

Shared Leadership

Shared leadership was assessed by three items measuring leadership perception, leadership reliance, and leadership influence. All three items were measured on a five-point Likert scale (1=strongly disagree, 5=strongly agree). Leadership perception was measured by asking the participants to rate the extent each member (including themselves) has led the team over the course of the project since the last survey. Leadership reliance was measured by asking the participants
to rate the extent to which they have relied on each person (including themselves) for leadership on the project since the last survey. Leadership Influence was measured by the extent to which they believe each member (including themselves) has influenced the direction and actions of the team since the last survey. All three measures show good reliability, with Cronbach’s alpha of .96 for leadership perception, .96 for leadership reliance, and .89 for leadership influence.

Shared leadership was measured with a social network approach. Since shared leadership is a relational process, “it may be best captured by an approach whose unit of analysis is the leadership link between team members” (p. 937) (Nicolaides et al., 2014). The social network approach allows the examination of patterns of relationships among all members. In particular, measurement of density was used, and it was measured by the proportion of network links that are currently present in the network (Kenny, Kashy, & Cook, 2006). For instance, in a three-person team, to reach maximum density, every member will be influencing all other members. The total number of possible network link is 6 as links are directional (e.g., A to B and B to A), and the number of currently present network link is also 6. Therefore, this team has a network density of 1 (i.e., 6 divided by 6), representing fully shared leadership.
Team Learning

Team learning was measured by a shortened version of Edmondson’s (1999) team learning scale that included the four most significant and reliable items from the original scale (Wiedow et al., 2013). An example item is “Our team frequently seeks information and feedback that leads us to make important changes and improvements.” Participants were asked to rate on a five-point Likert scale the degree to which they agree or disagree with each statement (1=strongly disagree, 5=strongly agree). This measure shows good reliability on the data with Cronbach’s alpha of .88. Higher scores indicate higher levels of team learning. Please see appendix A for the full scale.

Process-related Knowledge Structure

Eby and colleagues (1999) developed the Individual Expectations for Teamwork Measure to assess the shared team-level expectations for teamwork, and it has been used to study process-related team mental models (Ellwart et al., 2014; Vîrgă et al., 2014). Participants were asked to reflect on the way their team worked together, and indicate the level of perceived importance of teamwork behaviors on effective team functioning. Responses were recorded on a 5-point Likert scale from 1-strongly disagree to 5-strongly agree. Standard deviation was used to measure the amount of deviation in individuals’ responses within a team. Higher standard deviation indicated larger discrepancies in members’ perceptions of the team’s
process-related knowledge structure, and thus less overlap; whereas lower standard deviation indicated higher similarity in the process-related team knowledge structure. An example item is “Members monitor others’ performance”. See appendix A for full scale.

Content validity was established by the deductive approach: items were developed by subject matter experts based on teamwork facets and theories generated through an extensive literature review. Construct validity was established in both lab and field studies. The original item has 28 items, and in the current study, 16 items with the highest loadings (> .50) were included to measure process-related team knowledge structure. These items showed high reliability with Cronbach’s alpha of .95.

Task-related Knowledge Structure

Measure of task-related knowledge structure was adapted from the context-independent instrument for shared task understanding used by He, Butler, and King (2007). The original scale was applied in software development teams, and some IT-specific wordings were changed to more general terms to better fit the sample of this study. The adapted scale showed good reliability with Cronbach’s alpha of .92. The instrument included four items. Participants rated the extent to which their teams shared a common understanding of the project, knowledge and technologies involved, development procedures, and the overall task strategy on a five-point
Likert scale (1=strongly disagree, 5=strongly agree). A mean score for each team was generated by averaging members’ responses, and higher scores at the team level indicate more sharedness in task-related team knowledge. An example item is “Team members have a common understanding of the requirements of the project.” See appendix A for the full scale.

Team-related Knowledge Structure

Team-related knowledge structure was measured by the 15-item Transactive Memory Scale (TMS) scale developed by Lewis (2003). It measures TMS from three dimensions: specialization, credibility, and coordination. The scale showed good reliability with Cronbach’s alpha of .84. Participants rated how much they agreed with each statement on a five-point Likert scale ranging from 1-strongly disagree to 5-strongly agree. A mean score for each team was generated by averaging members’ responses, and higher scores at the team level indicate more sharedness in team-related team knowledge. An example item measuring specialization is “Each team member has specialized knowledge of some aspect of our project”, an example item measuring credibility is “I trusted that other members’ knowledge about the project was credible”, and an example item measuring coordination is “Our team worked together in a well-coordinated fashion.” See appendix A for the full scale.
Goal-related Knowledge Structure

Goal-related knowledge structure was measured by the 3-item shared vision scale used by Wong, Tjosvold, and Liu (2009). The items were adapted to fit the current sample by changing the referent from organizations to teams, and the adapted scale showed a good reliability with Cronbach’s alpha of .91. Participants were asked to rate the extent to which they agree or disagree with each statement on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). A mean score for each team was generated by averaging members’ responses, and higher scores at the team level indicate more sharedness in goal-related team knowledge. One example item is “Our team encourages everyone to feel we are one unit dedicated to a common purpose.” See appendix A for the full scale.

In addition, each participant was asked to describe the main goal of their team: “In a few sentences, please briefly describe the main goals your team is aiming to achieve on this project.” Ideally, this qualitative data would be content coded and analyzed (e.g., using the software MAXQDA) for degree of semantic overlap and similarity within each team. However, as explained in the results section, unfortunately the author was unable to perform content analysis due to low response rate on this item.
Team Effectiveness

Team effectiveness was measured by the 11-item timeliness and quality facets taken from the Team Effectiveness Survey (Gibson, Zellmer-Bruhn, & Schwab, 2003). Participants were asked to rate the extent to which they agree or disagree with the statements on a five-point Likert scale (1=strongly disagree, 5=strongly agree). This scales showed a good reliability with Cronbach’s alpha of .91. One example item from the quality facet is “This team has a low error rate”, and an example item from the timeliness facet is “This team meets its deadlines”. To measure overall team effectiveness, one addition item was added: “This team will get a great grade on our final project.” See appendix A for the full scale.
Shared Leadership

Shared leadership was captured by three variables: leadership perception, leadership reliance, and leadership influence, and they were measured by the network statistic, density (Nicolaides et al., 2014). Density was computed by dividing the number of existing leadership links by all possible leadership links in the team (Kenny, Kashy, & Cook, 2006). The leadership links were weighted by taking into account the extent to which each member believed they followed the lead of, relied on, and was influenced by each other member of the team. Therefore, in a three-person team, the number of possible un-weighted link for perceived leadership, leadership reliance, and leadership influence, respectively, is 6. When there is fully shared leadership, all members would rate the other two a maximum of 5 on all three measures of shared leadership. Multiplying that by the un-weighted leadership link gives us a weighted leadership link of 5×6=30, and results in the maximum density of 30/30=1. Density ranges from 0 to 1, with higher value indicating a higher level of shared leadership. Leadership density for each team was computed for all three measures of shared leadership: leadership perception, leadership reliance, and leadership influence.
**Regression**

Regression techniques were used to examine hypotheses 1 to 7. Measures of team learning and team knowledge structure were aggregated to the team level by computing an average score for each measure. The temporal changes in team learning and team knowledge structure were measured by the traditional “Naïve approach” of measuring change that calculates the difference in score between the two time points (Rogosa, Brandt, & Zimowski, 1982). The linear regression analyses will in particular test the following pairs of relationships:

1) Shared leadership at Time 1 and team learning at Time 2
   (Hypothesis 1)

2) Shared leadership at Time 1 and the change in team learning over time (Hypothesis 2)

3) Shared leadership at Time 1 and team knowledge structure similarity at Time 2 (Hypothesis 3)

4) Shared leadership at time 1 and the change in team knowledge structure similarity over time (Hypothesis 4)

5) Shared leadership and team performance (Hypothesis 5)
6) Team learning and team performance (Hypothesis 6)

7) Team knowledge structure similarity and team performance (Hypothesis 7)

**Bootstrapping Technique for Indirect Effects**

Mediation analysis examines whether the independent variable has an effect on the dependent variable directly or indirectly through an intervening or mediating variable (Hayes, 2012). Three pathways are examined: the first one from the independent variable to the mediating variable (pathway a); the second one from the mediating variable to the dependent variable (pathway b); and the third pathway from the independent variable directly to the dependent variable (pathway c). The premise for mediation analysis is that all three pathways need to be significant, and mediation is established when the third pathway becomes less or not significant after controlling for the first two pathways (Baron & Kenny, 1985). The traditional approach to test mediation proposed by Baron and Kenny (1985) uses the Sobel z-test to test the significance of the mediation link. However, this method has received many critiques on its low power, unrealistic assumption of a normal distribution of the indirect effect, and overly conservative nature (Hayes, 2013; MacKinnon, Warsi, & Dwyer, 1995). The more recommended method to test mediation, the bootstrap technique, is superior to the Sobel z-test due to its higher
power and more realistic assumptions (Hayes, 2012; Preacher & Hayes, 2004; Zhao, Lynch, & Chen, 2010). In addition, Preacher and Hayes (2004) also argue that with bootstrapping technique, mediation could be tested without all three pathways being significant as proposed by Baron and Kenny (1985). In the current study, Hypotheses 8 and 9 test the mediating role of team knowledge structures and team learning in the relationship between shared leadership and team effectiveness. Following best practices, the bootstrapping technique was used for mediation analysis.

Moderation analysis tests whether the strength of a relationship depends on a third variable. Hypotheses 10 to 13 explore whether properties of the team (i.e., team size and team heterogeneity) amplify or weaken the relationship between shared leadership and team learning or team knowledge structures, and thus were tested via moderation analyses. Bootstrapping is a highly valid and robust technique to test indirect effects via the statistical method of resampling randomly drawn sections of the sample thousands of times (Shrout & Bolger, 2002). Resampling with replacement allows the statistical program to build a distribution of effect size estimates, showing confidence intervals based on the distribution to provide an idea of how stable the effect size is. PROCESS Macro for SPSS, a modeling tool for testing indirect relationships using bootstrapping technique, is commonly used and highly recommended for various mediation and moderation
analyses (Hayes, 2012). Therefore, analyses on indirect effects (i.e., mediation or moderation) were conducted to test hypotheses 8 to 13 via bootstrapping technique (Preacher & Hayes, 2008).
Results

Descriptive Statistics

Although a total of 52 teams participated in the study, only 30 teams remained in the analysis. 12 teams had too many missing values and less than 50% completion rate in one of the surveys and were thus removed from the analysis. The final set of data comes from 30 teams across 7 senior-level undergraduate courses, involving a total of 130 participants. Descriptive statistics of the teams and team members are reported in Table 1. Univariate outlier analysis showed no outliers in the dataset and all analyses were performed on available data. Missing values were dismissed such that if a 5-person team only collected responses from 4 members, the average scores on all measures of those 4 members were used as the team-level statistic. Unexpectedly, a large number of participants did not provide response to the survey section on team knowledge, resulting in usable data from 6 teams for team knowledge structure measures at time 1, and usable data from 10 teams for team knowledge structure measures at time 2. The reason for this is unknown. Summary statistics for key team-level variables at time 1 and time 2 are shown in Table 2. Correlation matrices for team-level variables are reported in Table 3.
Table 1. Team and Individual Level Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
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<td>9</td>
<td>5.9</td>
<td>2.35</td>
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<tr>
<td>Gender</td>
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<td>1</td>
<td>2</td>
<td>1.37</td>
<td>2.35</td>
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<tr>
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<td>50</td>
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<td>4.41</td>
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<td>-</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note. Gender, 1=Male, 2=Female; 13 individuals reported more than one ethnicity.
Table 2. Summary Statistics for Team Level Variables at the Two Time Points

<table>
<thead>
<tr>
<th>Variable</th>
<th>Time 1</th>
<th></th>
<th></th>
<th>Minimum Value Possible</th>
<th>Maximum Value Possible</th>
<th>N</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>M</td>
<td>S.D.</td>
<td>Lowest Value Obtained</td>
<td>Highest Value Obtained</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shared Leadership</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Leadership Perception</td>
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<td>.11</td>
<td>.40</td>
<td>.93</td>
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<td>.12</td>
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<td><strong>Shared Leadership</strong></td>
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<td></td>
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<td></td>
<td></td>
</tr>
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Note. All team knowledge structures measured by the standard deviation of team responses to indicate the level of similarity in team knowledge structure within each team.
Table 3. Team-level Correlations

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Note. *=sample size of 30, ^=sample size of 10, ^=sample size of 6. *=significant at p>.05 (2-tailed), **=significant at p>.01(2-tailed). TKS = Team Knowledge Structure. All team knowledge structures measured by the standard deviation of team responses to indicate the level of similarity in team knowledge structure within each team.
Factor Analysis on Team Knowledge Structures

Based on the team knowledge structure framework and related theories, team knowledge is a superordinate construct that encompasses knowledge of various aspects of the team, in particular, areas related to process, team, task, and goal (Wildman et al., 2012). Since there is no measure of the team knowledge structure framework, this study used four individual measures of the four areas in the framework. To explore whether items from these four measures all tap on the same or multiple underlying latent variables, an exploratory factor analysis (EFA) was conducted. EFA allows exploration of the number of dimensions that exist among the variables by using common variance to understand the covariance among these variables (Thompson, 2004).

EFA was conducted with all items measuring team knowledge structures at time 2, principal components method was selected as the extraction method, and direct oblimin was selected as the rotation method since the items are expected to correlate (Kim & Mueller, 1978), and some of the measures do correlate as shown in the correlation table (Table 4). The factor retention criteria was based on an eigenvalue larger than 1, and results indicated a six-factor model. However, there was a sharp break in the scree plot between the first and second factor (Figure 8), as well as an almost six-fold difference in eigenvalues between the first and the second factor. The first factor explained 52.926% of the total variance (eigenvalue
for factor one = 20.11), the second factor explained 9% of the total variance (eigenvalue for factor two = 3.42), the third factor explained 7.14% of the total variance (eigenvalue for factor three = 32.71), the fourth factor explained 3.99% of the total variance (eigenvalue for factor four = 1.52), the fifth factor explained 3.39% of the total variance (eigenvalue for factor five = 1.29), and the last factor explained 3.24% of the total variance (eigenvalue for factor six = 1.22). Together, the six factors explained 79.69% of the total variance. Based on the sharp break in the scree plot (Figure 2), extracted eigenvalues, and percentage of variance explained by the factors, it is reasonable to argue for a one-factor solution and one common underlying construct.

Problematic items that showed low loadings (<.40) or cross-loadings on more than one factors as well as items that do not load on factor one were removed. To confirm that the remaining items fall under one overarching latent variable and fit in a one-factor model, confirmatory factor analysis (CFA) was conducted with R software. CFA is a statistical tool often used for theory testing that examines the a priori relationships between observed and latent variables (Jackson, Gillaspy, & Purc-Stephenson, 2009). The fit of the model is assessed by the fit indices, and although there is no established criteria for a good model fit, the commonly used rule of thumb is to have Root-mean-square error of approximation (RMSEA) <.06, Standardized root-team-square residual (SRMR)<.06, Tucker-Lewis index
(TLI) > .95, Comparative fit index (CLI) > .95, and an insignificant chi-square value (Hu & Bentler, 1999). Results from the CFA analysis showed that in this one-factor model, Chi-Square test of model fit is significant, $\chi^2(252) = 713.69$, $p < .01$, CFI=.67, TLI=.64, RMSEA=0.20, SRMR=.08, suggesting poor model fit. However, the poor fit indices for the model is very likely due to the small sample size. A four-factor CFA was also conducted, however, due to small sample size, the results were interpretable.

![Scree Plot](image)

*Figure 8. Scree Plot for Exploratory Factor Analysis on Team Knowledge Structures*
Based on the theoretical framework for team knowledge structure and supporting theories, it is reasonable to propose all measures of various aspects of team knowledge structure fall under one overarching latent construct. As a result, individuals’ responses to the retained items were aggregated into one composite score by taking the average. Standard deviation within the team was calculated to represent level of team knowledge structure overlap, with higher values indicating less similarity and lower values indicating higher similarity.

Table 4. Team-level Correlations for Measures of Team Knowledge Structure

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Note. N=6 for measures at time 1, N=10 for measures at time 2. *=significant at p>.05 (2-tailed), **=significant at p>.01(2-tailed). TKS=Team Knowledge Structure.

Hypothesis Testing

Hypotheses 1 to 7 were tested with simple linear regression techniques, while hypotheses 8 to 13 were tested with bootstrapping method. Statistical analysis software SPSS and the statistical package PROCESS Macro for SPSS
were used to conduct the analyses. Please refer to Table 6 for summary information on the hypotheses.

Hypothesis 1

The first hypothesis states that shared leadership at time 1 predicts team learning at time 2, such that higher levels of shared leadership will lead to higher levels of team learning at the later stage. Since there are three measures of shared leadership, three individual linear regressions were conducted with leadership perception, leadership reliance, and leadership influence, respectively, as the independent variable (IV), and team learning at time 2 as the dependent variable (DV). Results indicated that leadership influence was a significant predictor of later team learning, $F(1, 28)=4.69, p<.05$, explaining 14.3% of the variance, $R^2=.143$, supporting Hypothesis 1c. No significant relationship was found between leadership perception and later team learning, $F(1, 28)=.436, p=.51$, or leadership reliance and later team learning, $F(1, 28)=.23, p=.14$, and hypotheses 1a and 1b were not supported. Overall, the results showed partial support for Hypothesis 1 that leadership influence predicts future team learning.

Hypothesis 2

The second hypothesis predicts that initial levels of shared leadership positively relate to the speed of change in team learning between the two time
points, such that teams with a higher level of shared leadership experience a faster increase in team learning over time. The speed of change in team learning was calculated by obtaining the difference in team learning scores between time 1 and time 2. Results indicated that leadership perception, $F(1, 28)=13.347, p<.01$, leadership reliance, $F(1, 28)=10.472, p<.01$, and leadership influence, $F(1, 28)=10.308, p<.01$, all significantly and positively predicted the speed of change in team learning, explaining 32.3% ($R^2=.323$), 27.2% ($R^2=.272$), and 26.9% ($R^2=.269$) of the variance, respectively. Therefore, Hypothesis 2 was fully supported.

Hypothesis 3

Hypothesis 3 states that shared leadership predicts later team knowledge structure congruence, such that higher levels of shared leadership lead to a higher degree of overlap in team knowledge structures at a later stage. No significant relationship was shown between leadership perception and team knowledge structure congruence, $F(1, 4)=2.823, p=.17$, leadership reliance and team knowledge structure congruence, $F(1, 4)=.01, p=.91$, and leadership influence and team knowledge congruence, $F(1, 4)=1.74, p=.26$. Therefore, based on the results, Hypothesis 3 was not supported.
Hypothesis 4

Hypothesis 4 predicts that initial levels of shared leadership is positively related to speed of change in team knowledge structure over time, such that teams with higher levels of shared leadership develop more congruence in team knowledge structure at a later phase. The speed of change in team knowledge structure congruence was calculated subtracting the score for team knowledge structure at time 1 from that score at time 2. Results did not show a significant relationship between leadership perception and speed of change in team knowledge structure congruence, $F(1, 4)=1.9, p=.24$, leadership reliance and speed of change in team knowledge structure congruence $F(1, 4)=.12, p=.74$, and leadership influence and speed of change in team knowledge structure congruence, $F(1, 4)=2.71, p=.18$. Therefore, the results indicate that Hypothesis 4 was not supported.

Hypothesis 5

The fifth hypothesis predicts that shared leadership positively relates to team effectiveness, that higher levels of shared leadership lead to more team effectiveness. Results did not show a significant relationship between leadership perception and team effectiveness, $F(1, 28)=1.50, p=.23$, and leadership reliance and team effectiveness, $F(1, 28)=2.86, p=.10$, failing to support Hypotheses 5a and 5b. However, a significant relationship was found between leadership influence and
team effectiveness, $F(1, 28)=3.15, p<.01$, with leadership influence explaining 26.1% of the variance in team effectiveness ($R^2=.261$), supporting Hypothesis 5c. Therefore, Hypothesis 5 was partially supported.

Hypothesis 6 predicts a positive relationship between team learning and team effectiveness. Results from the linear regression provided support for a significant relationship between team learning and team effectiveness, $F(1, 28)=15.48, p<.01$, with team learning explaining 35.6% of the variance in team effectiveness ($R^2=.356$). Therefore, Hypothesis 6 was fully supported.

Hypothesis 7 predicts that team knowledge structure similarity positively predicts team effectiveness. Results fail to support such a relationship, $F(1, 28)=.762, p=.43$; therefore, Hypothesis 7 was not supported.

Hypothesis 8 states that team learning mediates the relationship between shared leadership and team effectiveness. As discussed in previous sections, the prerequisite for conducting mediation analysis is to have significant effects on all three pathways. Based on the results from Hypotheses 1 to 7, only the mediation
effect of team learning in the relationship between leadership influence and team effectiveness meets the prerequisite and could be tested. Results from the PROCESS Macro using Model 4 (i.e., mediation model) showed leadership influence was a significant predictor of team learning, $b=3.95, p<.001$, and that team learning was a significant predictor of team effectiveness, $b=.26, p<.05$. Leadership influence was no longer a significant predictor of team effectiveness after controlling for the mediator, team learning, $b=.68, \text{ns}$, supporting the mediation (Figure 9). Approximately 37.9% of the variance in team effectiveness could be accounted for by the predictor ($R^2=.379$). The indirect effect, tested by the bootstrap technique with 5000 bootstrap samples, indicated a significant indirect effect, $b=1.03, 95\% \text{ CL}=.2421, 2.1183$, and leadership influence network density was associated with 1.03 unit higher in team effectiveness as mediated by team learning. To sum, Hypothesis 8 was partially supported and team learning was found to mediate leadership influence and team effectiveness.

![Figure 9. Unstandardized regression coefficients for the relationship between leadership influence and team effectiveness as mediated by team learning.](image)

*p<.05, **p<.01.*
Hypothesis 9

Hypothesis 9 predicts that the level of overlap in team knowledge structures mediates the relationship between shared leadership and team effectiveness. Based on the results from Hypotheses 1 to 7, the prerequisites for conducting mediation were not met, and mediation analysis could not be performed. Therefore, Hypothesis 9 cannot be supported.

Hypothesis 10

Hypothesis 10 concerns the moderating effect of team size on the relationship between shared leadership and team learning and predicts this relationship to be stronger in larger teams. Results from the PROCESS Macro using Model 1 (i.e., moderation model) with 5000 bootstrap samples showed that the interaction between leadership perception and team size did not significantly predict team learning, $b=-.48, p=.44$; nor did the interaction between leadership reliance and team size, $b=.13, p=.87$, or the interaction between leadership influence and team size, $b=.56, p=.48$. Therefore, Hypothesis 10 was not supported.

Hypothesis 11

Hypothesis 11 concerns the moderating effect of team heterogeneity on the relationship between shared leadership and team learning and predicts this relationship to be stronger in more diverse teams. Team heterogeneity was
operationalized as the ethnical composition of the team. A heterogeneity score was computed for each team by dividing the number of ethnic groups represented in a team by the number of team members. Higher values indicate more diversity and heterogeneity within the team. Results from the PROCESS Macro using Model 1 (i.e., moderation model) with 5000 bootstrap samples showed no significant relationship between the outcome, team learning, and the interaction between leadership perception and team heterogeneity, $b=-1.90$, $p=.57$, the interaction between leadership reliance and team heterogeneity, $b=-.34$, $p=.90$, or the interaction between leadership influence and team heterogeneity, $b=4.15$, $p=.20$. Therefore, Hypothesis 11 cannot be supported, and team heterogeneity did not moderate the relationship between shared leadership and team learning.

Hypothesis 12

Hypothesis 12 states that team size moderates the relationship between shared leadership and team knowledge structure similarity, such that this relationship is stronger in larger teams. Results from the PROCESS Macro using Model 1 (i.e., moderation model) with 5000 bootstrap samples showed no significant relationship between the outcome, team knowledge structure similarity, and the combined effect of leadership perception and team size, $b=.53$, $p=.14$, combined effect of leadership reliance and team size, $b=.44$, $p=.30$, or the
combined effect of leadership influence and team size, $b = .51$, $p = .13$. Therefore, Hypothesis 12 was not supported, and team size did not moderate the relationship between shared leadership and team knowledge structure congruence.

Hypothesis 13

Hypothesis 13 predicts that team heterogeneity moderates the relationship between shared leadership and team knowledge structure similarity, such that this relationship is stronger in more diverse teams. Results from the PROCESS Macro using Model 1 (i.e., moderation model) with 5000 bootstrap samples showed no significant relationship between the outcome, team knowledge structure similarity, and the combined effect of leadership perception and team heterogeneity, $b = .30$, $p = .55$, combined effect of leadership reliance and team heterogeneity, $b = .22$, $p = .58$, or the combined effect of leadership influence and team heterogeneity, $b = .65$, $p = .31$. Therefore, Hypothesis 13 cannot be supported.

Exploratory Analyses

Since team knowledge structure is composed of four scales measuring process-related, team-related, task-related, and goal-related aspects of the construct, additional exploratory analyses were conducted to analyze the individual relationship between shared leadership and the four areas of team knowledge structure. In addition, results from EFA and CFA on team knowledge structure
showed a less than ideal one-factor model fit, indicating the four areas of team knowledge structure may show higher predictive values when independently analyzed.

Simple linear regressions were conducted with SPSS software on the relationship between shared leadership and process-related team knowledge structure, team-related team knowledge structure, task-related team knowledge structure, and goal-related team knowledge structure, respectively. Results showed a significant relationship between shared leadership and team-related team knowledge structure. Specifically, leadership perception network density significantly predicts team-related team knowledge structure, $F(1, 9)=6.06, p<.05$, explaining 43.1% of the variance ($R^2=.431$); leadership reliance network density significantly predicts team-related team knowledge structure, $F(1, 9)=12.63, p<.01$, explaining 61.2% of the variance ($R^2=.612$); and leadership influence network density significantly predicts team-related team knowledge structure, $F(1, 9)=10.07, p<.01$, explaining 55.7% of the variance ($R^2=.557$). Shared leadership did not predict other areas of team knowledge structure (Table 6).

Since results found a significant relationship between shared leadership and team-related team knowledge structure, linear regression was conducted to further test the relationship between team-related team knowledge structure and team
effectiveness. Unfortunately, no significant relationship was found, $F(1, 9)=1.97$, $p=.19$. PROCESS Macro (using Model 4. the mediation model) was used to test the mediating effect of team-related team knowledge structure in the relationship between shared leadership and team effectiveness, and results were not significant either.

Team heterogeneity was measured by the team’s ethnical composition, and this construct could also be operationalized by other team diversity characteristics such as members’ age and gender composition. To explore other potential team characteristics that may influence the strength of the relationship between shared leadership and team learning/team knowledge structures, additional moderation analyses were conducted using PROCESS Macro using the moderation model with team gender composition and team age diversity individually analyzed as the moderating variable. Team gender composition was dummy coded that same gender teams were coded as 1 and mixed gender teams were coded as 2. 16 teams were mixed-gender teams and 14 teams were same gender teams. Team age diversity was measured by the average age of the team, with higher values indicating more diversity in members’ age. Results indicated a significant relationship between the interaction of team gender composition and leadership reliance and team learning (N=10), $b=3.71$, $p<.05$ (Figure 8), supporting the moderating role of team gender composition (Figure 10). Controlling for the main
effects, $14.54\% (R^2=.1454)$ of the variance in team learning could be explained by the interaction between leadership reliance and team gender composition. Results did not support the moderating role of team age diversity in the relationship between shared leadership and team learning, or the relationship between shared leadership and team knowledge structures.

Figure 10. Moderation effect of team gender composition on leadership reliance and team learning
Table 5. Summary of Hypotheses, Analysis Techniques, Variables, and Results

<table>
<thead>
<tr>
<th>#</th>
<th>Hypothesis</th>
<th>Analysis</th>
<th>Variables/Time points</th>
<th>Supported?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shared leadership is positively related to later team learning:</td>
<td>Linear regression</td>
<td>T1 Leadership perception; T1 Leadership reliance; T1 Leadership influence; T2 Team</td>
<td>1a – No 1b – No 1c</td>
</tr>
<tr>
<td></td>
<td>1a). Leadership perception is positively related to later team learning;</td>
<td></td>
<td>learning.</td>
<td>- Yes</td>
</tr>
<tr>
<td></td>
<td>1b). Leadership reliance is positively related to later team learning;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1c). Leadership influence is positively related to later team learning.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Initial level of shared leadership is positively related to the speed</td>
<td>Linear regression</td>
<td>T1 Leadership perception; T1 Leadership reliance; T1 Leadership influence; Change in</td>
<td>2a – Yes 2b – Yes 2</td>
</tr>
<tr>
<td></td>
<td>of change in team learning over time:</td>
<td></td>
<td>team learning between T1 and T2.</td>
<td>c – Yes</td>
</tr>
<tr>
<td></td>
<td>2a). Leadership perception is positively related to speed of change in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>team learning;</td>
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<tr>
<td></td>
<td>2b). Leadership reliance is positively related to speed of change in</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>team learning;</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>2c). Leadership influence is positively related to speed of change in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>team learning.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Shared leadership is positively related to later team knowledge structure</td>
<td>Linear regression</td>
<td>T1 Leadership perception; T1 Leadership reliance; T1 Leadership influence; T2 Team</td>
<td>3a – No 3b – No 3c</td>
</tr>
<tr>
<td></td>
<td>congruence:</td>
<td></td>
<td>learning.</td>
<td>- No</td>
</tr>
<tr>
<td></td>
<td>3a). Leadership perception is positively related to later team knowledge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>structure congruence;</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>3b). Leadership reliance is positively related to later team knowledge</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>structure congruence;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3c). Leadership influence is positively related to later team knowledge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>structure congruence.</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
| 4 | Initial level of shared leadership is positively related to speed of change in team knowledge structure congruence over time:  
 4a). Leadership perception is positively related to speed of change in team knowledge structure congruence over time;  
 4b). Leadership reliance is positively related to speed of change in team knowledge structure congruence over time;  
 4c). Leadership influence is positively related to speed of change in team knowledge structure congruence over time. | Linear regression | T1 Leadership perception;  
T1 Leadership reliance;  
T1 Leadership influence;  
Change in team knowledge structure congruence. | 4a – No  
4b – No  
4c – No |
|---|---|---|---|
| 5 | Shared leadership is positively related to team effectiveness:  
 5a). Leadership perception is positively related to team effectiveness;  
 5b). Leadership reliance is positively related to team effectiveness;  
 5c). Leadership influence is positively related to team effectiveness. | Linear regression | T1 Leadership perception;  
T1 Leadership reliance;  
T1 Leadership influence;  
Team effectiveness. | 5a – No  
5b – No  
5c – Yes |
| 6 | Team learning is positively related to team effectiveness. | Linear regression | T2 Team learning;  
Team effectiveness. | 6 – Yes |
| 7 | Team knowledge structure similarity is positively related to team effectiveness. | Linear regression | T2 Team knowledge structure;  
Team effectiveness. | 7 – No |
<table>
<thead>
<tr>
<th></th>
<th>Team learning mediates the relationship between shared leadership and team effectiveness:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8a). Team learning mediates the relationship between leadership perception and team effectiveness;</td>
</tr>
<tr>
<td></td>
<td>8b). Team learning mediates the relationship between leadership reliance and team effectiveness;</td>
</tr>
<tr>
<td></td>
<td>8c). Team learning mediates the relationship between leadership influence and team effectiveness.</td>
</tr>
<tr>
<td></td>
<td>Bootstrap technique</td>
</tr>
<tr>
<td></td>
<td>T1 Leadership perception; T1 Leadership reliance; T1 Leadership influence; T2 Team learning; Team effectiveness.</td>
</tr>
<tr>
<td></td>
<td>8a – No</td>
</tr>
<tr>
<td></td>
<td>8b – No</td>
</tr>
<tr>
<td></td>
<td>8c – Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Team knowledge structure similarity mediates the relationship between shared leadership and team effectiveness:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9a). Team knowledge structure similarity mediates the relationship between leadership perception and team effectiveness;</td>
</tr>
<tr>
<td></td>
<td>9b). Team knowledge structure similarity mediates the relationship between leadership reliance and team effectiveness;</td>
</tr>
<tr>
<td></td>
<td>9c). Team knowledge structure similarity mediates the relationship between leadership influence and team effectiveness.</td>
</tr>
<tr>
<td></td>
<td>Bootstrap technique</td>
</tr>
<tr>
<td></td>
<td>T1 Leadership perception; T1 Leadership reliance; T1 Leadership influence; T2 Team knowledge structure; Team effectiveness.</td>
</tr>
<tr>
<td></td>
<td>9a – No</td>
</tr>
<tr>
<td></td>
<td>9b – No</td>
</tr>
<tr>
<td></td>
<td>9c – No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Team size moderates the relationship between shared leadership and team learning, such that this relationship is stronger in larger teams:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10a). Team size moderates the relationship between leadership perception and team learning;</td>
</tr>
<tr>
<td></td>
<td>10b). Team size moderates the relationship between leadership reliance and team learning;</td>
</tr>
<tr>
<td></td>
<td>10c). Team size moderates the relationship between leadership influence and team learning.</td>
</tr>
<tr>
<td></td>
<td>Bootstrap technique</td>
</tr>
<tr>
<td></td>
<td>Team size; T1 Leadership perception; T1 Leadership reliance; T1 Leadership influence; T2 Team learning.</td>
</tr>
<tr>
<td></td>
<td>10a – No</td>
</tr>
<tr>
<td></td>
<td>10b – No</td>
</tr>
<tr>
<td></td>
<td>10c – No</td>
</tr>
</tbody>
</table>
|   | Team heterogeneity moderates the relationship between shared leadership and team learning, such that this relationship is stronger in more diverse teams:  
11a). Team heterogeneity moderates the relationship between leadership perception and team learning;  
11b). Team heterogeneity moderates the relationship between leadership reliance and team learning;  
11c). Team heterogeneity moderates the relationship between leadership influence and team learning. | Bootstrap technique | Team heterogeneity; T1 Leadership perception; T1 Leadership reliance; T1 Leadership influence; T2 Team learning. | 11a – No  11b – No  11c – No |
|---|---|---|---|
| 12 | Team size moderates the relationship between shared leadership and team knowledge structure similarity, such that this relationship is stronger in larger teams:  
12a). Team size moderates the relationship between leadership perception and team knowledge structure similarity;  
12b). Team size moderates the relationship between leadership reliance and team knowledge structure similarity;  
12c). Team size moderates the relationship between leadership influence and team knowledge structure similarity. | Bootstrap technique | Team size; T1 Leadership perception; T1 Leadership reliance; T1 Leadership influence; T2 Team Knowledge Structure. | 12a – No  12b – No  12c – No |
| 13 | Team heterogeneity moderates the relationship between shared leadership and team knowledge structure congruence, such that this relationship is stronger in more diverse teams:  
13a). Team heterogeneity moderates the relationship between leadership perception and team knowledge structure congruence;  
13b). Team heterogeneity moderates the relationship between leadership reliance and team knowledge structure congruence;  
13c). Team heterogeneity moderates the relationship between leadership influence and team knowledge structure congruence. | Bootstrap technique | Team heterogeneity; T1 Leadership perception; T1 Leadership reliance; T1 Leadership influence; T2 Team knowledge structure. | 13a – No 13b – No 13c – No |
Table 6. Results on Regressing Individual Team Knowledge Structure Scales on Shared Leadership

<table>
<thead>
<tr>
<th>Variable</th>
<th>F</th>
<th>p-value</th>
<th>$R^2$</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>DV: Leadership Perception</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process-related TKS</td>
<td>1.12</td>
<td>.32</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Team-related TKS</td>
<td>6.06</td>
<td>.039*</td>
<td>.432</td>
<td>10</td>
</tr>
<tr>
<td>Task-related TKS</td>
<td>.31</td>
<td>.59</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Goal-related TKS</td>
<td>.55</td>
<td>.48</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>DV: Leadership Reliance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process-related TKS</td>
<td>1.16</td>
<td>.31</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Team-related TKS</td>
<td>12.63</td>
<td>.007**</td>
<td>.612</td>
<td>10</td>
</tr>
<tr>
<td>Task-related TKS</td>
<td>.39</td>
<td>.55</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Goal-related TKS</td>
<td>1.13</td>
<td>.32</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>DV: Leadership Influence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process-related TKS</td>
<td>.09</td>
<td>.77</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Team-related TKS</td>
<td>10.07</td>
<td>.013**</td>
<td>.557</td>
<td>10</td>
</tr>
<tr>
<td>Task-related TKS</td>
<td>.00</td>
<td>.97</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Goal-related TKS</td>
<td>.44</td>
<td>.53</td>
<td>-</td>
<td>10</td>
</tr>
</tbody>
</table>

Note. *=significant at $p>.05$ (2-tailed), **=significant at $p>.01$ (2-tailed). TKS = Team Knowledge Structure. All team knowledge structures measured by the standard deviation of team responses to indicate the level of similarity in team knowledge structure within each team.
Discussion

This study examined parallel mediators of team knowledge structures and team learning as well as team characteristics as moderators in a longitudinal team study with the goal of uncovering how and why shared leadership enhances team effectiveness. Despite the biggest limitation of a small sample size and hence low statistical power in statistical analysis, the results still showed support for several of the proposed hypotheses. The most exciting finding is that shared leadership enhances team learning, and in addition, predicts the advancement in team learning over time. This finding not only provides another valid case to strengthen the argument that shared leadership is beneficial to team processes, but also proposes a new and potentially very effective way in building a learning organization.

To survive and thrive in the highly competitive global economy, organizations need to foster a culture that supports and stimulates continuous learning and improvement, and this is often achieved through creating collaborative learning in teams (Senge, 2006; Watkins & Marsick, 1993). Results from this study demonstrated that a high level of shared leadership, manifested by high densities of leadership perception, reliance, and leadership influence among team members,
accelerated the rate of learning in subsequent time period. That is, when members actively share leadership responsibilities and reply on each other for direction and influence, they will engage in a significantly higher amount of learning behaviors over a period of time compared to teams with lower levels of shared leadership.

Team learning was found to be the mediator in the link between leadership influence and team effectiveness. Shared leadership was measured by social network analysis on factors of leadership perception, leadership reliance, and leadership influence. Although no significant relationship was found between leadership perception/leadership reliance and team effectiveness, this could be largely due to the low statistical power resulting from a small sample size. The three measured areas of shared leadership are theoretically closely interrelated, and statistically correlated in the study ($r>.40$, Table 3). Therefore, the results still support team learning as a main mediating team process through which shared leadership enhances team performance.

Although the results did not support any significant relationships between shared leadership and team’s emergent state of team knowledge structure, analyzing this relationship with individual measures of the team knowledge structure construct revealed a significant link between shared leadership and similarity in team-related team mental models. The results should be interpreted with caution as they are conservative due to the small sample size, and some
relationships may actually be stronger in a larger sample. One possible explanation for this finding is that the project teams are short-lived and task-focused, therefore, an understanding of members’ specialized skills and expertise and effectively leveraging on each members’ strength is critical for the successful completion of the project. As a result, the communication and member interaction stemming from sharing leadership activities will likely focus on discussions of skills, expertise, and resources, thereby enhancing the similarity of the team’s transactive memory system.

Another key finding is the moderating role of team gender composition on the relationship between leadership reliance and team learning. Same-gender teams engaged in the same amount of team learning regardless of the density of shared leadership; whereas a stronger relationship between leadership reliance and team learning was found in teams composed of both males and females. In particular, when there is low levels of shared leadership, members from mixed-gender teams engaged in less learning than members from same-gender teams; but when there is high levels of shared leadership, mixed-gender teams outperformed the homogenous teams in team learning. This finding is in line with theories and the previous research (Huang, 2013). Studies have found variations in leadership style. For instance, female leaders tend to adopt a more participatory style and are less autocratic (Eagly & Johnson, 1990). Therefore, members from mixed gender teams
will be experiencing more individual differences and will need to function in a more diverse team environment. The results demonstrated that a shared leadership structure is key to overcome the added burden of highly diverse teams. The sharing of influence and leadership responsibilities enabled a team environment more conductive to the open communication and feedback seeking behaviors necessary for team learning. This finding indicated that diversity itself is not necessarily bad for team performance, and it only becomes a disadvantage when it is poorly managed. Under effective leadership, heterogeneous teams is able to outperform homogenous teams.

Unfortunately, a majority of the hypotheses related to the main effects of team knowledge structures and the moderating variables were not supported. However, it would be premature to conclude that there is very little role for team knowledge structures in understanding shared leadership, or that team size and heterogeneity do not matter. The missing team knowledge measure data resulted in a lack of statistical power that likely contributed to failure in supporting these hypotheses. In addition, the measures used for team knowledge structures may not be the optimal. The team knowledge structure framework was proposed in recent years (Wildman et al., 2012) despite the long-recognized need in the field to integrate various constructs of team cognition that are similar in definition and conceptually interrelated (e.g., team mental model, transactive memory system).
Currently, there is no validated measurement to-date that taps on the multifaceted nature of the team knowledge structure framework. Therefore, this study selected psychometrically sound measurements in each of the four areas identified in the team knowledge structure framework as an alternative approach. Even though these measures showed sound reliability and validity in individual research studies and are good measurements of the respective field of team knowledge structure, they are independently developed measures, and the poor fit indices from the CFA analysis demonstrated their lack of ability in adequately representing the team knowledge structure framework. As further discussed in the limitations section, developing a sound measurement for a multidimensional team knowledge structure would be imperative in advancing further research and understanding of team knowledge structures.

A highlight of this study is the longitudinal study design. Due to measurement difficulties in conducting longitudinal research, although the effect of temporal intervals in teamwork has been widely discussed, not many studies have examined time as a variable in team processes or emergent states (He et al., 2007; Levesque, Wilson and Wholey, 2001). For instance, He and colleagues (2007) studied team cognition in software project teams and found that although familiarity and background similarity among team members led to higher mental model similarity in the initial stage, this effect faded over time. At the end of the
five-week project, all teams developed similar levels of team cognition, providing evidence that team cognition evolves over time through member interaction. Built on these premises, the current study takes a deeper dive into the dynamic nature of teamwork and analyzes not only how shared leadership affects team processes and emergent states, but also the rate of change in those variables. This approach enables a more holistic understanding of the mediators at play in the relationship between shared leadership and team effectiveness, and also provides a more precise understanding on how shared leadership affects team functioning over time. Although few significant relationships came out of the analyses, this study would serve as an example in guiding future research design and providing thoughts to future studies.

**Limitations**

Although the current study is able to provide a couple of new findings and insights, the limitations should also be carefully addressed. The biggest limitation is the sample size. Small sample size is a common issue in team studies, especially in longitudinal studies. With a sample size of 30 teams and even fewer usable team data for team knowledge structure, it is challenging to adequately examine the hypotheses, and a larger sample size with more statistical power would likely reveal more significant findings. Luckily, the current study is part of an on-going
research effort to understand team dynamics, and will continue in data collection efforts. Therefore, we are fortunate to have the opportunity to reexamine the proposed hypotheses with a potentially larger sample size in the future.

Using student population is often critiqued in research since characteristics of students do not equally represent that of a working population, and that poses questions on the generalizability of the results (Sears, 1986). However, studies comparing student sample versus working sample have found the concern to be minimal and external validity is affected only in a handful of settings (Druckman & Kam, 2009). Since this study explores the effect of sharing leadership behaviors on team functioning, and the identity of the participant will not impact their behaviors and cognitive structures in a team setting, it is acceptable to use student samples. In future research, it is encouraged to replicate the study on working populations, and ideally to groups at various levels in the organization working on tasks that vary in complexity, to truly rule out the effect from the sampling population.

Another limitation is the measurement of team knowledge structures. As discussed in previous sections, using four individual measures of different aspects of the team knowledge framework may not be the optimal way to measure this construct. Results from this study highlights an urgent need in developing measurements to assess the team knowledge structure construct, and we call for efforts in scale development in this area. Besides, this study only measured the
sharedness aspect of team knowledge structures and future studies should also look at the accuracy aspect with objective measures. Although a high level of similarity in team knowledge may imply accuracy, there are instances when this assumption does not hold. Therefore, it is beneficial to use objective measures of the team knowledge structures to identify both the similarity and accuracy of the mental representations. In addition, the current study measures team effectiveness with self-reported measures, and it would be beneficial to measure team effectiveness with an objective measure as well. The researcher has contacted professors teaching the various classes for their final grades, and could potentially reexamine the data with the objective team performance in the future.

Originally, it was planned to measure shared leadership by two social network statistics, density and centrality. Centrality can be measured by the number of ties each member has within the network. It shows how leadership is distributed within the team. Low network centrality could imply a high degree of shared leadership since everyone is exerting influence on everyone else, but could also imply an absence of shared leadership since no one exerts influence on anyone else. Therefore, it is helpful to use a combination of density and centralization measures when conducting social network analysis to better understand the way shared leadership is structured in the team. However, the way shared leadership ratings was collected made it difficult to calculate centrality scores. To ensure information
accuracy of the member composition of each team, information on the members was pre-entered. The shared leadership scale was displayed via a dynamic algorithm, such that the individual answering the survey would always see his/her name last, and would rate the self as the last item. Therefore, in a three-person team, since member information was pre-entered, the sequence of name in the backend of the survey platform will always be person A, person B, person C for the shared leadership rating scales. When person A enters the survey, A would first rate B, then rate C, and lastly self (A). When person B enters the survey, B would first rate A, then rate C, and lastly self (C). As a result, in the data output, people in the same team will be rating different people on the items measuring shared leadership. This is not an issue for calculating density but is a major issue for calculating centrality as centrality requires identification of leadership links per individual. However, the main reason for analyzing both centrality and density is that a low centrality score could either be due to fully shared leadership or zero shared leadership, and density provides additional information in which direction centrality should be interpreted in. Density alone, is still able to provide a good indication of level of shared leadership, and adding in centrality measure is not expected to affect the results in any major way.

Hypotheses 2 and 4, which measure the effect of shared leadership on the rate of change in team learning and team knowledge structure, used the difference
score between time 1 and time 2 variables as the dependent measure. This is a commonly used and acceptable method of analyzing change. However, there is a better method in measuring change that uses a slope variable calculated between the two measurement times (Chen, Ployhart, Thomas, Anderson, & Bliese, 2011; Zhu, Wanberg, Harrison, & Diehn, 2015). The slope value would be generated from the Empirical Bayes estimate from the random coefficient models of 1) team learning and 2) team knowledge structure over time. Larger Empirical Bayes values indicate greater increase, while smaller values indicate greater decrease over time. Unfortunately, this study is unable to use the slope measure for change, as this method has a higher requirement on sample size, and the current sample size does not meet the prerequisite. As more data are collected in the future, it would be beneficial to re-analyze the two hypotheses regarding speed of change by the slope method.

Lastly, the two mediating variables, team learning and team knowledge, most likely have mutually causal relationships with each other, as also depicted by the high correlation between the two (Table 4). Future research should further explore the interconnectedness between the two to fully understand the more complex mutual emergence of these variables over time.
Future Implications

This study brings added value to the research field regarding the relationship between shared leadership and team learning, and leads us one step further in the understanding of the complex interplay between leadership and team dynamics. Examining a team process (i.e., team learning) and an emergent state (i.e., team knowledge structures) as parallel mediators, this study provides a good framework to study the connection between shared leadership and team outcomes. Teams are complex systems and nothing related to team functioning is clean-cut – everything relates to each other and everything is the product of the combined action of various factors. Therefore, it makes the most sense to examine multiple related variables in one model for a more realistic understanding of how teams work. Following the IMOI model, this study provides some answers to the black box of shared leadership by focusing on team learning, furthering the understanding of how shared leadership leads to improved team processes as well as outcomes through the mediated link of team processes. Although shared leadership directly influences team learning, only leadership reliance was found to enhance team-related team knowledge structure. The results indicated that the interaction and communication resulted from sharing leadership activities only contributed to the overlap in knowledge of the team and team members, but not
knowledge of the team’s tasks, goals, and processes. Future research is needed to examine whether shared leadership enhances other aspects of team knowledge, and whether through the same mechanisms. Lastly, this is the very first study that incorporates the dynamic nature of team functioning into the hypotheses and examines how shared leadership influences the rate of change in team learning processes and similarity of knowledge structures. Such knowledge will trigger new thoughts and directions in future research.

Results of this study also provide practical insights. Understanding what makes shared leadership effective allows organizations to identify and target the appropriate team processes and emergent states in situations when shared leadership is not quite working, and to develop interventions to bring out the maximum benefits of utilizing shared leadership structures in organizations. Findings of this study also provide alternatives to organizations wanting to reap the benefits of shared leadership structures but are unable or unwilling to change the way work teams are structured. Instead, organizations could focus on enhancing team emergent states or processes such as team learning that link shared leadership to effective team performance.

The finding that initial levels of shared leadership significantly improve team learning in subsequent stages can have huge implications to businesses aiming to develop a learning organization. To foster a learning environment, organizations
should consider utilizing or shifting to a shared leadership team structure. If it is difficult or not practical to change the way teams or leadership is structured, alternatively, organizations could provide employees more autonomy, decision-making power, and voice to mimic the shared leadership team environment. It is also beneficial to consider the effect of team member composition and team characteristics on shared leadership when putting together a new team or conduct trainings to improve functioning of existing teams. For instance, in highly diverse teams, members will have higher needs for communication and interaction to carry out shared leadership. Therefore, it is recommended to have a sound team process and supporting facilities and technology to facilitate members in leading and following activities. Lastly, knowledge of shared leadership in general would enable organizations to make better decisions when deciding which leadership structure to implement in the work teams.
Conclusion

This research examines the relationship between shared leadership and team effectiveness by looking at the potential mediators and moderators at play. Team learning was found to be a significant mediating mechanism in this relationship. In addition, the study found that shared leadership not only positively influences team learning, but also positively enhances how quickly team learning emerges over a team’s lifespan. In addition to the research findings, this study also provides value to the field of research by utilizing innovative methods less used in I/O psychology (i.e., social network analysis) and studying emergent team processes in a longitudinal study. Research findings also provide practical value in helping organizations becoming more adaptive and competitive in the global marketplace through considering interventions in developing enhanced leadership structures in teams and a learning organization.
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Appendix A

Measures

Process-related Team Knowledge Structure: Individual Expectations for Teamwork Measure

Please rate the following statements on a scale from 1-strongly disagree to 5-strongly agree.

For my team to be optimally effective….

1. Team develops task strategy
2. Team outlines specific goals
3. Team has a specific approach to task
4. Team sets specific performance goals
5. Team spells out specific course of action
6. Members monitor others’ performance
7. Members are aware of what other members are doing
8. Members give emotional support to other members
9. Members feel sense of identity
10. Members believe in their ability to do the job
11. Members have shared commitment to reaching goals
12. All members have an equal chance to participate in discussions
13. Team does not make decision until everyone gives input
14. Member discuss possible solutions
15. Consequences of actions are carefully considered
16. Team focuses on factual information when problem solving

**Team-related Team Knowledge Structure: Transactive Memory System**

Please rate the following statements on a scale from 1-strongly disagree to 5-
strongly agree.

**Specialization**

1. Each team member has specialized knowledge of some aspect of our project.
2. I have knowledge about an aspect of the project that no other team member has.
3. Different team members are responsible for expertise in different areas.
4. The specialized knowledge of several different team members was needed to complete the project deliverables.
5. I know which team members have expertise in specific areas.

**Credibility**

1. I was comfortable accepting procedural suggestions from other team members.
2. I trusted that other members’ knowledge about the project was credible.
3. I was confident relying on the information that other team members brought to the discussion.
4. When other members gave information, I wanted to double-check it for myself.

(reversed)

5. I did not have much faith in other members’ “expertise.” (reversed)

Coordination

1. Our team worked together in a well-coordinated fashion.

2. Our team had very few misunderstandings about what to do.

3. Our team needed to backtrack and start over a lot. (reversed)

4. We accomplished the task smoothly and efficiently.

5. There was much confusion about how we would accomplish the task. (reversed)

Task-related Team Knowledge Structure, adapted from He, Butter & King’s (2007) Shared Task Understanding Instrument

1. Team members have a common understanding of the requirements of the project.

2. Team members have a common understanding of the knowledge and technologies used to carry out the tasks.

3. Team members have a common understanding of the project development procedures.

4. Overall, team members agree on the strategies used to complete the task.
Goal-related Mental Model

1. Our team tries to keep us informed about the team.
2. Our team encourages everyone to feel we are one unit dedicated to a common purpose.
3. Our team makes us feel responsible for goals.
4. Open-ended question: In a few sentences, please briefly describe the main goals your team is aiming to achieve on this project.

Team Learning

1. We regularly take the time to figure out ways to improve our team's work processes.
2. Our team frequently seeks information and feedback that leads us to make important changes and improvements.
3. Our team actively reviews its own performance as regard to any deficits.
4. Our team makes sure that we reflect on the team's work processes.

Shared Leadership

1. Who has led your team over the course of the project since the last survey?
2. Please indicate your agreement with the following statements on whose leadership you rely on during this project:

I have relied on (name)’s leadership on his project since the last survey.

3. Please indicate your agreement with the following statements on who has influenced the direction and actions of your team since the last survey:

(Name) has influenced our team since the last survey.

Subjective Team Performance

1. This team meets its deadlines.

2. This team wastes time.

3. The team provides deliverables (e.g., products or services) on time.

4. This team is slow.

5. This team adheres to its schedule.

6. This team finishes its work in a reasonable amount of time.

7. This team has a low error rate.
8. This team does high quality work.

9. This team consistently provides high-quality output.

10. This team is consistently error-free.

11. This team needs to improve its quality of work

12. This team will get a great grade on our final project.