Trasactive Memory Systems Virtual Team Training Model

Katharine Hixson  
*Graduate School of Computer and Information Sciences, Nova Southeastern University, Fort Lauderdale, FL, United States,*  
kh833@nova.edu

Souren Paul  
*Graduate School of Computer and Information Science, Nova Southeastern University, Fort Lauderdale, FL, United States,*  
spaul@nova.edu

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ABSTRACT
The use of teams, especially virtual teams, is growing significantly in corporations, branches of the government and nonprofit organizations. However, despite this prevalence, little is understood in terms of how to best train these teams for optimal performance. Team training is commonly cited as a factor for increasing team performance, yet, team training is often applied in a haphazard and brash manner, if it is even applied at all. Therefore, this paper attempts to identify the flow of a training model for virtual teams. Rooted in transactive memory systems, this theoretical model combines the science of encoding, storing and retrieving information with the science of team training.

Keywords
Transactive memory systems, virtual teams, team training, virtual team performance

INTRODUCTION
Virtual teams, in which members use technology to interact across boundaries imposed by location and time, are increasingly utilized in a wide variety of organizations (Martins, Gilson & Maynard, 2004); ranging from the government sector to private industry, virtual teams can be found accomplishing tasks from the simple to the complex. While the use of a team may vary across sectors, the definition remains fairly consistent: a team has clearly defined goals and performance objectives for which members are both individually and collectively accountable (Salas, Cooke & Rosen, 2008).

While the concept of a team is not novel, the concentrated analysis of what makes a team perform and the application of these principles for training teams is a relatively new industry. Furthermore, the advent of virtual teams also led to many questions surrounding team training and performance (Martins et al., 2004). However, despite the newness of the field, there are several significant discoveries in the arena of team performance. First, team training is beneficial for developing teamwork and improving team performance. Additionally, factors that effect team performance have been classified (Salas et al., 2008). Yet, research must determine the best methods for designing and delivering teamwork training (Schmidt, Keeton, Slack, Shea & Leveton, 2009). Furthermore, these applications are not specific to virtual teams.

Given these opportunities, the purpose of this paper is to develop a theoretical model of team training systems for virtual teams. This theory fills a current gap in the literature by first separately defining teams, team training types, transactive memory and effects on team performance. Through this analysis of existing literature, a model for increasing virtual team performance emerges based upon a combination of team training and transactive memory systems, which describe how members actively use transactive memory to cooperatively encode, store, and retrieve information (Prichard & Ashleigh, 2007). This model relates to affective social processes in virtual teams, as these disruptions can be mitigated via the application of this training model.

LITERATURE REVIEW
Team and Virtual Team
A team exists in an organization to perform complex, difficult and dynamic tasks. These tasks require expertise and the perspectives of multiple individuals synchronizing their work to perform collectively in the pursuit of defined goals (Salas,
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This differs from a work group, which is more loosely connected and has less defined tasks and goals (Salas et al., 2008).

However, simply forming a team does not guarantee that this team will perform well. Instead, there are several competencies and skills that must be present in order to maximize a team’s performance. Lerner, Magrane and Friedman (2009) define these competencies for teams as: knowledge-based, skills-based and attitude-based (KSAs). Knowledge-based competencies refer to the facts, concepts and relations that a team member must understand in order to perform a task. Skills-based competencies focus on behavioral sequences and procedures needed for task performance, while attitude-based competencies refer to feelings from the team members about the task and one another (Delise, Gorman, Brooks, Rentsch, & Steele-Johnson, 2010; Noe, Dachner & Saxton, 2010).

The specific skills needed to optimize team performance include: role clarification, goal setting, identifying work priorities, group problem solving, team coordination, interpersonal relations, consensus building and conflict management (Schmidt, Keeton, Slack, Shea & Leveton, 2009). Knowledge-based competencies, however, are more difficult to define, as they vary from organization to organization and task to task.

These skills and competencies combine to form the overall team performance, which is an emergent phenomenon resulting from a goal-directed process in which team members display task-work and teamwork processes (Salas, Stagl, Burke & Goodwin, 2007, as cited in Salas et al., 2008). The core components of teamwork are frequently associated with the Dickinson and McIntyre model (1997, as cited in Cortez, Nussbaum, Woywood & Aravena, 2009): team orientation, team leadership, monitoring, feedback, back-up behavior, coordination and communication.

These skills and competencies of teams are fairly consistent across organizations; however, the type of team varies widely according to functionality, purpose and duration. The Federal Aviation Administration provides several distinguishing factors: a functional team refers to team members who are from the same work unit. Cross-functional teams, on the other hand, are comprised of members from different and varied work areas. Problem-solving teams are dedicated to the purpose of focusing on specific issues. Developmental teams, conversely, concentrate on developing new products or systems. A time-limited team is created for a specific purpose and is dissolved when the task is complete, while a permanent team is a stable and enduring part of the organization. Furthermore, a team may be considered virtual if the members are geographically dispersed. While the functions of a virtual team may be equivalent to those of a face-to-face team, the distance between members poses unique challenges (Martins, Gilson & Maynard, 2004).

Therefore, the definition and scope of teams is well identified and supported in the literature. However, despite this clarity, there is still uncertainty regarding how to build high-performing teams, especially in the context of virtual teams, who may be geographically and/or organizationally dispersed. Thus, several scholars have addressed team training as a method of improving team performance, but there is still a large gap in the literature regarding applications to virtual teams. This gap is significant, for virtual teams are unique from traditional teams (Salas et al., 2008). Their methods of communication, processes of collaboration, team dynamics and affective states are distinctive and therefore, require special consideration.

TEAM TRAINING

Team training is a planned effort administered in a team environment to improve teamwork KSAs and team performance (Salas et al.; 2008; Noe et al., 2010). This differs from team building, in that a team building intervention is not systematic in nature and is usually conducted in an environment that does not simulate the actual performance setting. Additionally, where team training is focused on providing expert teams with the skills to engage in effective teamwork processes, team building is more concerned with role clarification and interpersonal relations between team members (Weaver, Wildman & Salas, 2009).

Essentially, team training teaches individuals to be experts at being team members (Weaver et al., 2009). Several researchers have determined that team training does positively influence team performance. For example, Salas et al. (2008) performed several meta-analytic integrations, ultimately identifying 168 relevant papers for inclusion. These papers were then coded according to 20 pieces of information. The coding was done in stages, with two checks performed to assess interrater reliability. The final database for the research consisted of a total of 93 correlations obtained from 45 primary studies. Salas et al. (2008) ultimately determined that team-training interventions enhance team outcomes. These interventions can positively affect cognitive, affective and performance outcomes, as well as overall teamwork processes.
Furthermore, following a meta-analysis of 21 studies, Delise et al. (2008) found that team training is positively related to overall team effectiveness. Additionally, team training has a positive effect on the following individual aspects of team effectiveness: affective outcomes, cognitive outcomes, subjective task-based skill outcomes, objective task-based skill outcomes, and teamwork skill outcomes. These findings support those of Salas et al. (2008).

In summary, team training is an essential component of achieving optimal performance (Schmidt et al., 2009). Training designed to develop expert teams must foster both the behavioral and cognitive aspects of teamwork (Weaver et al., 2009). However, the training must be grounded in the science of training and meticulously designed; well-designed team training increases the quality of team processes and overall performance outcomes (Salas et al., 2008).

Yet, despite the evidence on the positive effects of team training, it is not being utilized in organizations. This is especially true in regards to virtual teams: Rosen, Furst and Blackburn (2006) surveyed a random sample of Society for Human Resource Management (SHRM) members and found that over 60% of respondents \( n = 440 \) reported that their organization provided no specific training for either virtual team members or virtual team leaders. An additional 28% indicated that training for virtual teams was only provided to a “limited extent,” and only 2% of respondents reported that training was provided to a “great extent.” Therefore, a gap exists between theory and practice; while team training is proved to be beneficial to increasing team performance, it is not being utilized.

**TEAM TRAINING TYPES**

The first step in devising a team training strategy is to determine which type to utilize. Salas et al. (2008) analyzed the two most popular strategies as identified in their database: coordination training and cross-training. Cross-training is defined by Noe et al. (2010) as a type of team training in which team members rotate positions to develop an understanding of the basic knowledge necessary to successfully perform the tasks and duties of other team members. Team coordination training refers to training in which team members are asked to alter their coordination strategy and reduce the amount of communication necessary for successful task performance (Noe et al., 2010).

Thirty-three effect sizes were meta-analyzed by Salas et al. (2008) in order to assess the impact that coordination training had on team outcomes; the results indicated that this type of training had a moderate positive effect on outcomes. Cross-training was represented in their database by 14 effect sizes and 432 teams. These results suggest that cross-training does have a moderate positive effect on outcomes. However, Salas et al. (2008) urge caution in interpreting these results, and state that more research on specific types of training strategies is needed.

Gorman, Cooke and Amazeen (2010) compared three types of team training: cross-training, procedural and perturbation. Cross-training is the aforementioned system of rotating team members (Noe et al., 2010). Procedural training is a form of process training in which operators of complex systems are given positive reinforcement to adhere to a specific procedure each time a particular stimulus is encountered. Perturbation training disrupts standard coordination procedures multiple times during task acquisition, forcing teams to coordinate in novel ways to achieve their objective (Gorman et al., 2010).

The experiment was conducted in a synthetic task environment of an uninhabited air vehicle (UAV) simulator. Three team members had to coordinate to take photographs of stationary ground targets. A total of 26 teams (78 participants) completed the experimental sessions. The teams were randomly assigned upon the first session and received different training based upon which condition they were assigned: cross-training, procedural or perturbation.

The perturbation training teams significantly outperformed teams in the other two groups in two out of three of the test missions. Therefore, this type of training leads to high performance under novel conditions. Cross-training also resulted in high functioning: these teams obtained in the highest performance in one of the mission tests. Procedural training resulted in the least adaptive teams. This type of training leads to teams that are rigid and slow to adapt to new changes in dynamic task environments (Gorman, et al., 2010). However, it was recommended that future research examine mechanisms of flexible team interaction and how teams use them to adapt to the pressures of dynamic and high-stakes environments.

In the context of virtual teams, Beranek and Claiborne (2012) examined the effects of relational link training on group interactions by administering training to selected teams and tracking measurements of cohesion, group processes and satisfaction with the outcomes. The relational link training consisted of three parts: teamwork training, drawbacks to electronic communication and netiquette rules. Participants were 68 undergraduate students in several sections of a computer architecture course, working in 23 virtual teams. Teams who received the training had higher levels of cohesion, perceptions...
of the process and satisfaction with the outcomes. While this study supports the value of teamwork training on virtual team performance, it fails to describe the type of training utilized, as well as the methods for this training.

In summary, supporting and increasing team performance can be facilitated through team training (Salas et al., 2008; Noe et al., 2010). This training focuses on improving teamwork KSAs (Weaver et al., 2009). There is little doubt that this training does increase teamwork and team performance, and therefore, is effective (Salas et al; 2008; Delise et al., 2008; Weaver et al., 2009). Out of the various types of training, cross-training and perturbation are seen as the most effective. Procedural training is seen as the least effective (Gorman et al., 2010; Salas et al., 2008). However, there is little evidence regarding which type of training is most appropriate for virtual teams.

**TRANSACTIONAL MEMORY SYSTEMS**

TMS refer to the encoding, storage, and retrieval of knowledge from different domains that develops within a team (Wegner, 1987). Although initially conceptualized as a theory to explain the implicit division of cognitive labor that develops in intimate couples, TMS theory and research has expanded to explain the cognitive processes in groups, the factors that affect those processes, and the group performance outcomes that result (Lewis & Herndon, 2011). There is a distinction between *transactive memory*, which is memory held at the individual level, and *transactive memory systems*, which describes how members actively use transactive memory to cooperatively encode, store, and retrieve information (Prichard & Ashleigh, 2007). Therefore, transactive memory systems (TMS) enable a team to distribute information amongst the members. Accordingly, by knowing that an individual possess expertise about an issue, TMS facilitates the access of that expertise.

Kanawattanachai and Yoo (2007) examined three behavioral dimensions of transactive memory systems- expertise location, task-knowledge coordination and cognition-based trust- and how these dimensions affect virtual team performance. TMS has been shown to have a larger impact on team performance than other variables such as: cohesion, motivation and social identity (Liang et al., 1995, as cited in Kanawattanachai et al., 2007). After analyzing data from 38 virtual teams of MBA students, it was determined that the frequency and volume of task-oriented communications among team members played a significant role in forming expertise located and cognition-based trust. However, once TMS were established, task-oriented communication became less important; instead, task-knowledge coordination emerged as the key factor for influencing team performance. Task-knowledge coordination refers to the awareness of knowledge specialization among team members.

In addition to Kanawattanachai et al. (2007), several other researchers have found that TMS can enhance team performance. Lewis (2004) studied 64 MBA consulting teams and found that TMSs were positively related to team viability and team performance. Austin (2003) examined the relationship between transactive memory systems and performance in mature, continuing groups. It was determined that a group's transactive memory system is positively related to group goal performance, external group evaluations, and internal group evaluations. Moreland and Myaskovsky (2002) investigated the possibility of whether performance benefits from being trained together were due to transactive memory or just improved communication. Results indicated that the performance was due to transactive memory: groups whose members were trained apart, with no chance to communicate with one another, performed well after receiving information about one another's skills.

**THE THEOREY OF TRANSACTIONAL MEMORY VIRTUAL TEAM TRAINING**

Due to the research supporting the benefits of team training, as well as the literature supporting the value of transactive memory, there is an opportunity to combine the two into a model for virtual team training. Thus, this paper proposes a model (see Figure 1) of increasing virtual team performance through team training, which is based upon the following:

1. Team training can positively influence transactive memory systems.
2. Team training can also positively influence cohesion, openness and trust amongst team members.
3. Both transactive memory and cohesion, openness and trust can influence collaboration amongst team members.
4. Collaboration amongst team members can influence team performance.
Kanawattanachai et al. (2007) demonstrated that TMS can be formed in virtual teams, but it takes a long time to develop. However, once it is developed, TMS is essential to performing tasks effectively in virtual teams. Furthermore, task-knowledge coordination is the key factor to increase team performance. Oshri, Fenema and Kotlarsky (2008) echoed these results in their findings that transactive memory supports effective knowledge transfer across globally dispersed teams.

However, this begs the question: how can a team quickly and effectively form TMS? According to Prichard and Ashleigh (2007), team training can lead to development of transactive memory and TMS. In their study, teams that had received team-skills training \((n = 8)\) in problem solving, interpersonal relationships, goal setting, and role allocation were more likely to develop a TMS than were nontrained teams \((n = 8)\). These results suggest that team-skills training facilitate TMS development.

Additional research suggests that team training can facilitate TMS development in teams. Smith-Jentsch, Kraiger, Bowers and Salas (2009) suggest that organizations employ team simulation experiences accompanied by structured pre- and post-performance briefings to accelerate the development of teammate knowledge consensus. Marks, Sabella, Burke, and Zaccaro (2002) examined the effects of cross-training on team-interaction mental models and their subsequent effects on coordination, back-up behavior and performance. Their results indicated that cross-training improved team-interaction mental models, and that the effects of team mental models on team performance were mediated by improved coordination and back-up behavior. Thus, we propose:

**P 1**: Team training positively influences transactive memory systems in virtual teams.

**Team Training and Cohesion, Openness, and Trust**

Prichard and Ashleigh (2007) used an experimental approach on ad hoc teams of three people who completed a team task in one of two conditions: either with or without prior team-skills training. The study found that team-skills training increased the level of trust in the ad hoc teams. Beranek (2005) examined trust specifically in the context of virtual teams. Analysis of the results revealed that training delivered at the beginning and half-way through the completion of a team task led to a significant increase of trust. According to Searle and Skinner (2011), team training allows team members to openly share knowledge, develop interpersonal relationships and develop mutual trust. As training progresses and the team sees their skills and performance improve, so impressions about other team members trust worthiness are consolidated and their ability to work together increases (Rosen et al., 2006). Thus, we propose:

**P 2**: Team training positively influences cohesion, openness and trust amongst the members of virtual teams.

**Transactive Memory System, Cohesion, Openness, and Trust and Team Collaboration**

Cohesion is an important aspect in a virtual team; it has been linked to better collaboration, which in turn, increases performance (Lurey & Raisinghani, 2001). Also, cohesiveness was found to positively impact team effectiveness for dispersed student teams working to generate case solutions (Gonzalez, Burke, Santuzzi & Bradley, 2003).
In a case study across two organizations in the same industry using the same type of computer-mediated communication, Zack and McKenney (1995) found that cooperation and communication openness improved team performance. After studying a six member virtual team, Holton (2001) found that openness in communication was essential to building collaboration.

Trust development can also lead to improved collaboration; it is even noted as being essential to team performance (Powel, Piccoli & Ives, 2004). While high and low performing virtual teams may start with the same levels of trust, the high performers appear to be better able to develop and maintain high levels of trust throughout their project (Kanawattanachai & Yoo, 2002). After studying 23 members of a virtual team, Henttonen and Blomqvist (2005) found that developing trust can lead to efficient and flexible collaboration. Thus, we propose:

P 3: Transactive memory System positively influences collaboration amongst the members of a virtual team.

P 4: Cohesion, openness and trust positively influences collaboration amongst the members of a virtual team.

Team Collaboration and Team Performance
Several studies have examined what contributes to the successful performance of a virtual team. These factors include communication (Suchan & Kayzak, 2001), coordination (Maznevski & Chudoba, 2001) and collaborative conflict behaviors (Montoya-Weiss et al., 1999); each of these areas can be generalized to describe collaboration. Paul, Seetharaman, Samarah and Mykytyn (2004) found that collaborative conflict management styles positively impacted satisfaction, perceived decision quality, and participation. According to Schrage (1990), the success of collaborative effort can be measured by its results. In other words, it is widely believed that teams that collaborate effectively are more innovative, productive, and satisfied than teams that do not collaborate. Thus, we propose:

P 5: Collaboration amongst the members of a virtual team positively influences team performance.

DISCUSSION
There are several recent advancements in the science of team training. Perhaps most significantly, team training has been proven to increase team performance and outcomes (Delise et al., 2008; Noe et al., 2010; Salas et al., 2008). Yet, despite the numerous advantages, team training is not being utilized effectively in organizations. This is especially true in the context of virtual teams. While the use of geographically dispersed teams is on the rise across all sectors, these groups are not being supported via training (Rosen, Furst & Blackburn, 2006). Therefore, a need exists for an effective model for virtual team training.

By basing a team training intervention in the science of transactive memory systems, a framework emerges for facilitating effective knowledge transfer across globally dispersed teams (Oshri et al., 2008; Prichard et al., 2008; Smith-Jenstch et al., 2008; Smith-Jentsch, 2008). In turn, this training can also lead to an increase in cohesion (Gonzalez et al., 2003; Lurey et al., 2001), openness (Holton, 2001) and trust (Henttonen, 2005; Powel, 2004). All of these factors facilitate collaboration, which leads to an increase in team performance (Montoya-Weiss et al., 1999; Paul, 2004; Schrage, 1999).

However, in order for this framework to be accepted, empirical research needs to be performed. The most important one is being able to come up with measures and reliable measurement instruments for each of the dimensions within this model. These measures, which can be found in the literature, could help in grounding the model with empirical data via an experiment.

In addition to testing and validating this model, there are several other opportunities for future research. Chieffy, specific instructional strategies for team training interventions need to be identified and evaluated. Additionally, due to recent advancements in educational and collaborative technologies, team training can now be delivered via innovative methods. However, these new tools for instructional delivery systems also need to be researched, designed and evaluated.

REFERENCES


